No.

Vietnam
Ministry of Industry and Vietnam Electricity

The Study on Technical and Safety Standards for Electric Power Industry in Vietnam

FINAL REPORT
(MAIN REPORT)

July 2007

JAPAN INTERNATIONAL COOPERATION AGENCY

CHUBU ELECTRIC POWER CO., INC.
ELECTRIC POWER DEVELOPMENT CO., LTD.

ED
JR
07-085

Preface

In response to a request from the Government of the Socialist Republic of Vietnam, the Government of Japan decided to conduct "The Study on Technical and Safety Standards for Electric Power Industry in Vietnam" and commissioned it to the Japan International Cooperation Agency (JICA).

JICA sent a study team led by Mr. Takahide Yamamoto of Chubu Electric Power Co., Inc. (CEPCO) and organized by CEPCO and Electric Power Development Co., Ltd. to the Socialist Republic of Vietnam five times between May 2006 and June 2007.

The study team had a series of discussions with the concerned officials from Ministry of Industry in Vietnam and Vietnam Electricity, and conducted necessary field surveys. After returning to Japan, the study team carried out further studies and compiled the final results in this report.

I hope that this report will contribute to the enactment of the Technical Standards and Safety Standards, the safe and stable supply of electric power, and the further promotion of amity between the two countries.

I would also like to express my sincere appreciation to the concerned officials for their cooperation and assistance throughout this study.

July 2007

Tadashi Izawa
Vice President
Japan International Cooperation Agency

July 2007

Mr. Tadashi Izawa
Vice President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

We are pleased to submit to you the final report of the Study on Technical and Safety Standards for the Electric Power Industry in Vietnam.

This study was conducted by the joint-venture study team that consists of Chubu Electric Power Co., Inc. and Electric Power Development Co., Ltd. under the contract with JICA during the period of May 2006 to July 2007.

This study assisted the Ministry of Industry in Vietnam in preparing the draft of the Technical Standards and Safety Standards. The recommendation for practices and organizational structures to manage, to operate and to disseminate the Technical Standards and Safety Standards appropriately after they are enacted is concluded in this final report.

The Vietnamese government gives a top priority to the stable and affordable supply of electricity, and has explored various restructuring strategies for the energy sector, such as the breakup and privatization of Vietnam Electricity, deregulation of the electricity market and the introduction of foreign investment to promote a response to the large-scale investment demand and an endeavor to improve the management efficiency. This study was aimed to assist with the formulation of the Technical Standards and Safety Standards required for the safe and stable supply of electric power after various electric power suppliers enter the power market, we assisted our Vietnamese counterparts in preparing the draft, while taking into account internationality, neutrality and fairness. We collected electric power suppliers' opinions widely on the workshops held twice during this study, and the procedure for enactment of them is in progress now. All of the study members strongly hope that Technical Standards and Safety Standards will contribute to the development of the electric power industry in Vietnam.

Finally, we would like to express our sincere gratitude to JICA, Ministry of Foreign Affairs and the Ministry of Economy, Trade and Industry for their understanding and cooperation with this study. We also express our deepest appreciation to the Ministry of Industry in Vietnam, Vietnam Electricity, the Embassy of Japan in Vietnam, the JICA Vietnam Office and other concerned officials for their cooperation and assistance through our study.

Takahide Yamamoto
Team Leader,
The Study on Technical and Safety Standards
for Electric Power Industry in Vietnam
Chubu Electric Power Co., Inc.

[Contents]

[List of Figures and Tables]

[Figures]

[Tables]

Acronyms / Abbreviations

ANSI	American National Standards Institute
BOO	Build, Own & Operate
BOT	Build, Operate & Transfer
C/P	Counterpart
DIST	State Department of Industrial Safety Techniques
DSM	Demand Side Management
DST	Department of Science and Technology
ERAV	Electric Regulatory Agency of Vietnam
ETC	Electrical Testing Center
EVN	Vietnam Electricity
FERC	Federal Energy Regulatory Committee
GDP	Gross Domestic Product
GIS	Gas Insulated Switchgear
IE	Institute of Energy
IEC	International Electrotechnical Commission
IPP	Independent Power Producer
ISO	International Organization for Standardization
JICA	Japan International Cooperation Agency
JIS	Japan Industrial Standards
MARD	Ministry of Agriculture and Rural Development
MOC	Ministry of Construction
MOI	Ministry of Industry
MOST	Ministry of Science and Technology
OMC	One Member Limited Liability Company
PC	Power Company
PECC	Power Engineering Consultant Company
PMB	Project Management Board
PTC	Power Transmission Company
STD	Science and Technology Department
S/W	Scope of Work
SWG	Sub Working Group
WG	Working Group
WTO	World Trade Organization
QCDP	Quy chuan Dia phuong
QCVN	Quy chuan Viet Nam

TCCS	Tieu chuan Co so
TCN	Tieu chuan Nganh
TCVN	Tieu chuan Viet Nam

Chapter 1 Introduction

1.1 Background of the Project

The consumption of electricity in Vietnam is expanding at the rate of 14% per year and it is estimated that the consumption in 2010 will be 2.7 times the level of 2000. Electricity consumption in 2020 is forecast to be 6.6 times the year 2000 level. To meet this rapid demand growth, electricity generation and distribution facilities, whose capacity can cover two million kW, should be developed annually. To prioritize the stable and affordable supply of electricity, the Vietnamese government has explored various restructuring policies for the energy sector, such as unbundling and privatization of Vietnam Electricity (hereinafter EVN), deregulation of the electricity market and the introduction of foreign investment. Among these policies, the deregulation of the electricity market is planned for 2009. The Electricity Law, which forms the basis of the restructuring plan, was introduced in December 2004.

The introduction of diversified electricity suppliers and unregulated development and maintenance of electricity facilities can result in an unreliable electricity supply. The improvement of the qualification system for the development and maintenance of electricity facilities is indispensable for a reliable electricity supply. In Vietnam, however, the technical standards, which were introduced by the former Soviet Union in 1984, do not suit well and are not properly utilized at the present, Vietnamese electricity supply system and facilities are developed and operated not necessarily efficiently or systematically. To cope with the problems mentioned above, the present technical standards should be revised to meet the current status of the Vietnamese electricity sector and new standards should be introduced in some other areas.

At this point, Japan International Cooperation Agency (hereinafter JICA) has conducted a feasibility study in August 2005 in Vietnam to assess the institutional status requirements, and the outline of the existing technical standards and legal framework. Then, JICA carried out a preliminary study in Vietnam in December 2005 to confirm the detailed methods and timetable of the main project. Based on these steps, JICA and related Vietnamese institutions signed an agreement regarding the Scope of Work (S/W). The main project is scheduled for the new Japanese fiscal year, commencing in April 2006.

1.2 The Aims of the Study

(a) To revise and partially renew, in accordance with the situation of the Vietnamese power sector, the current technical and safety standards for a stable electricity supply. This should include setting standards for maintenance of electricity equipment, power plant operation, periodic inspection and construction of electricity facilities.

(b) To transfer the engineering methods to Vietnamese counterparts (hereinafter C/Ps). The Vietnamese C/Ps should be fully trained to maintain the developed technical standards by themselves.

(c) To propose the institutional framework and policies, which enable the Vietnamese C/Ps to manage, apply and propagate the technical and safety standards appropriately.

By fulfilling these aims, the electricity industry in Vietnam can operate in a safe and stable manner, this will allow the electricity sector can be deregulated smoothly.

1.3 Study Area

All over Vietnam

1.4 Counterpart (Corresponding Institution in Vietnam)

Ministry of Industry (hereinafter MOI) and EVN

1.5 Study Team

The members of the Study Team and their roles are shown in Table 1-1.

Table 1-1 Members and their roles of the Study Team

Name	Roles
Takahide YAMAMOTO	Team Leader/ Electricity
Masayasu ISHIGURO	Institutional System/ Law System
Kazuaki ISHIKAWA	Transmission, Substation & Distribution 1 (Transmission)
Megumi ICHIKAWA	Transmission, Substation & Distribution 2 (Substation)
Tomohide KATO	Transmission, Substation & Distribution 3 (Distribution)
Keiji SHIRAKI	Distribution/ Safety
Shinji MURATA	Thermal/ Machinery
Masahiko EBARA	Hydro/ Civil Engineering
Kozo UTSUMI	Hydro/ Electricity
Akira HIRANO	Coordinator (1st to 3rd Field Survey)
Hiroshi IMAGAWA	Coordinator (4th & 5th Field Survey)

1.6 Structure of the final report

This report is composed as follows:

In "Chapter 1 Introduction" the outline of the study is summarized, followed by the executive summary in which the conclusions to aims of this study were summarized.

"Chapter 2 Framework of Vietnam's Electric Power Sector" overviews the current system and restructuring trend of the electric power industry to which the technical and safety standard are applied.

In "Chapter 3 Juridical and Institutional Structure Related to Technical and Safety Kijun" juridical meaning of these standards and relation to the Standards Law are described and in "Chapter 4 Structure of Vietnam's Technical and Safety Standards concerning Power Industry" the contents of the current standards are presented.

"Chapter 5 Review of Vol.1 through 4 of the Technical Standards" summarizes the review results of these volumes that were already in the process of authorization for enactment as MOI's ministerial ordinance. The details of the review will be found in the Appendix 1.

"Chapter 6 Policies for Revising Vol.5 through 7 of the Technical Standards and Safety Standards and Outcome" is the main part of this report as its name shows. The proposal basis of each article are summarized in "Appendix 2 Quotation of Reference Material for Technical Standards" The revised technical standards Vol.5 through 7 and safety standards are bound as the separate volumes of this final report.

Lastly recommendations for the institutional framework and policies that enable the Vietnamese C/Ps to manage, apply and propagate the technical and safety standards are presented in "Chapter 7 Current System and Recommendation on Inspection" and "Chapter 8 Current Status and Recommendation for the Organizational Structure to Revise the Technical and Safety Standards"

Executive Summary

The summary of conclusions in line with the aims of study is as follows:

(Aim a) To revise and partially renew, in accordance with the situation of the Vietnamese power sector, the current technical and safety standards for a stable electricity supply. This should include setting standards for maintenance of electricity equipment, power plant operation, periodic inspection and construction of electricity facilities.

(Conclusion) As for the technical standards, the proposed versions of Vol.1～4 which were in the process of authorization were reviewed, and Vol.5～7 were newly reviewed and revised. The latter are expected to be enacted as MOI's mistrial ordinance by the end of December 2007 after approval of relevant ministries.

As for the safety standards, revision with drastic structural change for simplifying was made. The safety standards are expected to be enacted as MOI's mistrial ordinance by the end of July 2007 after approval of relevant ministries.

(Aim b) To transfer the engineering methods to Vietnamese counterparts. The Vietnamese counterparts should be fully trained to maintain the developed technical standards by themselves.

(Conclusion) Technical transfer was adequately fulfilled through the activities of working group and sub working groups, holding a technical seminar and a safety seminar, counterpart training in Japan, and so on.

(Aim c) To propose the institutional framework and policies, which enable the Vietnamese counterparts to manage, apply and propagate the technical and safety standards appropriately.

(Conclusion) The following recommendations were made in accordance with the current situation of the electric power industry and regulatory authorities in Vietnam.

>As for network facilities and electric facilities in hydro and thermal power plants, enough safety level will be secured by autonomous inspection considering the performance of power sector in Vietnam so far and precedents in other countries.

> Considering that boiler inspection as pressure vessels has already been in practice by Department for Industrial Safety Technique of MOI, the urgent task shall be establishment of official inspection system for hydropower, especially dams and appurtenant facilities. It can be realistic and indispensable that resources of MOI be concentrated on it for the time being.

>There are following options in order to establish inspection system, considering current status of MOI.

-Establish a new organization for inspection inside or outside MOI

-Enhance the function of Department for Industrial Safety Techniques

-Utilization of Electricity Regulatory Authority of Vietnam

>As for the organizational structure to revise the technical and safety standards, establishing a skillful secretariat and securing neutrality through the discussion of a technical committee are required.

Chapter 2 Framework of Vietnam's Electric Power Sector

2.1 Structure of Vietnam's Electric Power Sector

Immediately after Vietnam was reunited in 1976, their power sector was comprised of several public companies under jurisdiction of the Energy Ministry: three regional power companies, an equipment research and design company, a facility construction company and an equipment manufacturing company. Many of the technical and safety standards that are now to be revised were established in this era and have never been reviewed.

At the sixth Vietnam's Communist Party Convention in 1986, Doi Moi policies that are based on introduction of market economy system and open door policies were adopted, kick-starting Vietnam's full-swing economic growth. Since then, Vietnam's annual GDP growth had been between 8 and 9% until mid 1990s', and though there was the setback of the Asian Currency Crisis in 1997, it has been growing again at nearly 7% since 2000.

EVN was established in 1995, and since then, has been in charge of power supply that is essential to the economic growth. At the same time in 1995, two public companies that are in charge of coal and oil supply respectively were established.

Until recently, EVN had been a monopoly in charge of construction, operation and maintenance of Vietnam's vertically integrated power sector, implementing national policies concerning power source and transmission facility development.

In 1994, a year before the establishment of EVN, 500kV transmission lines were constructed, interconnecting north, central and south regional power systems. These had been operated independently from one another, they now allow power supply from large hydropower plants in the north (Hoa Binh Hydropower Plant was developed in the period between 1989 and 94)to demands in the central and south, and conversely from the south to the north during dry seasons and droughts.

Vietnam's power sector currently has many problems including rapidly growing power demand that had been over 15% pa from 1995 to 2004, more than double the figure of GDP growth in the same period, unstable power supply from hydropower plants during dry seasons, and large transmission loss. The power demand is expected to grow at 16% annually from 2006 to 2010 and at 11% from 2011 to 2015. Drastic reformation of EVN and the power sector as a whole has been called for in order to allow investment in new power sources, transmission and distribution facilities by introducing private sector methods.

In terms of power source development, EVN alone cannot respond to the rapid power demand growth, thus independent power producers (hereinafter IPP) have been allowed to sell power to EVN.

As of the end of 2004, Vietnam's national power generation capacity was 11,340 MW, of which EVN owned 8,822 MW: 4,155 MW from hydropower; 1,245 MW from coal-fired; 198 MW from oil-fired; 2, 939

MW from combined-cycle (gas and oil, incl. gas turbine simple cycle); and 285 MW from diesel engines. On the other hand, IPPs owned 2,518 MW accounting for 22.2% of the national generating capacity, which was a rapid growth from around 7% in 2001. 35 power plants of IPPs are listed on the Master Plan toward 2010, when IPPs are expected to account for 30%.

Power generation in 2004 was 46,201 TWh, of which EVN generated 40,175 TWh: 17,635 TWh from hydropower; 7,015 TWh from coal-fired; 602 TWh from oil-fired; 14,881 TWh from combined-cycle (gas and oil, incl. gas turbine simple cycle); and 42 TWh from diesel engines. IPPs generated 6,026 TWh accounting for 13.0%.

Those IPPs currently in operation, construction or planning are of various forms including BOT by foreign capital, BOT or BOO by other domestic public companies, and BOT or BOO by joint ventures between EVN and domestic or foreign capital.

In terms of management of EVN, it has already been reforming its organization toward unbundling and privatization. As the first move, distribution companies (called Power Company, hereinafter PC), consulting companies (Power Engineering Consultant Company, hereinafter PECC) and equipment manufacturing companies (Power Equipment Manufacturing Company etc.) have become affiliate companies with separate accounts.

In terms of capital reformation, Equitization of State Owned Enterprises (SOE) has been in progress.

In 2003, the consulting companies and some others became joint-stock companies, in which Vietnam's government owns less than a half stake. In the following year, one of the distribution companies, one of the hydropower plants, and the equipment manufacturing company became joint-stock companies, and two of the distribution companies became a One Member Limited Liability Company (hereinafter OMC).

Among power plants, major ones have been equitized: two thermal power plants under construction became joint stock companies; one thermal power plant under planning became an OMC; and Pha Lai Thermal Power Plant, which is the largest in the north became a joint-stock company at the end of 2005.

EVN is under jurisdiction of the MOI.

MOI supervises public companies concerned with energy and industry including EVN, and is in charge of power source development and investment planning, energy policies, commercial energy supply planning and natural the resources survey.

As for large power plant construction, Project Management Board (hereinafter PMB) is organized among concerned ministries and agencies including MOI and EVN in charge of supervision and management of the construction project.

2.2 Orientation of Power Sector Reformation

The fifth Long-Term Power Development Plan (Master Plan) of 2001 recommended power development by IPP, BOT, joint ventures and joint-stock companies between domestic and foreign capitals. The revised Mater Plan of 2003 further clarified this orientation.

In October 2004, the Electricity Law, which set a future institutional framework for Vietnam's power sector, was established. Article 4-2 of the law stipulates that national monopoly be limited to transmission, dispatching, and construction and operation of large power plants. Though the article describes those power plants that shall remain a national monopoly simply as "large power plants", it is considered referring it to multi-purpose large hydropower plants that are directly related to national land conservation.

The new law does not retain the previous regulation of the Master Plan requiring that power source development by foreign capital be limited to 20% of the national generation capacity. The sixth Master Plan (currently under discussion) is expected to encourage entry of foreign capital.

Article 18-1 of the law further clarified that an electric power market shall be established through three phases of a competitive market: generation, wholesale, and retail.

The MOI Road Map of July 2005 specified that the competitive market shall be of a generation phase between 2005 and 2014: internal single-buyer market for the first half period; and genuine single-buyer market for the second half period, where a single buyer purchases all generated power and resells it to distribution companies and large customers.

From around 2015, the competitive market shall shift to wholesale phase of two or more buyers: on the trial basis in the initial two years; and on the full scale after those years until around 2022.

Retail stage shall begin at around 2023, the initial two years being on a trial basis.

As described above, EVN has been implementing institutional reformation, and expected to remain as a large player in the electric power market.

Furthermore, the new Electricity Law stipulated the Electricity Regulatory Agency of Vietnam (hereinafter ERAV), will be in charge of supervising the electric power market development, licensing of electric power companies and regulating electricity prices. The agency was established in October 2005.

Chapter 3 Juridical and Institutional Structure Related to Technical and Safety "Kijun"

In Japan, Technology and safety "Kijun" are the rules that the related ministry requires an industry to observe, and are mandatory in nature. Meanwhile the term "Kijun" is in general translated to "Standards[1]."

However, as Japanese term corresponding to "Standards," there exist "Kikaku" or "Hyojun." They are widely known through the Japanese Industrial Standards (JIS) and International Organization for Standardization (ISO), and are rules and procedures of standardization. Needless to say, they are voluntary as opposed to mandatory in nature, and differ in concept from "Kijun".

Therefore, in respect of juridical character, "Kijun" is very similar to "Codes of Practice" or "Regulations."

As such, when the Japanese term "Kijun" is translated into other languages, its meaning may possibly be slightly changed due to the difference of juridical and institutional systems among countries.

To clarify this problem, in this Chapter 3, we review the general characteristics of the juridical and institutional structure related to "Kijun" in Vietnam, and set forth the orientation for the study works.

For the convenience of the readers, we often use the term "*Standards*" as English translation for "Kijun" especially in the latter chapters, in spite of the above-mentioned problems. Where this is not the case, we quote the original term in Japanese or Vietnamese.

3.1 Juridical Meaning of Technical "Kijun" and Terminology in Vietnam

The technical and safety "Kijun" of the Vietnamese MOI were called "Quy pham" or simply TCN.

Meanwhile, "Tieu chuan" and "Quy chuan" are also used similarly to "Quy pham."

"Tieu chuan" literally means "Industrial Standards," and refers to those of ISO and JIS. "Quy chuan" refers to rules promulgated as mandate corresponding to the English term "Regulations" or "Codes of Practice."

However, the question of whether the TCN is industrial standards or regulation is not resolved, because it is of a dual nature. Explanation of the nature of the TCN varies from person to person and ministry to ministry. There is no united definition.

For example, while one person explains that the TCN is basically "Regulation" but includes some aspects of "Industrial Standards," another person gives a different explanation, to the effect that the TCN is essentially "Industrial Standards" including some regulatory stipulations.

Meanwhile, administrative decision-making including issuance of regulation must be done based on relevant laws. The government and each ministry must also execute regulations under laws.

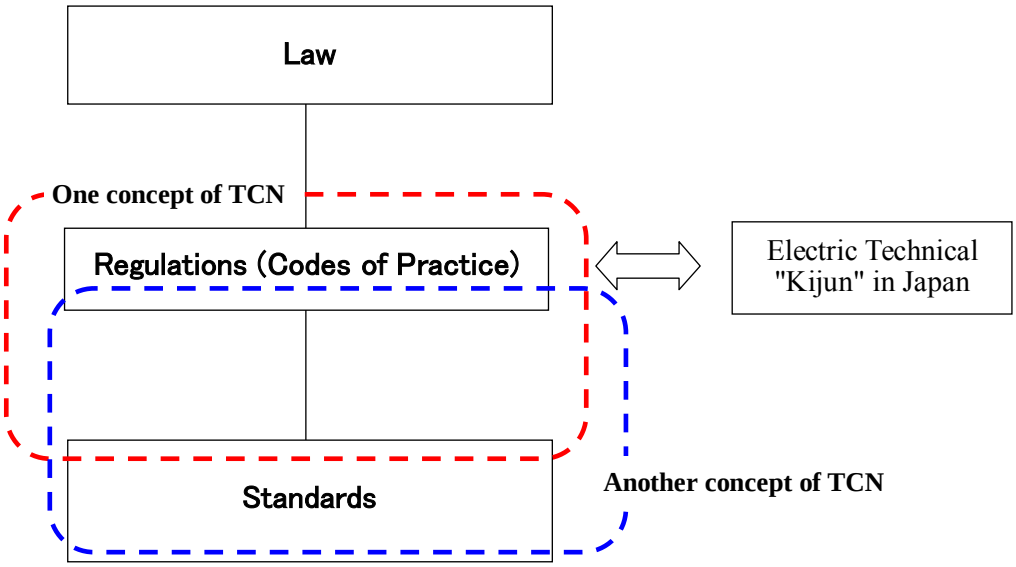
In contrast, "Tieu chuan" as "Industrial Standards" is on voluntary bases, and its juridical position is lower than that of regulations. Although terms "lower" and "higher" are not appropriate, the matter decided by regulation cannot be denied by standards.

As mentioned above, the concept of TCN spans the scopes of both regulation and standards. While it possesses the nature of regulation, it also prescribes some standards to make regulation items more concrete.

[1] Thus, the English term "Standards" is used as the study title.

The Japanese technology “Kijun,” on the other hand, is a sort of regulation and naturally does not stipulate detailed procedures and specifications, which must be clarified in the industrial standards including JIS.

Although there are some juridical (institutional) circumstantial deference between Vietnam and Japan, if we take account of the ideological status of TCN, it must be changed (purified) to regulations.



(Source) JICA Study Team

Figure 3-1 Concept of Regulations, Standards, and TCN

3.2 Points Requiring Attentions in the Revision Work

The objective of the revision of technical and safety TCN of the MOI is to set up new “Regulations” or Quy chuan in order to reinforce safety operations of the electric power industry[2]. MOI is going to issue the revised Technical “Quy chuan” and Safety “Quy chuan” as its Mistrial Decisions.

To this end, in principle, the contents of the revised Technical and Safety “Quy chuan” must stipulate the required performance rather than detailed specifications as shown in the industrial standards.

The technical and safety “Quy chuan” is to lay down the matters, by which the electric power industry must abide. Needless to say, it is the duty of individual entities of the electric power industry to follow the stipulations of the Quy chuan and check their performance. While Quy chuan does not clarify what the MOI must do, the subject of the Quy chuan stipulation is all the electric power utility companies.

From this standpoint the revised “Regulations” must stipulate the required performance rather than detailed specifications.

However, there is another problem in electric power industry in Vietnam. Under the current situation that

[2] However, the English word “standard” itself used in the study name was not to be changed to “regulation” based on the confirmation between the Vietnamese side and the Japanese side in order to avoid further confusion, because it had been used since the S/W conclusion of this study.

the compilation of the TCVN for technical and safety regulation is still practically nonexistent, “Regulation” that totally excludes prescription of matters of standards provides only conceptual explanations, and concrete procedure and methodology will possibly be unclear in some fields.

If we try to make technical and safety “Regulations” similar to those in Japan or in other developed countries, “Regulations” should stipulate only aspects of principle and clarify the level of performance, which the industry must meet. However, in order to solve above-mentioned problem and to reinforce the effectiveness of regulation, it is also necessary to include provisions which show certain levels of specification and concrete procedures to the extent that can be allied to all the utility companies.

With regard to the requisite extent of this balancing, decision-making must vary from one technical field to the other. It is impossible to adopt the same formula for all volumes of Quy chuan. Therefore, we must admit that some different styles will be applied depending on the scope of each volume.

3.3 Clarification of Definition under the Standards Law

There began a legal action in Vietnam that makes clear the characteristics of “regulations” and “standards”. The Standards Law was passed in the national assembly on June 29, 2006, and was promulgated on January 1, 2007. The promulgation of the law has been resolving the above-mentioned confusion related to the roles of regulations and standards.

The Standards Law clearly distinguishes “Regulations” and “Standards” and splits each term into two tiers, as follows:

- Regulations (i.e., Codes of Practice)

"Regulations" consist of QCVN, which is of national level, and QCDP, which is of provincial level. Both present basic rules, principles, and policies, though QCDP must comply with the upper concept of QCVN. Detailed procedures and specifications will be quoted from standards (i.e., TCVN or TCCS explained next). QC is an abbreviation of Quy chuan.

- Standards

"Standards" consist of TCVN, which is of national level and is applied to all over Vietnam, and TCCS, which is made in order to supplement TCVN and is of association and organization levels. TCCS must comply with the upper concept of TCVN. TC means Tieu chuan.

Due to the passage of the Standards Law, the items of existing TCN must be split into two parts, i.e., regulations and standards. Individual parts will be rearranged as QCVN and TCVN.

Some TCN items categorized as standards will be transferred to TCVN, and other prescribing mandatory issues will be rearranged into QCVN. Some issues prescribed in both TCN and TCVN will be transferred to TCVN.

This study prepared the draft of the Technical and Safety “Regulations” for electric power industry, which is QCVN.

When in the future the TCVN concerning electric power industry are well developed in Vietnam, the provisions which show certain levels of specification and concrete procedures can be deleted.

3.4 Electricity Law and MOI's Responsibility

Whatever the contents of the technical and safety Quy chuan are, the MOI as administrator is responsible for supervising the behavior of the industry and assurance of its safe business operation. Needless to say, the MOI has the authority to investigate whether the industry is abiding by the rules stipulated in the Quy chuan. Therefore, if operation and performance are suspicious, the MOI can audit the concerned entities.

The authority of individual ministries, such as the MOI, Ministry of Science and technology (hereinafter MOST), and Ministry of Construction (hereinafter MOC) is clarified in the official Decree105/2005/ND-CP. This decree also states that the MOI is responsible for the establishment of regulations and standards for electric power safety issues, and inspection and investigation of the electric power industry. (See Table 3-1)

Current technical and safety standards were made before the MOI and the EVN were established and the MOI has taken them over as its regulations. The revised technical and safety standards will be enacted in accordance with the above-mentioned roll and responsibility of MOI.

Table 3-1 Responsibility in the Administration of Technical and Safety Standards for Electricity

(Abstract from Decree105/2005/ND-CP)

Article 32 Responsibility of administrators of electricity safety

1. The MOI shall be responsible for the following matters:
   - To promulgate and guide sector regulations and standards for electricity safety, and set up a system to implement them;
   - To coordinate administrative activities for the assurance of electricity safety among state ministries, sectors and local authorities;
   - To set up a system to verify the safety of electrical equipment, devices and products;
   - To inspect and check the safety of activities of electricity supply and use among organizations; and individual persons, and to identify and settle actions violating electricity safety regulations.

2. The MOST shall be responsible for the following:
   - To administer studies on applications of science and technology to electricity safety; and
   - To formulate, complete, promulgate and administer the Vietnamese Standards on electricity safety, in coordination with the MOI.

3. The MOC shall be responsible for the following:
   - To promulgate standards for and regulations for installation of power network used for construction works, which are consistently applied to the whole country; and
   - To promulgate standards and regulations for safe ground systems of buildings.

4. People's Committees of provinces and centrally-run cities shall be responsible for the following:
   - To administer electricity safety within their local areas under the guidance and instruction of the MOI and related ministries.
   - To post the targets for assurance of electricity safety and take account of them in local socio-economic development planning and budgeting;
   - To set up an organization for administration and secure protection of hydropower plant reservoirs within the areas under their jurisdiction.
   - To publicize locations of safety corridors for electricity works;
   - To detect, prevent, and promptly settle encroachments on and illegal uses of hydropower plant reservoirs and safe corridors for electricity works.

Article 33 Technical standards and criteria for electrical works connected to the national power grid

1. Electrical works connected to the national power grid must comply with safety and technical standards and criteria, and agreements with the management unit, which operates the network on the connecting points.
2. The MOI shall stipulate criteria, technical standards, and procedures for connection of electrical works to the national power grid.

(Source) Decree 105/2005/ND-CP

Chapter 4 Structures of Vietnam's Technical and Safety Standards concerning Power Industry

4.1 Technical Standards

Article 11 of the Electricity Law, which regulates Vietnam's electric power industry as a whole, stipulates that electric equipment be constructed according to adequate technical standards, which are currently to be revised.

The mentioned technical standards refer to those standards concerning electric equipment including generation facilities, which MOI supervises. Intended equipment includes electric equipment for home use and for general use as well as electric equipment for business use owned by electric power companies. House wiring, which MOC supervises, shall be outside the scope of this technical standard under supervision of MOI. The technical standards consist of seven volumes, which according to their stipulations (intended equipment) are divided into four large categories: Vol.1～4; Vol.5; Vol.6～7. Fig.4-1 shows intended equipment for each of the four categories. In terms of hydropower equipment (civil engineering work) and thermal power equipment (boiler, turbine, etc), the existing technical standard specifies only operation of the equipment in its Vol.6, not providing any mandatory stipulations for design, installation or inspection of the equipment. Thus, the existing standard is insufficient to cover all electrical equipment. It was establish in the period between 1965 and 1990, nearly 20 years ago, with each volume being established in a different year, and furthermore, it is based on former Soviet Union's technologies, thus having become obsolete. Among the seven volumes, all of which need to be revised, MOST has already been in the process of revising Vol. 1～4 since 2000. Therefore, the proposed versions of Vol.1～4 shall be reviewed here, while the existing Vol.5～7 shall be newly reviewed and revised. Reviewing and revising was done based upon the English version of each volume of standards.

<table>
<tr><th></th><th>Hydropower (Civil Engineering Work)</th><th>Thermal Power (Boiler, Turbine, etc.)</th><th>Generator (Thermal Power, Hydropower)</th><th>Network</th></tr>
<tr><td>Design and Installation</td><td></td><td></td><td></td><td>Technical Standard Vol.1 to 4</td></tr>
<tr><td>Inspection</td><td></td><td></td><td colspan="2">Technical Standard Vol.5</td></tr>
<tr><td>Operation</td><td colspan="4">Technical Standard Vol.6</td></tr>
<tr><td>Construction</td><td></td><td></td><td></td><td>Technical Standard Vol.7</td></tr>
</table>

Figure 4-1 Intended Equipment of the Existing Technical Standard

Stipulations of Vol. 1～7 shall be outlined in the following.

4.1.1 Vol.1 (General Rules)

Vol.1 consists of seven chapters and an appendix. Contents of the chapters are as follows.

(1) General principles

Principles for electrical insulation and resistance to corrosion; Equipment selection based on equipment design; General instructions concerning the whole electrical equipment; Considerations for connecting new generation facilities to the grid; Definitions of common terminology

(2) Transmission and power supply

Principles for construction; Time frame for demand forecast; Principles for neutral grounding; Reliability class and power supply based on reliability; Principles for grid formation; Regulation values for grid voltage and power factor

(3) Selection of transmission conductor size

Selection of transmission conductor size considering economical current density, permissible voltage drop, permissible current, corona affection, etc

(4) Selection of electric equipment and transmission conductor size considering short circuit current and circuit breaker capacity

Calculation method for short circuit current; Equipment selection based on short-time permissible short circuit current and circuit breaker capacity

(5) Power meter

Location of power meters for calculation of electricity charges and their environment; capabilities required for the power meter; Installation of inspection meters, etc

(6) Measuring instrument for power grid

Capabilities required for measuring instruments for grid current, voltage, active power, reactive power and frequency

(7) Grounding equipment

Categories of equipment that need and need not to be grounded; Permissible earth resistance corresponding to grounding fault current, equipment voltage class and grounding type; Shapes of grounding equipment, especially minimum diameter of grounding wires

(8) Appendices

- Permissible current and electric parameter for underground cables that are supposed to have been

adopted in the past

- Calculation formula of permissible current for underground cables (Rice formula)
- Calculation formula of permissible current for overhead ground-wires
- Danger level sign for equipment room
- Touch voltage (for substation grounding design), etc

Size selection methods for transmission line and substation bus conductors taking economical equipment operation into consideration are described in Chapter 3. These methods seek required cross-sectional areas of the conductors through dividing a required current by an economical current density, which is unique to Vietnam and has no parallel in other countries including Japan. A table listing economical current densities corresponding to conductor types and operation modes is presented, regrettably with no source reference.

The appendices include permissible currents and their calculation formula for overhead transmission lines as well as many underground cables that are supposed to have been adopted in the past. However, permissible current significantly depends on design conditions and no calculation basis is presented, thus making no reference material for new cable installation. These appendices could be used only either by adding original design conditions or a calculation basis common for general use.

4.1.2 Vol.2 (Transmission and Distribution Systems)

In terms of transmission and distribution systems, in many developed countries including Japan, distribution pole, transmission tower, their base and support structure as well as electric components (conductor, insulator, etc) are specified in a single technical standard from the viewpoint of public safety. However, in Vietnam, these equipment and structures are specified in standards under supervision of MOC and are outside the scope of MOI standards. Thus, electric equipment for business use is regulated by a number of ministries in Vietnam.

Vol.2 consists of five chapters and appendices. Contents of the chapters are as follows.

(1) Power lines up to 1kV

Distribution lines up to 1kV covering various use including indoor-use, outdoor-use, office and construction site; Wire selection; Installation method for indoor-use (inside and on surface of walls) and outdoor-use

(2) Power lines up to 35kV

Distribution lines up to 35kV covering bus bars in distribution substations, synchronous compensators connecting to the bus and transmission lines connecting distribution substations; Clearance from other facilities (road, railway); Clearance between live part and grounded part, fire resistance, etc

(3) Power lines up to 220kV

Power cables up to 220kV covering cable selection, cable route selection, OF-cable oil pressure design,

cable connection, required cable surplus length, etc; Clearance from other underground facilities, light current wires, roads, railways, trees, etc as well as mutual clearance between cables, with specific numerical values (with reference to Decree 105, 106)

(4) Overhead transmission lines up to 1kV

Overhead transmission lines up to 1kV covering design conditions for wire and support structure, standard wire configuration, concrete pole and support wire, minimum height above the ground (road, railway, river and general land), sideway swing clearance, mutual clearance between cables, clearance from light current wires, etc

(5) Overhead transmission lines up to 500kV

Overhead transmission lines up to 500kV excluding railway and tramway use covering weather conditions for transmission line design, overhead wire design, required minimum cross-sectional area, insulation design including mutual phase clearance, number of insulators and lightning resistance, support structure design, permissible electric field strength, etc. Minimum height above ground for sparsely-populated and commercial district respectively with specific numerical values (with reference to Decree 105, 106). Required minimum height above ground for crossing other overhead lines, mutual clearance between overhead lines, clearance from light current wires, required clearance for crossing or approaching railways, roadways and other special structures.

(6) Appendices

- IP Code
- Power cable insulation performance test
- Chart describing power cable structures
- Simplified chart for wire sag

Details of cable burying methods including clearance from other underground facilities and required depth underground are specified in Chapter 3. In addition, close details of overhead wiring methods including minimum height above ground and required clearance from other structures are specified in Chapter 5. This is because Decree[3] 106 (enforced as of Aug. 17, 2005) provides those close stipulations. Therefore, it is desirable that contents of the Decree be incorporated into this technical standard and reorganized.

Electric field strength is specified on p.118 in Chapter 5. Though the permissible electric field strength in Vietnam is 5kV/m at the height of 1m above ground, sufficient height is not generally secured for overhead wires, which has caused a serious social problem across Vietnam, thus earnest research is being conducted into the problem. Though a regulation value of 3kV/m is adopted in Japan under a principle that the general public shall not be affected in any circumstances, Electric Technology Research Association Vol.31, No.5 recommends 5kV/m for empty districts such as mountain area, thus the

[3] Decree：Supplement to laws. Approved and enforced by Prime Minister

adoption of this value in Vietnam does not seem to present any problem. However, as this is one of the most important issues that may affect human bodies, it is necessary that problematic parts of existing facilities be identified and adequate remedial measures taken. Furthermore, it is necessary that the inspection system be strengthened in order not to overlook any inadequacy.

4.1.3 Vol.3 (Distribution System and Substations)

Vol. 3 consists of three chapters, contents of which shall be as follows.

(1) Distribution facilities up to 1kV

Installation of indoor and outdoor distribution facilities up to 1kV; Mutual clearance of naked wires and clearance from other metallic parts, fences, etc; Installation standard for insulated wires; Fire, earthquake and environmental resistances of distribution boards; Pathways (width, clearance from live parts, etc), fences around live equipment and doorways for distribution equipment in compartments; Distribution equipment in factories; Outdoor distribution equipment

(2) Distribution facilities and substations over 1kV

Distribution facilities and substations from 1kV to 500kV excluding mobile facilities; Insulation, pollution resistance, mechanical strength of transformer, circuit breaker, control, protection, measuring equipment, conductor, switch, base and structure; Precaution against natural disasters and clearance from trees at construction work of distribution facilities and substations; Interlock, grounding switch, fence, sump tank, noise reduction, etc

Maintenance pathway, conductor structure, mechanical strength (safety margin of conductors and insulators), insulation (surface leak distance, etc) and various clearances (between live part and ground, between phases, between bus and other facilities, between building and live part, etc) of outdoor distribution facilities and substations; fire prevention (clearance from other facilities and buildings, fire resistance level, installation of sump tanks and fire fighting equipment) of oil-filled equipment

Fire fighting equipment design, mutual clearance between live parts, clearance between live part and fence or ground, prevention of electrocution to live equipment (fence, etc), lead-in transmission line design (clearance from ground, clearance from adjacent transmission line) of indoor distribution facilities and substations; doorway design (quantity, location, fire prevention level, etc) for distribution equipment room with consideration to fire prevention, etc; oil-filled equipment and sum tank design; ventilation equipment and room temperature, etc.

Transformer overload operation, oil level monitoring, Buchholz relay, fire prevention (automatic fire fighting equipment, fire prevention zoning, non-flammable transformer), clearance from building walls, ventilation and cooling equipment, consideration at winding repair work of transformers and oil-filled reactors.

Installation of factory transformers, pole transformers, lightning protection (lightning prevention, lightning withstanding design), internal over-voltage protection, gas compressor, oil-related equipment (waist oil treatment tank, oil-filter, oil-recycling facilities, etc)

(3) Batteries

Installation of stationary-type lead batteries and alkali-type batteries;

Installation and specifications of battery charger; ampere and voltage meters; protection circuit breaker; rectifier for charging and discharging; emergency lights in battery rooms; battery rack and cabinet; pathway and bus layout; battery room conditions (ventilation, protection against dust, moist and vibration, etc)

4.1.4 Vol.4 (Protection relay and automatic control)

Vol.4 consists of four chapters. Contents of the chapters are as follows.

(1) Power system protection up to 1kV

Power system protection up to 1kV; requirements for protection relays (installation condition and location), short circuit protection (interrupting time and capacity) and over-load protection

(2) Protection relay

Protection relay for electric power equipment between 1kV and 500kV;

Protection against a short circuit, grounding, over-voltage, etc for generators of more than 1kV and 1MW that are directly connected to a bus

Protection against a short circuit, grounding, oil-level fall, oil-pressure rise, temperature rise of oil and windings as well as bushing partial discharge for transformers and shunt-reactors of more than 6kV and 500kV on the primary side respectively

Protection relays against a short circuit, grounding, over-load, over-voltage, oil-level fall and 500kV bushing partial discharge, etc

Protection and fault recording equipment for a short circuit and grounding of overhead and cable transmission lines between 15kV and 500kV; Fault detection relay for overhead transmission relays of more than 110kV

Protection relays for over-current, current-imbalance, over-voltage of series and power condensers; protection for substation and power plant bus systems, circuit breakers, synchronous phase modifiers of more than 110kV

(3) Automatic and remote controls

Automatic and remote controls of power systems, power plants, etc;

Installation standards, protection objects and control methods of automatic and remote controlling equipment; re-closing (transmission, bus, transformer, etc), restoration, synchronous switch-in; voltage and reactive power control, frequency and active power control, system stabilization, frequency control, voltage control, load control, etc

(4) Secondary circuit

Secondary circuit (control, measurement, indication, remote control and protection); cable selection

(wire type, cross sectional area, etc), installation and connection, accuracy of current transformers, power loss of potential transformers, installation of test terminal and relay-lock of instrumental transformers, insulation check, test method for protection relay and remote monitoring and controlling system, alarm and fault indicating system, grounding of secondary circuit of instrumental transformers

(5) Appendices

A list of numerals and symbols that represent automatic control functions

4.1.5 Vol.5 (Inspection standard)

Vol.5 covers generator, synchronous compensator, transformer, cable and wire. Table 4-1 shows subject equipment. While all primary equipment in substations is covered OF cable is included for transmission equipment with no stipulation for overhead transmission equipment. There is no mention of hydropower and thermal power equipment, with the exception of generator, which is provided.

Inspections are largely classified into two types, completion inspection, which shall be implemented before commencement of equipment operation in order to check that relevant equipment has been installed according to design specifications and periodic inspection, which shall be periodically implemented after the commencement in order to maintain the equipment. Meanwhile, two versions of inspection standards exist, the 1965 and 1987 versions, where the 1965 version covers both completion and periodic inspections, and the 1987 version is a modified abstract of the contents for completion inspection of the 1965 version, which means that periodic inspection is covered in the 1965 version while completion inspection is covered both in the 1965 and 1987 versions.

Organization for completion inspection shall be detailed in Chapter 6, where PMB is mainly responsible for the inspection. The 1987 version for inspection standard is titled "Standards for Test, Acceptance and Hand-over of electrical equipment", where "Hand-over" means that PMB shall implement the inspection according to the standard and hand over the relevant equipment to EVN or a PC after the inspection.

Table 4-1 Subject Equipment in Vol.5

	Subject equipment
Completion inspection (1987 version) Periodic inspection (1965 version)	【Power plant】 1) Synchronous generator, synchronous compensator, DC machine, AC motor 【Substation】 1) Transformer, instrumental transformer 2) Circuit breaker (oil, air, vacuum), switch 3) Distribution equipment (distribution board, etc) 4) Other equipment (battery, lightning arrestor, phase modifying condenser) 【Transmission】 1) OF cable

※) Subject equipment is common for completion and periodic inspections.

In terms of the contents of stipulations, not only inspection methods but also numerical criteria are

provided. These numerical criteria are specified for each equipment model according to equipment model numbers (former Soviet Union made), thus many of them being not general stipulations. Meanwhile, inspection frequencies are provided in addition for periodic inspection.

4.1.6 Vol.6 (Operation standard)

1) Network facilities

Current technical standard volume 6 Part 5 " Mechanical and Thermo Equipment of Powerplants and Grids" stipulates articles concerning operation of network facilities. The scope of applications are Transformer, Distribution equipment, Overhead transmission line, Underground Cable, Protection Relay, Grounding Equipment, Equipment for measurement, Over voltage protection and Energy Oil.

Totally speaking, current Volume 6 Part 5 includes some articles stipulate periodic inspection. Therefore completion inspection should be stipulates newly and systematically.

Some articles concerning ACB (Air circuit breaker) are stipulated in Chapter29 "Distribution System". As a result of discussion with Vietnamese side, they never install ACB, therefore the articles of ACB are decided to be deleted. These articles are typical type of stipulations that are conflicted with the present Vietnamese situation.

2) Outline of Provisions for Hydropower

i) Civil Works

Current technical standard volume 6 consists of six parts. Parts relevant to civil works of hydropower are part 1, 2 and 3. In part 1 and 2, fundamental issues common to all categories, i.e. transmission and distribution, thermal power and hydropower, are described. On the other hand, provisions specialized to the operation and maintenance of civil works are gathered in chapters 12 and 13 of part 3. Structure of those chapters is as shown in Table 4-2.

This standard includes fundamental and important issues as a matter of course. But simultaneously it also contains provisions that are obviously voluntary based upon the sense in developed countries. As this may lead to over-regulated conditions, it is indispensable to investigate the necessity of those interrogative provisions sufficiently.

Furthermore, although technical standard volume 6 is basically that for operation and maintenance of civil works, issues related to design, taking-over etc. are included in volume 6. It may be because other volumes of technical standards do not include any chapters where civil issues are to be described.

Table 4-2 Structure of Chapters relevant to Civil Works in Technical Standards Volume 6 (Chapter 12 and 13)

Part	Chapter	Title of Chapter	Sub-title	Number of Articles
3	12	Civil works and mechanical equipment for civil works	Civil works	18
			Check of civil works' condition	9
			Mechanical equipment for civil works	6
	13	Management of water sources in powerhouses, assurance of meteorology and hydrology	Water regulation	7
			Keeping from sedimentation	7
			Hydro-meteorological activities	11

ii) Hydroelectric

Technical standards Vol.6 are composed 6 parts.

There are 3 Parts related to Hydroelectric equipment, such as Part 1 Organization, Chapter 5 Frequency of overhaul inspection, Chapter 14 Hydraulic turbine,Part5 Chapter 26 Generator and synchronous compensator, and Chapter 27 Electric motor.

In Part3 Chapter14 hydraulic turbine, it is standardized for Automatic operation, Remote control and Protection relay system; however the contents are mostly mentioned as technical specification matter.

As for numerical standards, it is standardized for Vibration and Frequency of periodic inspection (same as part 1).

Regarding Part 5 Chapter 26 Generator and synchronous compensator, it is standardized for operation management of Thermal, Hydroelectric equipment and synchronous compensator.

As for inspection, it is itemized for Inspection of Reserved power source, checking of temperature for Bearing and winding and Maintaining of stable rated operation.

Necessity of firefighting alarms, prevention of Overload operation are standardized; however they are also as technical specification matter as same as Part 3.

The numerical standards are Over current factor of excitation circuit, Axial insulation resistance, Over load factor during operation and Permissible values of ground fault of winding and vibration. These sentences are combined with Thermal power and steam turbine. It is not divided independently as Hydroelectric part.

As for Chapter 27 Electric motor, it is standardized of Maintaining of reliability, Necessity of Ventilation system, Supervising of Overload operation, Vibration, Temperature rise and necessity of periodic inspection. Numerical standard values are mainly operation voltage and permissible vibration.

Table 4-3 Component of Hydroelectric equipment in Technical standards Vol.6

Part	Chapter	Title	Article
1	5	Repair of Equipment, Houses and Works as Scheduled	1
3	14	Hydraulic turbine	28
5	26	Generator and Synchronous Compensator	39
	27	Electric Motor	12

3) Thermal power

Volume 6 is composed of six parts. Those relating to operation of facilities in thermal power plant are described in Part 4 and Part 5.

- Part 4

Part 4 is composed of twelve chapters. The regulations concerning the operation of mechanical equipment in thermal power plants are stipulated in this part. The equipment concerned is shown in Table 4-4. In this regard, what is described here includes not only the main equipment, such as the boiler and turbine, but also the other general mechanical equipment relating to the operation of thermal power plant.

Table 4-4 List of the equipment to be regulated (mechanical)

Equipment	Facilities to be regulated
Boiler-related (Chapter 15, 16, 17, and 25)	Boiler, fuel transport/supply equipment, pulverized coal handling equipment, precipitator/ash treatment
Turbine-related (Chapter 18, 20A, and 22)	Steam turbine, gas turbine, water treatment
Others (Chapter 19, 20B, 21, 23, and 24)	Generating unit, diesel generator, control and instruments, pipe/valve, auxiliary equipment

This part mainly covers the matters concerning operation. It has a rather broad range from design and construction to completion and periodic inspection is also included. The contents includes, a general description to a more detailed one including common senses, company standards, operation manuals, organization, and company procedures. Since there aren't standards for design and inspection for mechanical equipment of a thermal power plant, all the regulations of power plant management, ranging from the operation to the process from construction to inspection as well, are estimated to be summarized and stipulated in this volume.

As for concrete contents, the operational objective, check/monitoring items for operation, daily inspection items, response to trouble; for each equipment type are stipulated. Most of the standards

are appropriate as EVN company standards.

In addition, the interval for the periodic inspection of the boiler and turbine is also specified here.

・ Part 5

This part is composed of fourteen chapters. The standards concerning the operation of electrical equipment in a thermal power plant are mainly stated in four chapters[4]. The facilities concerned are shown in Table 4-5.

Table 4-5 List of the equipment to be regulated (electric)

	Facilities to be regulated
Chapter 26	Generator, synchronous compensator
Chapter 27	Motor
Chapter 38	Hydrogen production equipment
Chapter 39	Turbine oil, grease

The contents stated in this part are similar to Part 4 (mechanical equipment). Also most of the standards are appropriate as EVN company standards. The hydrogen production equipment in Chapter 38 is installed for the cooling of generators, thus specified in the electrical part as the auxiliary equipment of generators. Chapter 39 summarizes oil including turbine oil, grease together with the insulating oil for transformer and the like.

4.1.7 Vol.7 (Construction standard)

Vol.7 covers substation and distribution equipment, underground cables and overhead transmission lines as well as lighting equipment, auxiliaries including grounding equipment and low voltage wires, electrical equipment including motors, cranes, elevators, etc. Table 4-6 subject shows the subject equipment.

In terms of electrical equipment, installation standards for motor, switch and controlling equipment as well as electrical equipment for consumer use including crane, belt conveyer, elevator, etc are provided, which is considered to be outside the jurisdiction of MOI.

[4] In the case that transformer, circuit breaker, and so on are considered as network facilities

Table 4-6 Subject Equipment in Vol.7

	Primary subject equipment
General stipulation	Preparation for construction and installation Materials and equipment for temporary use at construction and installation
Substation	Bus, transformer, rectifier, cubicle, distribution board, secondary circuit, battery and power condenser for distribution system
Transmission	Underground cable Overhead transmission line (up to 220kV)
Others	Low voltage wire Lighting equipment, distribution board Grounding system Electrical equipment (motor, crane, belt conveyer, elevator, etc)

This standard was established in 1985, more than 20 years ago, thus it contains many stipulations for equipment that are currently not used、and not expected to be adopted in the future. For example, there are many stipulations for mercury-arc rectifiers for DC power source in substations, though semiconductor rectifiers, which are integrated into battery chargers thus presenting no stipulations of their own, are currently used.

The contents of the standard are divided largely into three categories: "Engineering work methods and procedures"; "Engineering work planning, acceptance of equipment and materials, procedures for pre-operation inspections and document submission"; "Technical standards for electrical equipment".

In terms of "Engineering work methods and procedures", methods, procedures and regulation values, as well as equipment and materials that are used in the engineering work are specified in detail. This is because this standard has served as EVN's internal standards, which naturally should be specified according to different type, specification, manufacturer, installation environment, etc of individual equipment. When this standard, as Vietnam's national standard, is applied to new entrants of Vietnam's electricity market, it may limit their discretion, making adoptions of new engineering methods, equipment and materials, which in turn will prevent efficient facility formations.

Further, in terms of "Technical standards for electrical equipment", what is covered in Vol.1 through 4, such as diameters and clearances of pipe ducts, are included in Vol.7.

As described above, the current Vol.7 is not well organized and at the same level as EVN's internal standards and manuals, thus it is necessary that it be revised to be limited to the minimum requirement for maintaining engineering work quality and equipment integrity, so that equipment owners' discretion is not hampered.

4.2 Safety Standards

The current safety standards were drawn up according to Soviet Union techniques in 1984, and the State Department for Industrial Safety Techniques (hereinafter DIST), the MOI holds jurisdiction over safety

standards. DIST is planning the revision or newly establishment of safety standards, because it has been over 20 years since they were established. It has been decided that DIST and Department of Science and Technology (hereinafter DST) will cooperate to draw up safety standards, and the draft of them will be prepared by EVN on consignment from DIST and DST. Therefore, JICA supports the preparation of the draft of safety standards in this study.

The current safety standards include various detailed items with specific methods and tools. There seems to be few items that have become obsolete, even if it has been a long time since they were established. The contents that we obviously consider the company regulations of EVN are included in the current safety standards, for example, concrete positions of supervisors for work safety, and penal regulations for violation of safety standards such as reduction or termination of monthly safety bonus, warning and demotion. A small part of the current safety standards is worth having mandatory power as a national regulation, and most of them have absorbed almost the same contents of the company rules without change. The same regulations are repeatedly reflected in every volume.

The titles of Volume 1 to 7 of the current safety standards are as follows;

Volume 1: Standards on Technical Safety for Management and Operation of Electrical Equipment at Power Plants and Power Stations

Volume 2: Standards on Technical Safety for Management and Operation of Overhead Lines with Voltage higher than 1000V

Volume 3: Standards on Technical Safety for Management and Operation of Electrical Equipment of City Networks with Voltage higher than 1000V

Volume 4: Standards on Technical Safety for Management and Operation of Electrical Equipment of City Networks with Voltage up to 1000V

Volume 5: Standards on Technical Safety when Building and Installing Electric Lines running nearby Existing High Voltage Lines with Active Current

Volume 6: Standards on Technical Safety for Management and Operation of Testing Stations, Laboratories of Power Enterprises and Research Institute for Electric Science and Engineering

Volume 7: Appendices

The concrete regulations are reflected in volume1 to 6, and the volumes are categorized by the types of facilities. Repeated contents or similar contents concerning the following "Common Topics" are reflected in every volume.

<Common Topics>

- Roles of superiors such as work supervisors and manager
- Power interruption during works
- Qualification concerning safety works
- Work permission, work order
- Clothes of workers (Protective Clothing and Devices)
- Detection of electricity
- Earthing
- Measures for prevention of wrong operation or errors of switches
- Installation of warning and fence (prohibition of outsider's entering)
- Safety level necessary for each content of work or supervision

The contents of volume 1 to volume 6 of the current safety standards except <common topics>, are shown in the following subsections.

4.2.1 Vol.1: Standards on Technical Safety for Management and Operation of Electrical Equipment at Power Plants and Substations

(1) Management and Operation of Electrical Equipment with voltage higher than 1,000V

Security of distance from an energized part, suspension of an outdoor work in case of bad weather, procedures concerning the work plan, start of work, end of work, etc.

(2) Generator, Synchronous motor

Safety measures individually taken to generator, or synchronous motor, handling of oil, air and hydrogen used for refrigerant of cooling system, and safety measurements for welding operation

(3) Motor (rated voltage is over 1,000V)

Handling of operation and stopping of motors, and measurements against negative rotation of motor

(4) Operation at switchgears, load breakers, disconnectors with automatic actuating mechanism and remote control.

The regulation about lock of automatic operation and remote control, and the regulations in case of a work in an oil-tank for oil for an oil circuit breaker

(5) Repair the cables placed within the power plant and substation

Depth of a buried cable, measures in case of digging up a trench or hole, and measures for work in cable wells.

(6) Measurement apparatus

The short-circuit of secondary circuit of current transformers

(7) Cleaning insulators of distribution equipment without cutting off power Safety measures for the above work

(8) Device experiment and measurement

Implementation methods and used tools

(9) Works using crane cars, lift-cars and forklift trucks

Operation methods, responses to an unexpected occurrence

(10) Battery System

Ban on using fire, ventilation, and handling of acid solutions or alkali solutions

4.2.2 Vol.2: Standards on Technical Safety for Management and Operation of Overhead Lines with Voltage higher than 1000V

(1) Operation and management for overhead power lines

Points to consider when patrolling overhead power lines, necessary distance from an energized part, in the case of a working near a live line, regulations in case of climbing or descending a pole (use of a safety belt etc.), work plans, measures for the start of work and end of work, work permission, supervision during work

(2) Specific works

Tree trimming near the power line route, excavation for foundation hole of poles, installation or removal of poles, measurement of an earthing resistance, methods of maintenance work for wooden poles

4.2.3 Vol.3: Standards on Technical Safety for Management and Operation of Electrical Equipment of City Networks with Voltage higher than 1000V

(1) Operation and management of electric equipment installed indoor with voltage higher than 1,000V

Replacement of fuses, handling of ladders, work plans, measures in case of start of work or end of work, work permission, supervision during work, suspension of works

(2) Cable line work and underground work

Verification of underground installation before excavation, measurement for excavation, handling of cable box, discharge of residual electric charge before cable work, insulation treatment for cable

termination, treatment of tar poured into cable connection box, checking for flammable gas or noxious gas during underground work, ban on using fire

(3) Management and operation overhead of power lines and transformer stations on electric poles with voltage up to 20kV

Regulations in the case of inspection of overhead power lines, operation of switchgears, or replacement of fuses are reflected. Take caution when climbing a pole, verification of conveyance or suspensor tools such as a winch, rope and pulley and measures taken for specific works near a load, sidewalk, railway or communication line (prior announcement, disposition of a guardsperson) are also included.

4.2.4 Vol.4: Standards of Technical Safety for Management and Operation of Electrical Equipment of City Networks with Voltage up to 1000V

(1) Works on overhead power lines with voltage up to 1,000V

Inspection along overhead power lines, measurement of the height of facilities, tree trimming near the power line routes, measurement of earthing resistance, replacement of fuses, inspection of rotten wooden poles

(2) Repair of power lines

Excavation for foundation hole of poles, repair of components for supporting structures, work on poles, relocation or removal of conductors, work for low-voltage lines or a service drop line are reflected. And work for low-voltage lines in parallel with power lines with a voltage higher than 1,000V, works on crossing existing power lines, and works near a load, sidewalk, railway or communication line

(3) Work in street illumination network

Cleaning of lights, handling of ladder trucks

(4) Management and operation of electric distribution installation with voltage up to 1,000V

Replacement of fuses, and cleaning of distribution and equipment rooms

(5) Cable work with voltage up to 1,000V

Excavation, cable trench, cable connection box, cutting of cables, injection of plastic into cable connection box

(6) Specific works

Installation of meters and instrument transformers, operating machines such as a crane, communication method in case of works with power interruption

4.2.5 Vol.4: Standards on Technical Safety when Building and Installing Electric Lines running nearby Existing High Voltage Lines with Active Current

(1) Building work near existing live high voltage power lines

Tree trimming to prevent trees from falling down on high voltage lines, pile driving, excavation for foundation holes for supporting structures, construction of supporting structures, assembly method of supporting structures etc.

(2) Installation of conductors at the crossing with the existing live high voltage power line

Handling of ropes etc.

(3) Installation of power conductors and lightning conductors within the area of effect of the existing live high voltage power lines of 35 to 500kV

Judgment of necessity of power interruption, handling of ropes, steel cables and safety belts, security of distance from an energized part, disposition of guards and installation of the second circuit of power conductors in two-circuit power line while one circuit has electricity

4.2.6 Vol.6: Standards of Technical Safety for Management and Operation of Testing Stations, Laboratories of Power Enterprises and Research Institute for Electric Science and Engineering

(1) Safety measures for testing stations and laboratories

Full equipment for ventilation, water drainage and oil drainage systems, installation of interlocks and installation of warning light and alarm systems

(2) Special tests

Handling of oscilloscopes, mercury rectifiers etc.

Chapter 5 Review of Vol.1 through 4 of the Technical Standard

5.1 Review policies

As described in the previous chapter, Vol.1 through 4 of the technical standards, which originally were established in 1987, have been under a revision process of Vietnam's own since 2004, and MOST is currently working to enact them anew. This study shall review this ongoing revision draft.

Among the topics concerning circumstances surrounding Vietnam's national standards, one of the most important is Vietnam's accession to the WTO. Vietnam's mandatory standards including technical standards may not present any trade barriers from technological aspects, thus they should be compatible with international standards. Under this circumstance, the first priority of the review is identifying problems on the current technical standards from an international perspective, considering its importance as a mandatory standard. This is true not only for reviewing Vol.1 through 4 but also to Vol.5 through 7. In addition, to incorporate the latest technological knowledge (only internationally recognized knowledge) is also one of the priorities of the review. Based on these priorities, important points for identifying problems that constitute review policies have been established as follows.

Review Policies

1) Identify inappropriate stipulations for ministry ordinances as mandatory standards
   a. Stipulations that will significantly affect future facility formation
   b. Stipulations that should be treated as company internal rules
2) Identify stipulations that require incorporation of new technology or knowledge
3) Identify stipulations that are incompatible with existing facilities

This review shall not propose a draft revision, but rather place priority to identifying problems, presenting relevant information to Vietnam side and transferring technology so that Vietnam shall be able to properly revise the technical standards on her own based on this review.

5.2 Review results

Vol.1 through 4 were studied according to the above described review policies, and problematic clauses have been identified. Those clauses are classified into three categories corresponding to the review policies: 1) through 3).

1) Identify inappropriate stipulations for ministry ordinances as mandatory standards
   a. Stipulations that will significantly affect future facility formation

Clause Ⅱ.5.115

"Arrangement of overhead power lines going over houses and structures is prohibited, ・・・"

Comment

This clause limits building construction under transmission lines. Japan has a similar regulation in order to prevent power supply disruptions on extra-high voltage overhead transmission lines. Article 48 of "The Technical Standard for Electrical Equipment" prohibits building construction within 3.0m of the most outer line of transmission lines of more than 170kV, which are an integral part of power grids. For transmission lines of less than 170kV, building construction is allowed where a required clearance is secured.

This clause prohibits building constructions under transmission lines of all voltage classes, and will present a large impediment to future urban development and transmission route planning. Therefore, the study mission proposed that voltage classes to be regulated should be limited considering required power supply reliabilities.

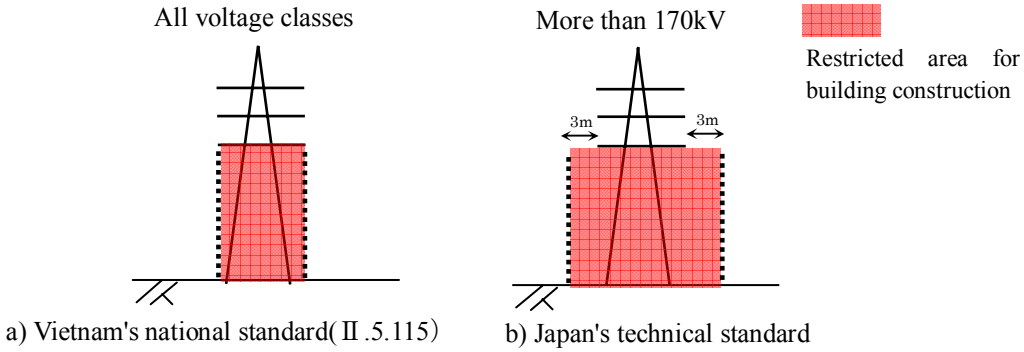


Figure 5-1 Comparison of building construction regulation under transmission lines

1) Identify inappropriate stipulations for ministry ordinances as mandatory standards
b. Stipulations that should be treated as company internal rules

Clause Ⅱ.5.13

" In order to manage operation and maintenance of 500 kV overhead power lines, roads with at least minimal width of 2.5m must be arranged for transport means to access the line route."

Comment

Installation of patrol route is crutial for facility maintenance, thus an obligation of the installation is necessary. This clause not only obligates the installation but also specifies patrol routes, where Vietnam set the minimum requirement of 2.5m for the patrol route width, which allows passage of patrol viecles. Usage of viecles for patrols as well as route widths should not be specified by mandatory regulations but rather be decided by individual power companies, thus the study mission proposed that the road specification be eliminated or the whole clause be deleted.

2) Identify stipulations that require incorporation of new technology or knowledge

Clause Annex Ⅰ.3B

◇Caluculation formula for permissible continuous currents

・Heat dissipation coefficient（h_w)

$$h_w = 0.000572. \frac{\sqrt{\frac{v}{d}}}{\left(273+T+\frac{\theta}{2}\right)^{0.123}} \quad (W/^oC.\ cm^2) \quad \text{(Rice Formula)}$$

Comment

Permissible currents for naked wires are an important element. Among parameters used for the caluculation, the heat dissipation coefficient bears the largest influence. The above formula, generally called the Rice Formula, is currently adopted in Vietnam' technical standards. This formula was proposed at IEEE (Institute of Electrical and Electronics Engineers) in 1923, and is internationally recognized. However, CIGRE lately proposed the following new formula, which Japan has verified its accuracy through experiments. This formula estimates the heat dissipation more accurately than the Rice Formula, thus allowing larger permissible currents, which inturn enables more efficient power system operation. Therefore, the study mission has proposed adopting this formula.

$$h_w = \frac{\lambda_f \times N_u}{D \times 100} \quad (W/^oC.\ cm^2) \quad \text{（CIGRE formula）}$$

3) Identify stipulations that are incompatible with existing facilities

Clause Ⅱ.5.13

"Bamboo or wooden poles must not be used for overhead power lines in any cases."

Comment

This clause prohibits usage of bamboo and wooden poles as overhead transmission line supports. Wooden poles are generally used as supports in Japan and expected to be used also in Vietnam, thus this clause has been identified as imcompatible with existing facilities. Though wooden poles are not widely adopted, further applications of them are considered from an economical perspective in Vietnam. The study mission informed the Vietnam side that wooden poles would require anti-corrosion treatments, which might present environmental problems, thus requiring adequate environmental consideration.

As above exemplified, all clauses have been reviewed in order to identify problematic stipulations. The review results are summarised in the format described in Fig.5-2. The summary table is attached as Appendix 1.

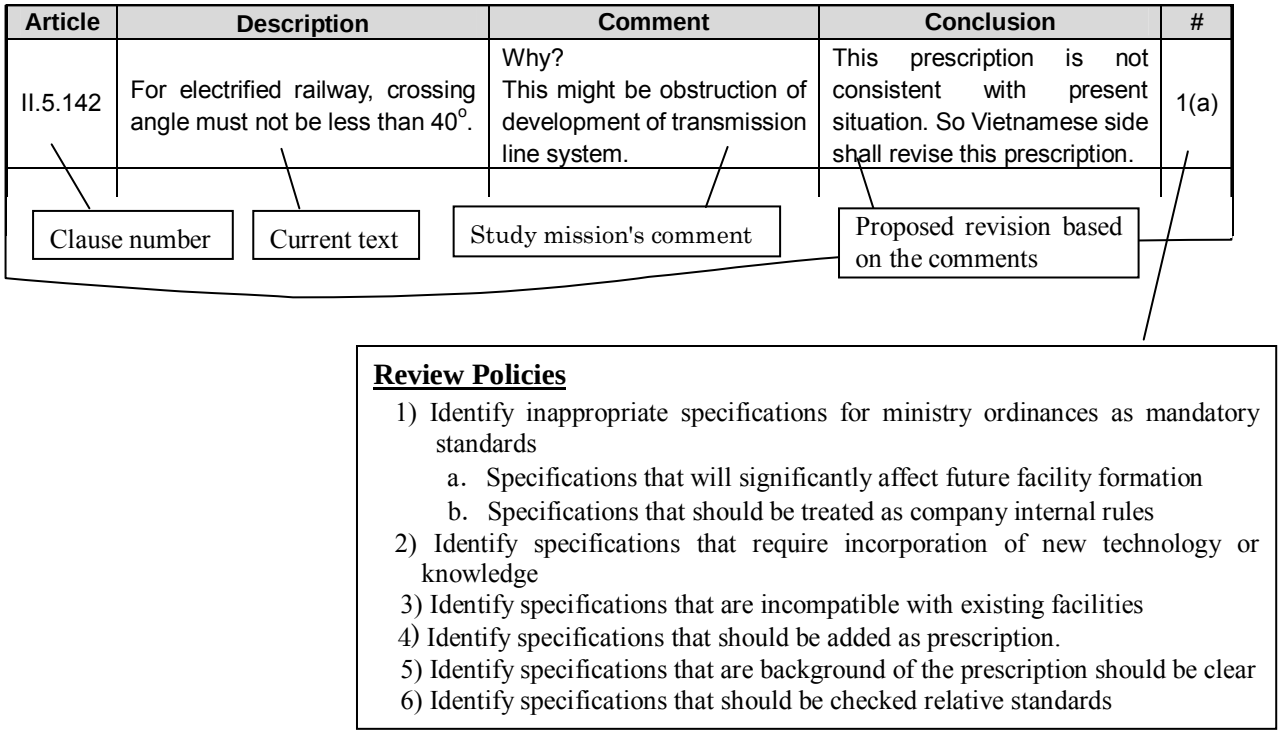


Figure 5-2 Summary Format for Review Results

Chapter 6 Policies for Revising Vol. *5* through *7* of the Technical Standards and Safety Standards and Outcome

In this chapter, policies for revising the technical standards Vol. *5* through *7* and safety standards along with the outcome are described. The drafts of technical standards and safety standards are bound separately.

6.1 Revising Vol.5 through 7 of the Technical Standards

6.1.1 Basic Policies for Revising the Technical Standards

As Chapter 5, 6 and 7 of the technical standard are different in contents from each other, policies for revising them shall be different in detail accordingly. However, technical standards to be revised are all established by ministerial ordinances of MOI, thus of a same class. Therefore, they shall be revised based on the following common basic policies.

- Generalization and minimization of contents

As facilities of EVN are not the only one intended and mandatory standards around the world are becoming narrow-focused on equipment performance, Vietnam's technical standard also should focus on equipment performance in the future. However, Vietnam's existing technical standards provide many detailed numerical stipulations, thus serves as a guideline as well. In addition, awareness for voluntary security has not fully developed in Vietnam yet. In these circumstances, transforming the existing standard that is like a guideline into a performance-focused one will present security problems, thus this transformation should progress in phases. Therefore, at the current revision work, not a few numerical stipulations of the existing standard shall be retained, while maintaining the performance-focused orientation as well. Furthermore, the numerical stipulations shall be not unique to Vietnam but international and thus minimum requirements.

In addition, the following two basic policies shall be observed.

- Compatibility among different volumes
- Addition of necessary stipulations

Consultation sessions were held with the Vietnam side concerning articles that overlap in their contents beyond volumes, and it was decided that to avoid the overlaps the most suitable volume to the contents should provide a major part of the stipulations (For example, stipulations concerning inspections shall be provided in Vol.5.) while other volumes shall refer to the relevant volume.

Table 6-1 shows intended equipment and facilities by each volume of the revised technical standard. In the table, ○ shows that the existing standard provides stipulations, which shall be revised at the current

revision work, while ● shows that the existing standard provides no stipulations, even though the MOI needs them now as its standards, since the generation facilities other than those of EVN also have been constructed and come into operation, thus new stipulations shall be added at the current revision work.

Table 6-1 Equipment and Facilities by Each Volume of the Revised Technical Standard

		Network	Hydropower		Thermal power (boiler, turbine, generator)
			Generator	Civil engineering work	
Vol.5	Completion inspection	○ (Excl. pole, tower, base)	○	—	●
	Periodic inspection	○	○	●	●
Vol.6		○	○	○	○
Vol.7		○	—	—	—

Explanatory note ○ : Existing stipulations shall be revised. ● : New stipulations shall be added.

Detailed revision policies of each volume shall be described in the following.
The technical standards Vol.5 though 7 revised in this study are expected to be enacted as MOI's mistrial ordinance by the end of December 2007 after checking and approval of the relevant authorities.

6.1.2 Policies for revising Vol.5 (Inspection standard) and outcome

As described in Chapter 3, Vol.5 of the existing technical standard concentrates on transmission and generation facilities not providing any stipulations for hydropower, civil engineering or thermal power (boiler, turbine) facilities. At the current revision, Vol.5 shall newly cover hydropower, civil engineering and thermal power facilities, thus covering the whole range of electrical power equipment.

Inspections are divided into two large categories, completion inspection and periodic inspection, and Vol.5 shall cover both. Fig.6-1 shows the basic structure of Vol.5.

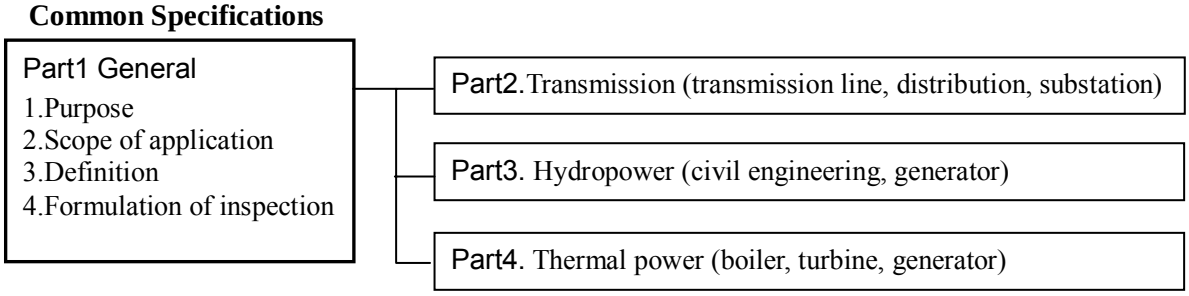


Figure 6-1 Basic Structure of Vol.5

This standard shall be partitioned into sections for transmission, thermal power and hydropower. Inspection items specified here are those required for electrical power companies to implement as legal inspections, results of which the MOI shall examine.

Modes of inspection are specified not uniformly but rather considering varying characteristics of different facilities of transmission, thermal power (boiler and turbine) and hydropower (civil and electrical

engineering), based on a combination of field inspections by MOI and examination of inspection reports submitted to the inspection department of MOI. The study mission made and presented to the Vietnamese side is an example of the inspection model described in Table 6-2.

Each electrical power company shall additionally establish its own voluntary inspection items covering contents specified in Vol. 6, based on an understanding that they are obligatory inspection items to be examined by regulatory authorities.

With the above-mentioned notion in mind, revision policies were established respectively for transmission, thermal power and hydropower facilities, which are described bellow.

Table 6-2 Role of MOI in Inspection System

		Thermal Power Plant		Hydro Power Plant		Network
		Boiler	Turbine, Electric Machines	Civil	Electric Machines	
Characteristic of Facilities	Magnitude of anticipated public hazard caused by trouble of facilities	**Large**	**Small**	**Large**	**Small**	**Medium**
		Boiler explosion is expected to have an impact on public safety.	The magnitude of public hazard (except Boiler) is small.	The influence of flood caused by the trouble is expected to be great (wide area).	The magnitude of public hazard is small.	Electric shock is anticipated. However, magnitude is not large. Because the disaster area is limited to trouble point.
	Extent of facilities in public space	**Small**		**Large**	**Small**	**Large**
		The facilities are closed and limited to Power Plant Site.		The facilities (include Reservoir and the lower area) extent widely.	The facilities are closed and limited to Power Plant Site.	Overhead Transmission Line passes through public area widely.
	Efficiency of inspection. (Number of facilities to be checked)	**High** (Number is small)		**High** (Number is small)	**High** (Number is small)	**Low** (Number is large)
		The number is small, so efficiency of inspection is high.		The number is small and inspection item is mainly visual check, so efficiency of inspection is high.	The number is small, so efficiency of inspection is high.	The number is quite large, and also many items (including measurement) shall be inspected. Therefore, efficiency of inspection is low.
Comment for inspection system		Magnitude of public hazard and extent of facilities is large. Therefore, field inspection by MOI is appropriate system.	Magnitude of public hazard and extent of facilities is small. However, inspection of documents by MOI is necessary from the aspect of power system reliability.	Magnitude of public hazard and extent of facilities is large. Furthermore, field inspection can be carried out economically. Therefore, field inspection by MOI is appropriate system.	Magnitude of public hazard and extent of facilities is small. However, inspection of document by MOI is necessary from the aspect of power system reliability.	Field inspection by MOI is not an appropriate system from the viewpoint of an economical aspect. However, magnitude of public hazard is not small. Therefore, MOI should carry out document inspections instead of field inspections properly.
Role of MOI in Inspection System		/Field Inspection /Inspection of document (*)	/Inspection of document (*)	/Field Inspection /Inspection of document (*)	/Inspection of document (*)	/Inspection of document (*)

(*) : means results or data of Inspection and document relative to maintenance work.

MOI should request the Owner of facilities to submit relative related documents properly (for example periodically or at accident or trouble of facilities).

(1) Policy for revision of standards for each facilities

Basic revision policies for hydropower, thermal power and transmission facilities shall be described in the following.

(1)-1 Transmission

As before mentioned, inspections are divided into two large categories: completion inspection and periodic inspection. Completion inspections for transmission facilities are conducted in divided segments before commencement of operation. Table 6-3 shows inspections that are conducted in Japan. Surveys implemented in Vietnam found that similar inspections are conducted in Vietnam, thus each inspection shall be specified based on the division in the table. Factory inspections are not conducted by electric power companies but mainly by manufactures, thus shall be outside the scope of the current revision work

Table 6-3 Division of Inspections before commencement of Operation (Transmission)

Category	Inspection	Time of inspection	Outline
Receiving inspection (Equipment and material)	Factory inspection	At the time of manufacturing	Check that equipment and materials have structures, performances and properties described in specifications (of manufactures or EVN) by manufactures at their factory at the time of manufacturing
	Field receiving inspection	At the time of field work	Check that equipment and materials have been properly delivered in specified quantity and shape without any damages
Contract work inspection	Field work inspection		Check that fieldwork (contract work) has been implemented according to engineering work specifications at each work completion (wiring, insulator installation, etc) or for each piece of equipment (transformer, circuit breaker,
Completion inspection	Completion inspection	At the time of completion	Check of comprehensive quality of substations or transmission lines as a whole before commencement of operation

: Inspections intended at the current revision work

In addition to the three inspections (field receiving inspection, field work inspection and completion inspection), periodic inspections that are implemented after commencement of operation shall be specified.

Hereafter follows the definition of periodic inspections, which shall be specified inVol.5.

Fieldwork for equipment maintenance consists of patrols and inspections. Their purposes are as follows.

Patrols : Check of presence or absence of abnormalities on transmission facilities and their environment mainly visually and by meters and indicators installed on equipment and instruments as well as collecting operation records

Inspections : Check of presence or absence of abnormalities on each piece of equipment, instrument and component of transmission facilities with the facilities operated or stopped as well as adjustment of the facilities and replacement of abnormal parts by using maintenance tools and instruments if necessary to comprehend the condition and maintain the function of the facilities

Inspections are indispensable for maintenance of facility function, thus should be specified in mandatory standards. Meanwhile, patrols are conducted voluntarily by equipment owners and with their own methods, thus shall be outside the scope of revision work.

Inspections are divided into ordinary inspection, close inspection and temporary inspection according to their purposes as in Table 6-4.

Table 6-4 Division of Inspections

Inspection	Contents
Ordinary inspection	Check of presence or absence of abnormalities from outside visually or by measuring instruments for internal diagnosis and performance test
Close inspection	Close internal inspection with equipment or instrument disassembled and performance tests by measuring instruments
Temporary inspection	Implemented when abnormalities have developed to other equipment of the same type as the relevant equipment in order to prevent the same kind of abnormalities, failures and accidents with appropriate inspection contents and methods

: Inspections intended at the current revision work

Close inspections and temporary inspections are not implemented on a periodical basis but out of equipment owners' volition if necessary. Therefore, the current revision work shall be limited to ordinary inspections, which are fundamental and indispensable thus should be mandatory inspections.

Inspections of poles, towers and bases are implemented according to MOC standards and do not seem to be in need of being newly specified as the MOI standards and Vietnam side judged it was not necessary, thus rendered outside the scope of MOI standards as shown in Table 6-1. However, periodic inspections shall

cover the whole range of transmission facilities including poles, towers and bases.

Stipulations of inspections are as follows.

Field accepting inspection

Field accepting inspections are implemented according to detailed specifications in international standards including IEC, thus should not be specified independently in each country. Therefore, only a clause that says, "Performance of products shall be checked in field inspections to comply with purchase specifications or manufactures' specifications." shall be included.

Completion inspection

Completion inspections for transmission facilities had been legally defined as mandatory inspections with specified contents and methods in presence of officials from relevant ministries and agencies before the revision of the Electric Power Company Law in 2000. However, since then, they have become voluntary inspections implemented out of equipment owners' volition, thus changing their legal definition.

Despite being not mandatory under the current law, Japan's current completion inspections still retain contents that formerly were mandatory, thus Vietnam's technical standard shall be based on them.

Fieldwork inspection, periodic inspection

These inspections are voluntary in Japan and implemented independently out of each equipment owner's volition with its own contents. Consultations were held with Vietnam's side concerning what inspection items should be mandatory, and Japan's survey mission proposed that inspection items be selected from the viewpoint of public safety as one example.

In Japan, items of those inspections are selected in general from viewpoints of both public safety and power system reliability. Among them, public safety is based on "the obligation to maintain facility performance" stipulated in Article 39 of the Electrical Power Company Law, thus legally binding. Meanwhile, power system reliability is specified independently out of each equipment owner's volition, thus not legally binding. Therefore JICA study team recommended to select the prevention against large-scale power system collapse and heavy damage of facilities from the aspect of system reliability.

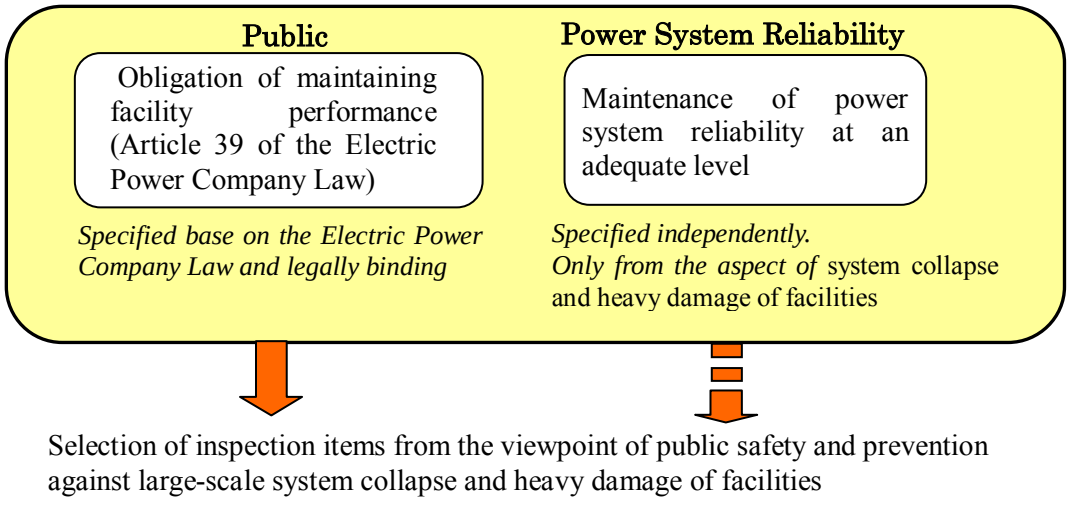


Figure 6-2 Basis for Selecting Inspection Items

As public safety is considered to be mandatory as a basis for selecting inspection items, items of fieldwork inspections and periodic inspections shall be selected from the viewpoint of public safety in Vol.5. Specific viewpoints of public safety to be considered shall be the following five, based on which inspection items shall be selected.

- Insulation of transmission and substation facilities
- Prevention of facility collapse
- Grounding of transmission facilities
- Security of clearance from live part
- Prevention of wire break

Auxiliary equipment other than primary equipment such as fire-fighting equipment, compressors and oil feeders in substations shall be outside the scope of the technical standard.

In terms of inspection intervals, Japan's survey mission presented examples of Japanese power companies' practices leaving the final decision to Vietnam's side in principle. Proposed stipulation values are not uniformly defined but flexible ones such as "Minimum five years, and decided independently by each equipment owner", so that each equipment owner may use it's own discretion.

In terms of numerical criteria other than inspection intervals, those items that require much of manufactures' proprietary judgment shall in principle comply with the manufactures' specifications.

(1)-2 Civil Works in hydropower

(a) Outline

Contents of the technical standards Volume 5 consist of two types of inspections, i.e. acceptance

inspection and periodic inspection. However, as for civil works in hydropower, acceptance or taking-over inspection is usually carried out according to the standards issued by MOC. Therefore MOI decided not to stipulate provisions related to acceptance or taking-over inspections newly, considering circumstances mentioned above. This scope was confirmed at the 1st Steering Committee held on 13 June 2006. Accordingly provisions in the volume 5 for civil works in hydropower are limited to those on periodic inspections.

(b) Basic Courses to stipulate Technical Standards

There are no provisions relevant to civil works in hydropower in the current technical standards volume 5. Therefore it is necessary to stipulate newly a series of provisions concerned to periodic inspections for civil works in hydropower. Basic courses for stipulation are as follows:

i) Primary purpose of technical standards is to prevent public hazards due to failure of electric facilities and their operation. Therefore technical standards should include necessary requirements for facilities and related human activities in order to realize the above-mentioned purpose.
ii) Environmental protection shall be also considered as a fundamental policy of technical standards. Because development and operation of hydropower have close relationship with natural conditions and environment.
iii) Reliability and sustainability shall also be considered as a fundamental policy. Once large failure would happen in hydropower facilities, long-term interruption will be anticipated in electric power supply.
iv) When stipulating technical restrictions, it shall be described not by detailed specifications or procedures, but by performance-based requirements as much as possible. However, due attention shall be paid to the current situation about Vietnamese organization to control technical issues, i.e. there are no private organizations such as academic societies that compile and issue technical guidelines or recommendations. Accordingly it is necessary to make technical standards easy to apply in Vietnam. Resultantly it shall be possible to describe procedures and numerical targets together with performance-based requirements, as far as provision never lose generality. However, it shall be noted that the generality shall be ensured as much as possible in order to avoid over-regulated condition, even if procedures and numerical targets are stipulated.
v) Revised technical standards shall be conformed to the present state of Vietnamese electric sector.
vi) As this technical standard is mandatory regulation, voluntary or vague provisions shall be removed by discussing with Vietnamese C/Ps.

(c) Outline of Technical Standards

Outline of new provisions for civil works in hydropower are proposed as shown in Table 6-5, and agreed through the discussion at the sub-working group (hereinafter SWG), 1st Workshop. The following item were included by request of Vietnamese C/P, though these facility and works are not in service.

1. Pumped storage powerplant
2. Fiber reinforced plastic penstock

Table 6-5 Outlines of Newly proposed provisions in Volume 5 for hydro civil works

Items	Contents
Type of Inspection	Official periodic inspection
Inspection items	- Check of documents /Fulfillment of provisions on organization /Results of independent inspection and maintenance - Field inspection /Confirmation subjects at the powerplant
Contents of technical standard	- Purpose of technical standard - Definitions of terms - Formulation of periodic inspection - Frequency of periodic inspection - Document inspection - Field inspection (Requirements for each civil works to be maintained during operation)
Type of hydropower	- Dam type - Dam and waterway type - Run-off-river type - Pumped Storage type
Civil works to be inspected	- Dam (Concrete dams, Fill dams, Spillways) - Waterway (unpressurized waterways, pressurized waterways) - Appurtenant structures to waterways (Intake, outlets, surgetanks, headtanks) - Powerhouse (on-ground type and underground type) - Steel structures (Gates, Valves, Hoists, Standby power supply) - Environment of reservoir and river - Measuring instruments

(1)-3 Hydro electric

Regarding the part of Hydro-electric matter, Technical standards, Vol.5 will be revised according to the following principles:

i) Autonomic Technical standards regulated as ministerial ordinance

New Technical Standards Vol.6 is premised to be Autonomic Technical standards regulated as ministerial ordinance. Therefore the contents of the standards should cover thoroughly Hydro-Electric Power Plants including electro-mechanical equipment.

Filed test and commissioning test of generator, hydro turbine and auxiliary equipment of Hydro Electric Power Plant should be standardized in the Field Inspection and Completion Inspection.

ii) Securing of general security and maintaining of reliability

The present standards will be revised taking into account of the basic points of securing general security and maintaining of reliability.

From the viewpoint of securing general security reason, insulation level of equipment, dielectric voltages, measuring gaps at assembling parts are very important factors.

These items are standardized in present technical standards; however the values are not general on the viewpoint of world-wide standards.

Therefore the values, such as insulation level, dielectric voltages etc, will be revised and International Standards which are used world-wide will be applied.

iii) Matching with present standards

The following standards are applied presently for a Hydro electric field.

(1) NORMS FOR TESTING VOLUME AND STANDARDS OF ELECTRICAL EQUIPMENT No.365 BCNNg/KT April 9th, 1965

(2) VOLUME AND STANDRADS FOR TEST, ACCEPTANCE AND HAND OVER OF ELECTRICAL EQUIPMENT MOI DECREE No.48NL/KHKT 1987

Above (1) is used as the Periodic Inspection Standards、and (2) is used as the Completion Inspection Standards presently. These standards are classified as follows and each inspection is carried out based on each standards.

① Individual equipment inspection

② Acceptance inspection

③ Periodic inspection

Present measuring values described in the present standards such as vibration is applied in the new standards because the values are judged independently in any cases.

(1)-4 Thermal power

The mechanical standards are newly drafted while the electric ones are revised from the existing standards. The points for revision are stated in the following.

a. Minimum requirements

In Vietnam, the whole network scale is small, so the breakdown of a power-generating unit makes a larger impact on the stable supply of electricity than in Japan. Therefore, the breakdown of facilities in a power plant at the time of tight demand and supply of electricity could cause a massive power outage.

The objectives of this volume to be achieved cover not only securing the publics safety, but also avoiding substantial influence on power supply. The standards specified in this volume don't cover the whole inspection items that are normally conducted in power plant, but include only a part of them that are minimum requirements for achieving the objectives.

b. Mandatory standards

Since the standards in this volume are the mandatory ones by which all the power generating utilities in the entire nation of Vietnam must abide, the standards must also be equally applicable to the power generating utilities besides EVN. Therefore, if the standards include company rule, operation of this standards may be difficult and stipulations like EVN's company rules in existing standards is not covered in the standards.

c. Inspection framework

Different inspection procedures are generally stipulated for different equipment. Therefore, it is impossible to include all the inspection procedures applicable to all the facilities. Such procedures should be specified in company manuals and guidelines, etc. Similarly in the aspect of judgment criteria, it is hard to include the values except part of electric equipment since different facilities basically have different values concerned. Consequently, this volume shows a framework for inspection.

Considering the above-mentioned points, this volume provides a framework for inspection, not a detailed stipulation of inspection so that the power utilities can flexibly respond to the inspections.

The object equipment for completion and periodic inspection includes boiler, steam turbine, gas turbine, generator, and their auxiliary facilities. As for the pressure vessel of boiler and so on, the inspection with consolidated system is conducted; therefore the consistency with such inspection standards has been taken into consideration in this volume.

Originally, inspection is an act to confirm the current status of equipment in comparison with the status that it should be maintained. In other words, after the equipment standards (equivalent to existing

Volume 1 to 4) for thermal equipment is established, inspection items can be decided. However, due to the absence of equipment standards in Vietnam, different Vietnamese and international standards are being applied for each power plant at the time of their construction. Considering this, the inspection is established to cater to these standards.

・Completion inspection

In Japan, the completion inspection is carried out by the utilities on their own initiatives before being put into operation. The cases of appropriate inspection methods are illustrated by METI (Ministry of Economy, Trade, and Industry), among which inspection items include boiler, steam turbine, gas turbine, generator, and so on. Although these cases are not mandatory, mostly the utilities conduct inspections by following them.

Therefore, this revision is made on the basis of inspection items of this illustration in Japan.

・Periodic inspection

Just like completion inspection, periodic inspection is conducted in Japan by the utilities themselves on their own initiatives. Inspection items are illustrated in the same manner, but the internal combustion type of gas turbine, which are ordinarily used in power plant, and generator are excluded from this illustration.

Except for internal combustion type of gas turbines and generators, this revision is made on the basis of inspection items of this illustration in Japan. As for gas turbines and generators, the revision is made on the basis of the inspection normally conducted in Japan.

(2) Work for revision and outcome

(2)-1 Transmission facilities

As a first step of revision process, the inspection items specified in the existing standard were compared with Japan's practice. Table 6-6 shows a part of the comparison. In principle, globally acknowledged IEC standards should be used for comparison. However, they do not provide any stipulation for field inspection. Thus, inspection of Japan's practice is presented solely as examples for reference. The examples are selected with a view to providing technological information useful not only for the current revision but also for future revisions and serving for technology transfer. As described in Chapter 6, the study mission has recommended that minimum necessary inspection items be specified solely from a viewpoint of public safety, and that inspection items for securing power supply reliability will not be specified since they are inappropriate as a mandatory standard. However, as a result of consultation with the Vietnam side, several items, specifically, opening and closing test of switching equipment and operational test of relays and control systems, were added in particular for preventing a widespread and long-term power system breakdown.

Table 6-6 Comparison of Inspection Items between the Existing Technical Standard and Japan's Practice (a partial presentation)

Equipment	Type of Inspection	Existing Vietnamese Standards	Standards in Japan	Remarks
Transformer	In Progress Inspection	3-1-1 (Article Number) Determination of the conditions for electric connection of transformer	None	Necessary.
The existing standard shall be retained.				
Shall be omitted and moved into factory inspections.		3-1-4 Measurement of coil resistance by tester	None	Unnecessary. Included in Factory Inspection. Additionally, it has some risk causing accident because of forgetting degauss.
Shall be retained with Japan's practice reflected.		3-1-8 Inspection of the tap changer and curve graph set up	On-load tap changer a) Switching operation test b) Measurement of current	Necessary.
		⋮	⋮	⋮
	Completion Inspection	None	Measurement of noise / vibration (shall be implemented for the substation as a whole)	Necessary
Japan's practice shall be adopted since the existing standard provides no stipulation.		⋮	⋮	⋮
	Periodic Inspection	None	Operation test of alarm, indicator and protective relay for on-load tap changer	Unnecessary for mandatory
Japan's practice shall be presented for reference.		⋮	⋮	⋮

Inspection items to be specified were determined at consultation with the Vietnam side. A revision of stipulations for those inspection items was proposed based on Vol.5 of the existing technical standards and Japan's practice. Supplementary Document shows the proposed revision of Vol.5.Table 6-7 shows structures and outline of technical standards for transmission facilities.

Table 6-7 Structure and Outline of Technical Standard for Transmission Facilities (Part 2)

Section		Structure and Outline of Technical Standard
Chapter 1	General （1 article）	Specifies generally above-mentioned contents. Definition Terms concerning inspection of transmission facilities are specified.
Chapter 2	Operation and Maintenance Organization （2 articles）	Specifies operational systems and inspections concerning facility maintenance including storage of technical documents.
Chapter 3	Acceptance Inspection （2 articles）	Specifies acceptance inspections on materials and equipment after their transportation.
Chapter 4	In Progress Inspection （31 articles）	General(1 article) Overhead Transmission (7 articles) Earth resistance, wiring, wire connection, OPGW, insulating clearance, insulator installation, transmission tower span and wire height Underground Transmission (9 articles) Cable connection, phase check, earth, cable installation, support structure, insulation resistance, snaking, number of earth points and mutual clearance among cables Substation Equipment (14 articles) Power transformer, instrumental transformer, gas circuit breaker, gas insulated switchgear, vacuum circuit breaker, air circuit breaker, disconnecting switch, air compressor, distribution board, power condenser, lightning arrester, battery and protection relay Specified for each type of equipment above-mentioned and its engineering work in order to check work reliability.
Chapter 5	Completion Inspection （16 articles）	General (1 article) Overhead Transmission (Article 3) Insulation resistance measurement, phase check and voltage withstanding test Underground Transmission (5 articles) Appearance inspection, insulation resistance measurement, phase check, voltage withstanding test and insulating clearance measurement Substation Equipment (7 articles) Appearance inspection, earth resistance measurement, supervision and control tests, interlock test, voltage withstanding test, operation monitoring test, noise and vibration measurements Specified for each type of equipment above-mentioned and its engineering work in order to check work reliability.
Chapter 6	Periodic Inspection （17 articles）	General (2 articles) Stipulations concerning inspection frequency Overhead Transmission (1 article) Inspection items (represented in a list) Underground Transmission (5 articles) Cable inspection, terminal box, cable connection box, oil feed equipment, insulating oil test Substation Equipment (9 articles) Power transformer, instrumental transformer, gas circuit breaker, gas insulated switchgear, vacuum circuit breaker, air circuit breaker, disconnecting switch and protection relay Specified for each type of equipment above-mentioned and its engineering work in order to check work reliability.

The proposed revision was disclosed to concerned parties at the first workshop held in November 2006, where the basic framework and structure of the revision obtained a general agreement and not an objection.

(2)-2 Civil Works in Hydropower

In the current regulation system in Vietnam, a completion inspection for civil works in hydropower is performed according to the technical standards of MOC. Therefore the technical standards Vol. 5 shall include a periodic inspection only for civil works in hydropower.

There have been no institutions on the official periodic inspection for civil works in hydropower so far in Vietnam. Therefore assurance of public safety has depended on only the owners of power facilities substantially.

However, MOI has decided to create the new institution of periodic inspection on hydropower. This implies that what to do is not only to stipulate technical requirements on civil works, but also to create the system itself on periodic inspections. That is why meanings and significance of "official" periodic inspection became one of main issues in discussion with the MOI and SWG, as well as a scope of application, contents of inspection, frequency of inspection, and so on.

1) Meanings of "Official" Periodic Inspection

According to the Electricity Law and related Government Decree, the owners have a responsibility to abide the Law and the relevant Decree, and MOI also has a responsibility to confirm abidance of the Law and the decree. Furthermore, liberalization of the Vietnamese electric sector and participation of IPPs to this sector shall be taken into consideration in regulatory management of electric power industries in Vietnam. Considering these backgrounds, it will be indispensable to establish the confirmation rules and methodology to regulate this sector. The official periodic inspection will be one of tools for MOI to accomplish this purpose.

Basically considering the worldwide trend in regulation of electric sector, basis to secure public safety should be independent efforts by the owners. But MOI should check the fundamental safety of facilities as own duty. Through discussion with MOI and the Sub Working group, it was agreed that the official periodic inspection should be performed by MOI on civil works, which may affect the public safety highly in case of failure.

2) Scope of Application

There is a possibility to cause serious public hazards even for small hydro powerplants. Therefore the technical standards shall apply to civil works of all hydro powerplants, excluding those with the special dams defined by the Government Decree No. 143/2003/ND-CP. This scope was also agreed with MOI.

3) Contents of Periodic Inspection

Assurance of public safety is basically depending on the owners of powerplants. Therefore the MOI's official periodic inspection does not cover all the structures and equipment in hydro powerplants. Issues to be confirmed in the official periodic inspection shall be limited to the fundamental checkpoints on major civil works. Because mandatory requirements shall be minimum for economical and technological point of view, and it shall allow plenty of scope for discretion of private companies as much as possible. In other words, the official periodic inspection is an action to confirm the essential points of independent periodic inspection performed by the owners.

The official periodic inspection consists of two parts. One is check of documents specified at the technical standards. The other is field inspection. Outlines of each inspection are as follows.

Document Inspection: MOI shall confirm that the required documents are prepared and preserved properly by the Owners. MOI shall also examine conditions of civil works of hydro powerplants by checking submitted documents.

Field Inspection: It shall be confirmed mainly by visual inspection whether major civil works conform to the technical standards or not.

However, it is described in the technical standards that execution of field inspection is based on judgment of MOI, considering characteristics such as class, latest condition and risk of failure of each hydro powerplant. In other words, MOI can cancel the field inspection for hydro powerplants, which have no serious risks. This will contribute rational execution of periodic inspection in point of human resources and time.

4) Frequency of Official Periodic Inspection

In principle, frequency of periodic inspection shall be determined according to the conditions of civil works and failure risks. However, as there have been no rules to check the safety of hydro powerplants officially in Vietnam so far, it will be realistic to define fundamental frequency of inspection officially, and to modify it in future empirically if necessary.

In the provision relevant to this issue, it is stipulated that the fundamental interval shall be equal to or less than three years. This is similar to that in the official inspection based on the River Law, which is carried out by Authority in Japan.

5) Procedures of Official Periodic Inspection

MOI shall determine the implementation rules and procedures for the official periodic inspection in near future. During this study, the JICA Study Team presented an example of fundamental procedures as in Fig.6-3. MOI agreed this scheme basically. According to this procedure sequence, the Owner shall submit documents to the Authority on results of independent inspection, repair work and operation such as discharging from spillway. Therefore these documents to be submitted are also stipulated in the technical standard.

6) Organization to carry out official periodic inspection

Main body in official inspection will be MOI in principle. However, it is very possible that the

organization entrusted by MOI carries out periodic inspection, considering a precedent of FERC in USA. Therefore "the Authority" who carries out periodic inspection is defined as "MOI or organizations upon which MOI devolves specified competence in enforcement of the periodic inspection" in the definition of the technical standards. Furthermore an "inspector" is also defined as "a person belonging to or appointed by MOI who carries out periodic inspection" similarly. However, as for inspection organization, further discussion will be indispensable.

Based on the above, outline of the technical standard on periodic inspection for hydro civil works is shown in Table 6-8.

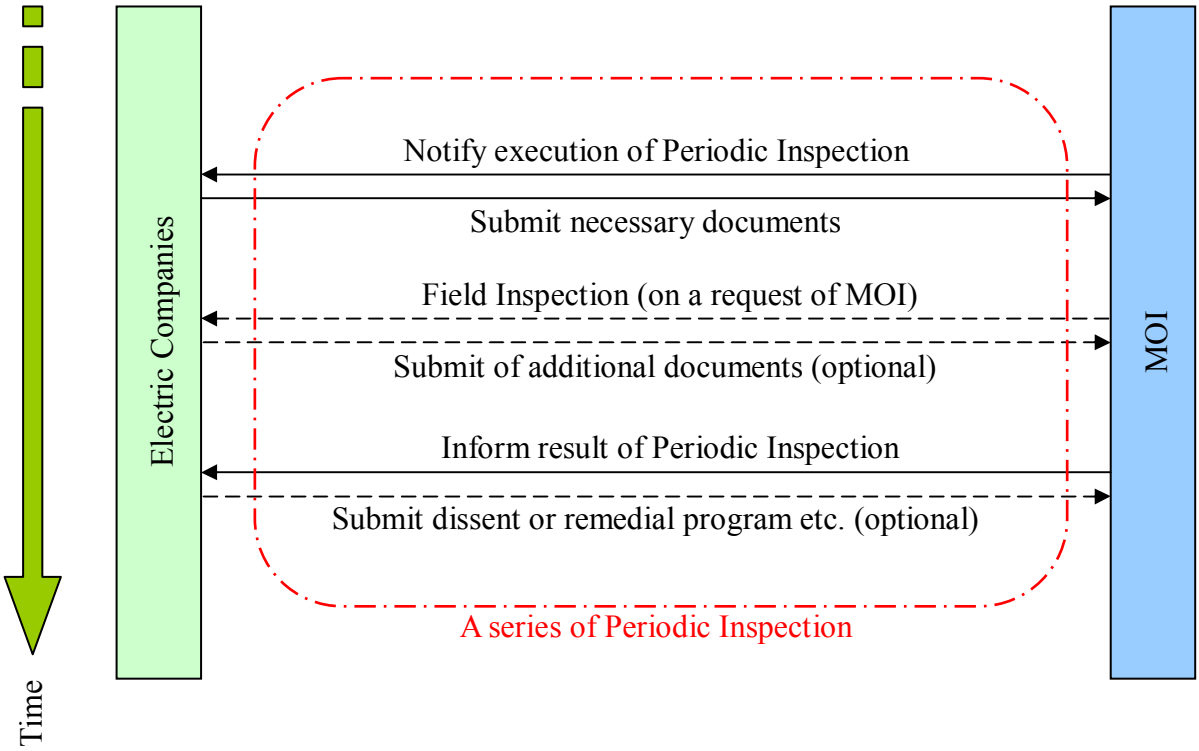


Figure 6-3 Outline of Procedures in Periodic Inspection

Table 6-8 Structure and outline of Technical standard on Periodic inspection of Hydro Civil Works

Structure		Outline of Contents
Chapter 1 General Provision		Common items to Civil works and electric equipment are stipulated in 1 articles: - Definitions.
Chapter 2 Organization and Management of Operation and Maintenance		Administrative issues are stipulated in 2 article.
Chapter 3 In-progress Inspection		(Electric Equipment)
Chapter 4 Completion Inspection		(Electric Equipment)
Chapter 5 Periodic Inspection	**Section 1** General	Following items are stipulated in 2 articles: - Formulation of Periodic Inspection; - Frequency of Periodic Inspection.
	Section 2 Dams	Following items are stipulated in 4 articles: - Concept of checking dam safety; - Concrete dams; - Fill dams; - Spillway.
	Section 3 Waterways	Following items are stipulated in 2 articles: - Pressured waterways; - Non-pressured waterways.
	Section 4 Appurtenant Structures to Waterways	Following items are stipulated in 4 articles: - Intakes and outlets; - Settling basins; - Surgetanks and Headtanks; - Spillways at Headtanks.
	Section 5 Powerhouses	Following items are stipulated in 3 articles: - Structure of powerhouses; - Rock supports; - Slope stability around powerhouses.
	Section 6 Hydromechanical Equipment	Following items are stipulated in 3 articles: - Gates and Valves; - Hoists; - Standby Power Supply.
	Section 7 Reservoir and River Environment at Downstream of Dam	Following items are stipulated in 3 articles: - Slope stability; - Sedimentation; - Erosion of riverbed and riverside.
	Section 8 Measuring Instruments	Following items are stipulated in 2 articles: - Condition and performance of measuring instruments; - Calibration of equipment
	Section 9 Electric Equipment	

(Common provisions: 3 articles in total, Provisions for Civil works: 23 articles in total)

(2)-3 Hydroelectric equipment

Regarding Hydroelectric equipment of Technical standards Vol.5, was studied with Sub working group members.

The principles of this revision are studied on the view points of (1) Self Inspection under the electric low, (2) Secure of public safety and reliability, (3) Matching for existing standards, according to the Item 6.1.2.

By making comparison table of inspection items between existing standards and draft of new standards, started the study.

Conception of Self inspection regulation, it has already taken root in Japan under the Electric Low. The contents of Self inspection regulation are regulated as "Ministerial Ordinance of METI" issued as No.61 which is named "Ministerial Ordinance of Technical Standards for Electrical Equipment".

As for the detail content, it is standardized as "self company inspection rule" at each electric company. Regarding, necessary inspection item on Hydroelectric equipment, the method and criteria are common, therefore the basic common inspection items are adapted.

The test items to be inspected before commercial operation are (1) Generator characteristic test, (2) Gap measurement, (3) Hydro turbine control test, (4) Load rejection test.

These items are already inspected at existing site under the existing standards; therefore these items were agreed with Vietnamese side. Numerical values of inspection are changed to the new values according to the international standard which is used widely in the world taking into account of getting increase electric power company and fitting to the global standard.

On the view point of secure public safety, insulation performance of electric power equipment have to be maintained, therefore (1) Earth resistance measurement, (2) Insulation resistance measurement, (3) Dielectric test are taken up as inspection items. These items, the Numerical values are changed to the new values of international standards as same as above mentioned.

Regarding Periodic ordinary inspection, existing frequency is adapted.

The revised Vol.5 is shown as attachment.

Inspection items are shown in Table 6-9.

Table 6-9 Summary on component of technical standard of Hydroelectric

Chapter		Contents
Chapter 3	In Progress Inspection 11 articles	Inspection items —Earth resistance measurement —Insulation resistance measurement —Dielectric test —Air gap measurement —Tan δ test and DC current absorb test —Generator characteristic test —Axial voltage measurement —Hydro turbine control test —Inlet valve operation test —Auxiliary equipment test —Vibration measurement
Chapter 4	Compression Inspection 11 articles	Inspection items —Initial run —Bearing run —Automatic start and stop test —Load rejection test —No load no excitation test —Emergency stop test —Quick stop test —Load test —Output test —Generator-pumping operation test
Chapter 5	Section 9 Electrical Equipment 11 articles	Inspection frequency Frequency periodic ordinary inspection is 3 years Inspection items —Visual inspection —Insulation measurement —Dielectric test —Axial voltage test —Vibration measurement —Hydro turbine control test —Inlet valve operation test —Auxiliary equipment test —Automatic start and stop test For above items, the purpose, inspection method and judgment criteria are regulated.

(2)-4 Thermal Power Facilities

Before revising the standard, the necessary information for the revision should be shared with Vietnamese side. Information for outline of this standard, status of technical standards in Vietnam, status of inspection in Japan and the world, etc. was exchanged. The policies of revision are shown in 6.1.2 as a result of discussion.

It was confirmed that most of power plants don't use existing technical standards because the existing

standards is too old to apply to inspections in power plants. As for mechanical equipment, since there is no existing technical standard, inspections are conducted by each power plant based on manufacturer's instruction. Power plants conduct inspections on their own. In addition to it, it is necessary to stick to the existing standards and there are few countries which has mandatory regulation for inspection of thermal power facilities, except Japan. Therefore, technical standard was set to be revised on the basis of technical standards in Japan after the discussion with Vietnamese side. Each article of draft revised standard was modified according to the discussion with Vietnamese side.

While the standard includes completion inspection and periodic inspection, in-progress inspection is out of scope. This is because that it is possible to basically confirm safety of thermal power facilities at the completion inspection, and in-progress inspection can be left to the utilities' hands. And necessity of the in-progress inspection hasn't come out from the Sub-working group. Therefore only completion inspection is included in the standard as inspection after engineering work.

The draft revised standards was disclosed to the stakeholders at the 1st workshop on November 2006 and 2nd workshop on February and March 2007 and any obvious objections about policies of revision and structure of draft standard were raised. The other comments were examined and reflected to the revised standard if necessary.

Structure and outline of stipulation for thermal power facilities are shown in Table 6.1.10.

Table 6-10 Structure and outline of stipulation for thermal power facilities (Part 4)

Section		Basic structure and outline
Chapter 1	General Provisions (1 articles)	The following contents are prescribed as general provisions. Definition of term Term for inspections of thermal power facilities is defined.
Chapter 2	Organization for operation and maintenance (2 articles)	Inspections for operation organization and storage of technical material necessary for safety of facilities are stipulated.
Chapter 3	Completion inspection (21 articles)	Inspections at the completion of construction, etc. are prescribed. General (2 articles) General information concerning completion inspection are prescribed. Mechanical equipment (9 articles) General inspection, safety valve test, alarm device test, interlock test, speed governor working range test, emergency governor test, load dump test, load test and so on. Electric equipment (11 articles) Visual inspection, measurement of grounding resistance, measurement of insulation resistance, dielectric strength test, protective device test, protective device test for hydrogen and seal oil, protective device test for the stator cooling system of generator, unit interlock test, load dump test, load test, measurement of noise and voice.
Chapter 4	Periodic inspection (20 articles)	Inspections which are periodically conducted are prescribed. General (2 articles) General information concerning periodic inspection and its interval are prescribed. Mechanical equipment (9 articles) Visual inspection and open inspection for boiler, steam turbine, gas turbine and so on are stipulated. Electric equipment (7 articles) Visual inspection and open inspection for generator, synchronous phase modifier motor and so on are stipulated.

(3) References Cited

Appendix2 shows a summary of references that are cited or consulted for compiling Vol.5. Therein, Japan's technical standards and other industrial standards are adopted as well as globally acknowledged standards including IEC and ANSI. Vol.5 provides stipulations for transmission, hydropower and thermal power facilities, which global standards including IEC basically do not concern. Therefore, in consultation with the Vietnam side, it was decided that Japanese standards will largely be adopted.

6.1.3 Vol.6 (Operation standard)

Structure and contents of Vol.6 shall be based on the current standards with generalization and minimization of contents and compatibility with other volumes in mind.

(1) Basic Policies for Revising

(1)-1 Transmission facilities

Part5 "Electrical Equipment of Power Plants and Grid" and Part6 "Load Dispatch Command and Operation" specify transmission facilities. Otherwise, the National Standard for Power System Dispatching （QTDD-11-2001） provides for power system dispatching and operation, which shall be referred to at the current revision work.

(1)-2 Civil Works in hydropower

(a) Outline

Technical standards volume 6 is based on the operation of powerplants and grids. As it is not particularly appropriate to stipulate mandatory provisions for daily operation and maintenance of electric facilities, it is usual to treat those provisions as voluntary standards in developed countries except for some critical rules such as gate operation of spillways. However, it is not recommended to shift this volume to voluntary guidelines immediately or to eliminate from the technical standards of MOI. Because this volume has been used as a manual of EVN or transfer tool of know-how from an historical angle.

Considering this circumstance, the JICA Study team shall revise this volume under the principles, the same as those for volume 5.

(b) Basic Courses to amend Technical Standards Volume 6

Basic courses for the amendment of volume 6 are fundamentally the same as those for volume 5, which are described in the previous section 6.2.1. In addition to this, the following criteria shall also be employed, considering that the volume 6 is concerned with daily activities at powerhouses.

i) Provisions related with the pursuit of efficiency and benefits in operation shall not be included in the technical standards.
ii) Manual-like guidelines and detailed procedures, which do not have technical universality and necessity, are basically eliminated.
iii) Transfer or distribution of know-how on a daily operation and maintenance shall be basically excluded, because it does not fit in with mandatory provisions.

(c) Outline of Technical Standards

Results of investigations of chapter 12 and 13 in the current technical standards volume 6, where provisions for civil works are gathered, are shown in Table 6-11.

In this Table, each article is classified into predefined categories and judged whether it is appropriate as a provision of technical standards or not. Judgment criteria are shown in the previous section (b).

As a result, the number of articles to remain in chapter 12 and 13 will be 39, which is about 70% of the original. Furthermore two articles are newly added.

Table 6-11 Investigation and Classification of Current Technical Standards Volume 6

Titles	Article No.	Category					Classification	
		Design	Construction	Taking-over	Operation & Maintenance	Periodic Inspection	Regulation	Company Rules
Civil Works	141	○			○	○	○	
	(142)				○		○	
	143				○		○	○
	144				○		○	○
	145				○		○	
	146				○		○	
	147				○		○	○
	148				○		○	
	149				○		○	
	150				○	○	○	
	151				○	○	○	
	152				○	○		○
	153				○			○
	154				○		○	
	155				○	○	○	
	(156)							
	157				○			○
	158				○		○	
Check of Civil Works' Condition	159					○	○	○
	160			○				○
	161			○			○	○
	162	○			○	○	○	
	163				○	○	○	
	164				○			○
	165				○		○	○
	166					○	○	○
	167					○		
Mechanical Equipment for Civil Works	168				○		○	○
	169				○	○		○
	170				○			○
	171				○		○	○
	172				○			○
	173				○			○
Water Regulation	174				○		○	○
	175				○		○	○
	176				○		○	○
	177			○	○		○	
	178				○		○	
	179				○		○	
	180				○		○	
Keeping from Sedimentation	181				○		○	○
	182				○			○
	183				○			○
	184	○			○			○
	185				○			○
	186				○			○
	187				○		○	○

Hydro-meteorological Activities	188				○		○	○
	189				○		○	○
	190				○			○
	191				○		○	○
	192				○		○	
	193				○			○
	194				○			○
	195				○		○	○
	196				○		○	○
	197				○		○	
	198				○		○	
Total	**56**	2	0	3	51	11	**39**	36

(1)-3 Hydro electric

1. Status of present standards Vol.6

In the present standards for Vol. 6, mostly the Steam Turbine Generator in Thermal Power Plant is regulated, while the Hydro generator is regulated partially.

Standardized items of Hydro electric matters are Interval of periodic inspection, automatic control of turbine, remote control of generator, protection relay, emergency power source, allowance of bearing, winding temperature, and overload operation.

The descriptions are mostly provisions and not values, however allowance of vibration, interval of periodic inspection, insulation resistances and percent over load are numerically described.

2. Principles of revising

As for the new version of Vol.6, taking into account the present standards, it will be revised according to the following principles:

1. A part of the double standards (interval of periodic inspection, insulation resistance) is matched with the new version vol.5.

The basic component of the present vol. 6 has not changed.

2. Present allowance values described in the present standards such as vibration is applied in the new standards because the values are judged independently in any cases.

3. Contents of the present vol.6 are mostly described as provisions, therefore the provisions which are judged unnecessary to revise are maintained in the standards vol.6.

(1)-4 Thermal power

Regarding the revision relevant to thermal power in Volume 6, the following principles have been determined in response to the current situation and the issues of Volume 6 upon the agreement at Sub working group.

a. Generalize or delete the articles that are not general or insignificant

The existing Volume 6 is actually applicable as mandatory standards to only EVN. Thus, many stipulations that can hardly be applied to other utilities except EVN are found, for example, the EVN corporate organization, procedures, and so on. Such kind of articles are generalized or deleted since the mandatory standards can also be applied to IPPs other than EVN after revision.

Besides, the existing Volume 6 includes a lot of stipulations that aren't related to securing public safety, such as operation methods and standards for equipment. Since such articles have influence on the efficiency of equipment operation and should be decided on by each utility, it is not desirable to stipulate them as mandatory regulations. From this point of view, articles with lower importance are deleted.

b. Avoid the inconsistency with the contents of Volume 5 (Inspection standards)

Just as it has been stated in Chapter 3, since the inspection-related matters are also described in Volume 6, the repetition of and contradiction between Volume 5 and 6 may occur. To avoid such an inconsistency, those articles are either moved to Chapter 5 or deleted.

c. No change of present structure

Without changing the structure based on the existing Volume 6, work specified in a. and b. is conducted.

In accordance with these principles, SWG discusses the proposed revision made by the JICA Study Team and prepares the final version.

However, as for Chapter 17 (Boiler) and Chapter 18 (Steam turbine), we discussed the proposed revision that were made by the JICA Study Team and prepared the final draft at the on-site research conducted in October 2006.

(2) Work for revision and outcome

Vol.6 provides stipulations for management and operation of all transmission, hydropower (civil work, electrical equipment) and thermal power facilities. As described in Table 6.1.12, each sub-working group discussed concerned Parts. Parts concerning all sub-working groups, such as Part 1 and Part 2, were discussed at each working group in parallel.

Table 6-12 Role Division among Sub-Working Groups in Revising Vol.6

		Hydro	Thermal	Network
Part 1	Organization for Operation	○	○	○
Part 2	Plan, House and Power Plants	○	○	○
Part 3	Chapter 12 Civil work and mechanical・・・	○		
	Chapter 13 Management of water sources・・・	○		
	Chapter 14 Hydraulic turbine	○		
Part 4	Mechanical and Thermo Equipment of ・・・		○	
Part 5	Chapter 26 Generator and Synchronous compensator	○	○	
	Chapter 27 Electric Motor		○	
	Chapter 28 Transformer, auto-connected transfer			○
	Chapter 29 Distribution network			○
	Chapter 30 Battery system		○	○
	Chapter 31 Overhead lines			○
	Chapter 32 Power cable lines			○
	Chapter 33 Protective relay and automation			○
	Chapter 34 Grounding equipment			○
	Chapter 35 Over-voltage protection			○
	Chapter 36 Electrical indicating and measuring equipment		○	○
	Chapter 37 Illumination			○
	Chapter 38 Electrolyte station		○	
	Chapter 39 Energy oil		○	○
Part 6	Load Dispatch Command Operation			○

○ shows the shared part with each SWG

In consultation with the Vietnam side, opinions for Vietnam to list a study mission's comments and proposed revisions to original stipulations

Table 6-13 compares the numbers of articles of each Part between before and after the revision.

Table 6-13 Numbers of Articles of Vol. 6 before and after Revision

	Number of article	
	Original	Revised
Part1 General	0	3
Part2 Organization for Operation	113	25
Part3 Plan, Houses and Power Plants	26	13
Part4 Civil Works, Water Sources Management of Power Houses -Hydraulic Generator-	84	50
Part5 Mechanical and Thermo Equipment of Power Plants and Grids	334	142
Part6 Electrical Equipment of Power Plants and Grids	293	133
Part7 Load Dispatch Command - Operation-	92	23

Part1: "General" is newly added, which shall clearly specify purpose and scope of Vol. 6.

Other Parts are largely simplified through generalizing stipulations and deleting inappropriate stipulations as mandatory ones.

Supplementary Documents shows the proposed revision of Vol.6. Since the contents to be covered in Vol.6 were changed at the second field survey according to Vietnam side's request, it was not presented at the first workshop. It shall be presented at the second workshop.

6.1.4 Vol.7 (Construction work)

(1) Policies for revision

Like Vol.6, structure and contents of Vol. 7 shall be based on the current standard, with problems of the current standard described in Chapter 3 kept in mind, and will be revised according to the following basic principles.

JICA Study Team shall make a revision scheme, which SWG shall consult and modify if necessary.

(i) Compatibility with the contents of Vol. 1～6

Contents that already are or naturally should be covered in Vol.1～6 are covered in the current Vol.7. To avoid incompatibility, contents of Vol.7 as well Vol.1～6 shall be modified or deleted and be reflected in Vol.1 ～6 as necessary.

(ii) Generalization of contents

Engineering work methods, procedure and regulation values as well as materials and equipment that are used in the engineering work, which are different according to equipment type, specifications and environment that each manufacturer and engineering work company adopts, should largely be left to each equipment owner's discretion.

Therefore, items that cannot be uniformly specified shall be deleted or modified into general descriptions with only minimum requirements from the viewpoints of engineering work quality and system reliability.

(iii) Deletion of stipulations for equipment that are not currently adopted

Mercury-arc rectifiers, open-type batteries and other equipment are not currently adopted in general, while semiconductor rectifiers and closed-type batteries are used instead. Therefore, stipulations for old-type equipment shall be deleted with stipulations for only new-type equipment retained.

(iv) Deletion of stipulations for equipment outside the jurisdiction of MOI

It has been agreed between the Vietnam and Japan sides that the current revision work shall cover transmission facilities, not including domestic wiring. Therefore, stipulations for installation and domestic wiring of electric equipment for consumer use (motor, crane, belt conveyor, elevator, etc) shall

be deleted.

(v) Addition of stipulations for installation of GIS

Vietnam side required that stipulations for installation of GIS (Gas insulated switchgear) be added and that was agreed.

Items to be added shall be decided by referring to Japan's engineering work procedures and quality control standards, while contents that have been reported by Electric Technology Research Association, etc and generally adopted shall be incorporated in order to generalize the stipulations.

(2) Work for revision and outcome

Like Vol.6, Vol.7 shall be revised based on the structure and main stipulations of the existing standard. The study mission produced a consultation material, which sub-working groups then worked on and adjusted. Supplemental Document shows the proposed revision of Vol. 7.

The proposed revision was disclosed to concerned parties at the first workshop held in November 2006, where the basic framework and structure of the revision obtained a general agreement and not an objection.

6.1.5 Future Tasks for Revision and Management of the Technical Standards

For appropriate revision and smooth management of the Technical Standards, further improvement in management and technical aspects surrounding the Technical Standards is essential in addition to organizational development, recruitment and education of inspectors, which shall be discussed in Chapter 7.

These aspects are described as follows.

(1) Proper linkage between related laws and regulations

It is desirable that the following items be clearly specified in the legal system (the Electricity Law and its enforcement regulations).

1) Establish implementation rules of the Technical Standards

The technical standard Volume 5 specifies inspection items and their contents, and does not include its implementation rules. Therefore it is indispensable to establish concrete rules for procedures, formats, application forms and other aspects for enforcement of the technical standard Volume 5.

2) Clarify obligation of the Owner of the electric facilities on reporting of accidents to MOI

According to the present law and decree, in case of faults or accidents at electric power facilities, immediate report to the National Load Dispatch Center is obligatory for the Owner. However, it is necessary to extend this obligatory report to the MOI in order to secure public safety. This obligation shall be to stipulate in the law or related decree.

(2) Establishment of technical guidelines

Considering international trends and WTO requirements, the technical standards are fundamentally prepared according to “performance-based” style. Therefore, in order to realize smooth application of those technical standards, it is desirable that technical guidelines that provide explanation of technical

backgrounds of provisions and examples of application are prepared.

(3) Establishment of database system

In order to carry out proper management of electric facilities, it is desirable that a database system of accidents and other information is established in MOI.

Furthermore, design standards for civil works in hydropower are under control of other ministry (MOC). Thus it is difficult for MOI to reflect its demands concerning measurement equipment for in-service safety management of the facilities. In order to solve this issue, the following efforts are required.

(4) Alignment with other ministries and agencies concerning design standards

MOC, which is in charge of design standards for dams and other civil works, examines and issues a specific design standard for safety and rationality of each individual construction project, rather than establishes common and minimum requirements for all projects. Thus, measuring instruments for safety management are different among construction projects, which inhibits establishment of a rational system for regular inspections. It is desirable that MOI arranges basic design requirements for safety management of hydro power plants including measuring instruments and consult with Ministry of Construction and other authorities in order to adequately reflect the requirements on design standards.

6.2 Basic Policies for the Revising of the Safety Standards and Result

The present standard composed of 7 volumes for each facility was integrated into the standard with one volume with 12 chapters[5]. The clauses of the revised standard are grouped into chapters for each electrical work so that the overlap of clause described in each volume should be cleared, however the present safety standard is composed according to type of facilities. The clauses of the present safety standards classified as “company rules” are excluded and only the rules worth having mandatory power as national regulation are to be carefully selected, and the contents that we avoided the expression specifying a particular operation method, or used tools or materials so that it should be applied not only to the existing specified electric power company such as EVN, but also to newcomers after liberalization of power industry.

We accepted the opinion in the first workshop held on November 2006 that it is also important to regulate the detailed procedure of some works in order to prevent the accidents of small-scale companies other than EVN, even though the policy that the new standards should have only general contents worth having mandatory power does not have any problem. As the result of MOI and EVN, some detailed clauses corresponded to voluntary regulations are added for such dangerous works as “hot line work”, “the work near hot line” and other items especially requested by C/Ps on condition that the detailed clauses cannot lead to extreme regulation, generalizing the contents of the present safety standards.

There are the regulations about necessary safety qualification (safety level I to VII) for every kind of work, supervision and management everywhere in the current safety standards. This safety level is the one

[5] At first, the draft safety standard consisted of 6 chapters. But as the final stage, we changed the number of chapters to twelve, because the Vietnamese side proposed that the former "Chapter 5" should be divided into 7 chapters, and finally the safety standards become to consist of 12 chapters.

of the company rules of EVN and the criteria of its certification are age, experience and knowledge about safety of the staff. The safety level is not authorized by a national organization. In Japan, there are the qualifications stipulated in "Occupational Health and Safety Law" that people can obtain by taking a lecture etc. such as " Chief safety specialist for oxygen deficiency and hydrogen sulfide". But they are specified to license of particular work, and there is no qualification concerning overall safety works.

If the safety level is to be continued in the newly established safety standards in future, it seems that the Vietnamese government needs to build new qualification concerning overall safety works that is authorized by a national organization. (In Japan, there is the system of chief electrical engineer concerning supervision of safety matters of construction work, maintenance and operation of the power facilities, and for the chief electrical engineer's license, the qualifying examination taking the questions about overall electrical engineering is administered. It is considered a similar example.) If the system of the safety qualification concerning overall safety works is to be instituted, it is necessary to make a sufficient design of institutional arrangements in Vietnam in future. Therefore, we decide that the safety qualification concerning overall safety works is not to be reflected on the newly established safety standards, because the reflection of it is premature.

The content and the policy of each chapter are described as follows.

The safety standards revised in this study are expected to be enacted as MOI's mistrial ordinance by the end of July 2007 after checking and approval of the relevant authorities.

6.2.1 Chapter 1: General Provisions

In order to make clarify the position as a national regulation, the articles concerning ‘purpose’, ‘scope of application’, ‘definition of words’, ‘observance of related laws and regulations’ and ‘responsibility of employer’ , ‘safety when contract work’, ’Observance of regulations’ etc. are described in accordance with constitution of articles in general laws or ordinances.

It's notable that the safety of workers themselves and the public safety during a work are two centerpieces of safety standards, and it is clarified in "Purpose of these Safety Standards". Safety standards have the specialized contents for safety during works, and do not apply to standards for facilities concerning safety.

Thus, the applied scope is established so that it can have a clear distinction between the role of safety standards and technical standards.

6.2.2 Chapter 2: Setting up a Work Area

(1) Work for equipment at power plants and substation

The measures taken to prohibit or to prevent from the third persons from entering in work places (Installation of fences, warning signs, locking devices etc.) are stipulated. And the regulations concerning security of necessary distance from an energized part, luminous intensity on the work area, which is based on the article 604 of ‘Ordinance on Industrial Safety and Health’ in Japan are also reflected

(2) Work for equipment at power networks

The safety can be secured in a usual condition in case of equipment at power networks because it was constructed so that it can take enough distance from the third persons. But when working at equipment at power networks, the measures such as fences and warning signs have to be taken to prevent the third persons from coming close to it, depending on circumstances. In this section, the regulations concerning these measures are reflected. In addition to installation of fences or warning signs, the measures (prior announcement, security of passage for walkers, disposition of guardspersons) for road traffic restriction frequently implemented in case of works on transmission lines or distribution lines.

6.2.3 Chapter 3: Organization of a Work Unit

(1) Responsibility of a supervisor

Organization of a work unit centered around the supervisor and setup of administrative chain of supervision and order are stipulated, which are necessary for the security of safety of works. And the additional designation of a responsible person (general administrator) is stipulated, who administrates the overall work when more than one work unit are engaged in a large-scale work.

And the additional designation of an electrical safety supervisor is stipulated, who specialize in managing the electrical safety for the workers if necessary.

(2) Role of a supervisor

The roles that a supervisor should fulfill are stipulated, such as promotion of activities for safety work, security of public safety, check of health condition of workers, explanation of the work contents before a work, monitoring of workers during a work, etc.

(3) Attitude of a Worker

The items that each worker should obey are reflected, such as obedience to orders from a supervisor, prohibition of entry to dangerous area, carrying of first-aid kits, etc.

6.2.4 Chapter 4: Protective clothing and devices, appliances and equipment for hot-line work

Use of protective clothing and devices, use of appliance and equipment[6] for hot line work, periodical check and maintenance for them, daily inspection for them, etc. are stipulated.

---

[6] The study team suggested that the words "Appliance for hot-line work" and "Apparatus for hot-line work" should be defined in the Article 3 “Definition of Words” at first, but finally they are not defined because the Vietnamese side judged that it is unnecessary. The meanings of these words are as follows:

"Appliance for hot-line work" means an insulated stick tool the part of which grasped by a worker during a work is made of an insulating material.

"Apparatus for hot-line work" means a vehicle for hot-line work, or an insulating stand that is electrically isolated from the ground.

6.2.5 Chapter 5: Measures for Safety concerning a Work

The common regulations applied to overall works are reflected, that are implemented when planning, when preparation, during a work, after a work or when suspending a work due to an unexpected occurrence.

(1) Planning a work

Arrangement of a work plan, decision of the chain of supervision and documentation of the work plan are stipulated. And cancellation or postponement of a work in case of bad weather is also stipulated.

(2) Work order, work sheet

The work necessary for a work sheet[7], submission and approval, the contents are stipulated, concerning a work sheet. The contents of the work sheet that correspond to the minimum requirements as the safety standards are as follows:

- Full name of the authorizing person and the issuer
- Full name of the supervisor
- List of the workers
- Content of work
- Working time (time, day, month and year)
- Condition of work (Work with Power Interruption, Hot Line Work or Work near Hot Line)
- Allowable working area

(3) Preparation of a work

Confirmation of safety measures, check of the condition of voltage detector, protective devices, etc. are stipulated.

(4) During a work

Operation of heavy load, conveyance of materials, check before climbing supporting structure, check of power interruption and earth leakage, etc. are stipulated. And Safety measures taken for excavation work are also stipulated. In response to the requests from Vietnamese side, the contents of present safety standards are additionally reflected as they are, such as the limited value of the depth of excavation and the use of pales for retaining soil (refer to Article 61).

[7] Vietnamese C/Ps discussed which is better for the title of the document, “Work Permit” or “Work Sheet”. As a result, the title seemed to be decided as “Work Sheet”.

(5) Suspension of a work

Safety measures when suspending a work because of day's end etc. are stipulated. And safety measures when discovering unusual equipment, or when an accident or a disaster has occurred are stipulated. Additionally, first-aid treatment to help a sufferer is reflected.

(6) After a work

Check and cleanup after work, and handover of a site are stipulated.

6.2.6 Chapter 6: Measures for Work on Electrical Equipment

Measures for prevention of wrong operation or errors of switches are stipulated. And safety measures individually taken to motors, switchgears, circuit breakers, instrumental transformers, battery system, etc. are also reflected which are necessary for the security of safety during a work on electrical equipment.

And according to the wishes of Vietnamese side, the detailed contents of the present safety standards are stipulated, concerning the following items.

- · Flammable dangerous substance (refer to Article 71)
- · Operating the electric motor (refer to Article 72)
- · Measures concerning work with Switchgears (refer to Article 73)

Moreover, in response to the request from Vietnamese side, the following items are stipulated.

(a) Distribution cubicle

The regulation about the structure of distribution cubicles is formulated based on the regulation in Japan (refer to Article 73).

(b) Cable work

The regulations about the cable work are formulated based on the regulations in Japan, such as discharge of residual charge, prohibition of use of bulldozers, placement of the cables and cables stripping (refer to Article 75 to 78).

(c) Instrumental transformer

The earthing of the coil of the secondary side during a work is stipulated (refer to Article 79).

(d) Battery system

Treatment of acid and alkali in the battery system, prohibition of fire, and ventilation of battery system room are stipulated (refer to Article 80).

6.2.7 Chapter 7: Measures for Work with Power Interruption

Installation and handling of earth for work, direction of starting work, demonstration of equipment number etc. for discrimination, measures for prevention of wrong operation or errors of switches, discharge of residual electric charge, implementation of voltage check, etc. are stipulated.

6.2.8 Chapter 8: Measures for Hot line work

Security of distance from an energized part, use of protective clothing and devices in case of hot line work, etc. are stipulated. The necessity of using of appliances and equipment for hot line work is made clear on the condition that the voltage is over 1000V or up to 1,000V. And the regulations about specific hot line works are formulated, such as replacement of chain insulators and cleaning of insulators.

6.2.9 Chapter 9: Measures for Work near hot line

Security of distance from an energized part, use of protective clothing and devices in case of work near hot line, etc. are stipulated.

6.2.10 Chapter 10: Measures for Work at Site in danger of Oxygen Deficiency

The following measures are stipulated, referring to 'Ordinance on Prevention of Anoxia, etc.' in charge of Ministry of Health, Labor and Welfare in Japan

(Before a Work)

- Installation of fences to prohibit the third persons from entering in the work area
- Measurement of the density of oxygen and noxious gases
- Measures in case that the density is not within range of the regulated value

(During a Work)

- Ventilation
- Prohibition of using products causing ignition
- Disposition of watching person

(Measures for Accident)

- Evacuation
- Medical examination and treatment

6.2.11 Chapter 11: Specially-Equipped Vehicles

The regulations concerning operators, periodical inspection, and prevention of operation in case of strong wind are reflected. And prevention of falling, prevention of workers being hit and use of a safety

belt are also reflected. The participants on the 2nd workshop are divided over the stipulation of using safety belt with supplemental lope during the work on an aerial-working vehicle[8], and we stipulate that the using of it is obligated in principle, even though the same shall not apply to the aerial-working vehicle without the part where the hook of a safety belt is hanged.

6.2.12 Chapter 12: Testing Stations and Laboratories

After the careful selection of the contents from the volume 6 of current safety standards, installation of the fences on the area where a test or an experiment is performed, inspection and maintenance of experimental tools, check of test circuits and safety measures for discharge experiments are stipulated. According to the request from Vietnamese side, the following detailed regulations are also reflected.

- Switching instruments in a supplying circuits for circuit connection capacitors
- Earthing
- Check of inverse voltage
- Mechanical Strength Test for Insulators

6.2.13 Appendix

The sample of the work sheet stipulated in Chapter 5 is shown in this chapter.

[8] There are no international regulations that an aerial-working shall have the equipment where the hook of a safety belt is hanged. (But the necessity of the using the safety belt is widely recognized, and some standards stipulate the installation of a hooked part.)

Chapter 7 Current Status of Inspection System and Recommendation

In the technical standards amended in this study, roles of MOI and the Owners of electric power facilities were clarified in securing safety of the facilities. In addition to the clarification about roles, in order to secure effectiveness of the framework employed in the technical standards, inspection by MOI shall be indispensable to check the Owner's observance of the technical standards. Although it is very necessary for MOI to establish proper inspection system in order to fulfill his responsibilities, an inspection system in MOI has not been undeveloped excluding the one department so far.

In this chapter, current organization of MOI is referred from viewpoint of inspection implementation structures at first, and then current situation on how to secure safety of electric power facilities and equipment in network, hydro and thermal power is described, including the Owners' own activities for safety. In conclusion, desirable direction in establishing inspection organization in MOI is recommended based upon the current status.

7.1 Current Status of Inspection

7.1.1 Organization of MOI

Organization of MOI is outlined in Fig.7-1. MOI consists of nine departments and one authority, and is in charge of administrating not only electricity but also overall energy and other industrial sectors. In the organization showed in Fig.7-1, DIST, Department for Local Industry Development and ERAV are affiliated agencies of MOI, and their finance and personnel management are carried out independently of main body of MOI.

In this study, DST, ERAV and DIST participated in the steering committee as constituent members. The DST is responsible for establishing laws, ordinances, coded and standards concerning the energy sector. As for inspection on abidance of laws and regulations, it is stipulated as one of DST' tasks in the Minister Decision No.1352/QD-BCN dated 23 May 2006. But it is not organized as of April 2007. ERAV is a regulatory authority in the electricity sector, but positioned as an organization mainly responsible for issuance of business licenses and management of an electricity market that will be created in the future. ERAV has not owned any inspection system so far. DIST is in charge of inspections concerning management of codes and standards solely in MOI. Still, currently, only boilers, which are pressure vessels, are subject to inspections among electrical equipment. Other electrical equipment is not inspected at all.

Outlines of the three departments, namely the DST, the DIST, and ERAV, whose duty includes or is closely related to inspection and regulation shall be described in the following.

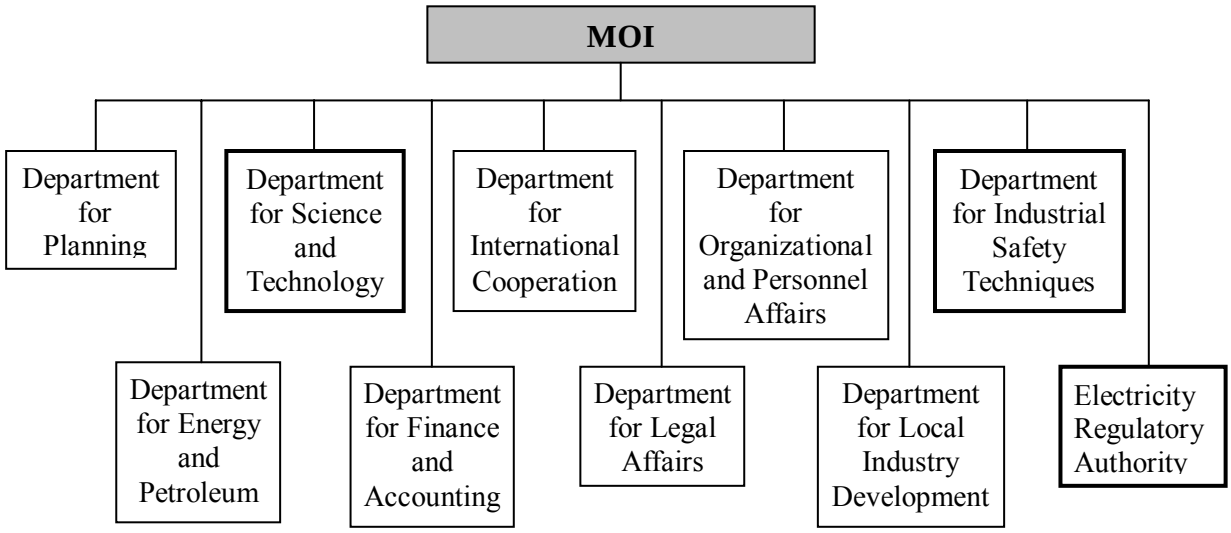


Figure 7-1 Organizational Structure of the MOI

1) The Department for Science and Technology

The responsibilities of the Department for Science and Technology are specified in No.13/2006/QD-BCN, a governmental decision that was approved on May 23, 2006. The decision stipulates that the department shall be the administrative organization that manages and supervise science, technology, environment, standards, products quality, information technology, and industrial property. Detailed tasks prescribed therein are as follows.

/ Drafting and promulgating the laws and ordinances concerning scientific, technological, environmental and product quality management activities in the industrial field.

/ Organizing and managing work concerning standardization, measurement, industrial product quality, and industrial property.

/ Participation and cooperation in drafting and promulgation of laws and ordinances, TCN, econo-technical indices and in drafting TCVN for products in industrial fields.

/ Structuring quality management

/ Drafting and promulgating standards, regulations, econo-technical indices, and in the field of electric power and present them to the minister.

/ Enforcement of laws and ordinances concerning electric power activities and its use, and inspection thereof.

/ Cooperation and participation in international cooperation activities in the field of energy and energy related environment issues.

2) State Department of Industrial Safety Techniques (DIST)

Responsibilities of the Department for Industrial Safety Techniques are specified in No.13/2006/QD-BCN, a governmental decision that was approved on May 23, 2006. Principal ones

prescribed therein are as follows.

The DIST shall be an administrative organization that regulates and oversees safety techniques concerning mechanical technology, metallurgy, new energy, renewable energy, petroleum, gas, mineral resources, chemical industry, explosives, commercial goods and other industries. Details of its responsibilities are as follows.

/ Establishment and revision of codes and standards concerning the above mentioned industries
/ Instruction and oversight of compliance and implementation of codes and standards (as an inspection agency)
/ Approval of safety measures for construction projects under the jurisdiction of the MOI
/ Establishment of countermeasures against accidents concerning the above mentioned industries in collaboration with related organizations
/ Professional education concerning safety techniques and environmental protection

Its organizational structure is as follows:

There are six sections under supervision of the director and the vice director of the department.

Section for Business Administration
Section for Organization, Education and International Cooperation
Section for Power Industry
Section for Mining, Petroleum and Gas Industries
Section for Pressure Vessels
Section for Chemical Industry and Explosives

The Section for Power Industry is responsible for establishment of laws, ordinances, codes and standards, while the Section for Pressure Vessels is in charge of inspection for pressure vessels including boilers.

3) Electricity Regulatory Authority of Vietnam (ERAV)

Responsibilities of ERAV are specified in No.285/2005/ND-CP, a governmental decision that was approved on Oct. 19, 2005, which provides for functions, responsibilities and organizational structure of Electricity Regulatory Authority. Its principal responsibilities prescribed therein are as follows.

Electricity Regulatory Authority shall be an administrative organization that regulates over all power industry in terms of safety, economy and efficiency of electricity supply, which includes an electricity market that will be created in the future as an important part of its responsibilities. Details of them are as follows.

/ Establishment of a national power industry master plan toward the creation of electricity market
/ Approval of electricity tariffs
/ Issuance of electricity business licenses
/ Planning of new power sources in light of generation cost reduction

/ Support for DSM (Demand Side Management)
/ Oversight and coordination of the electricity market (including balancing between demand and supply, competition among power companies, etc.)
/ Oversight concerning long-term power purchase contracts

Organizational structure prescribed in the above-mentioned decision is as follows:

Prescribed structure is not completed as of June 2007, but being developed rapidly. Number of staff is approximately 50, who are selected from MOI, EVN, Electrical Testing Center (hereinafter ETC), Institute of Energy (hereinafter IE). (ETCs are divisions of the PC No.1, 2 and 3 respectively, which are subsidiary companies of EVN.) About 80 percent of staff is university-educated engineer, which specialty is electric, mechanical, civil engineering and so on. Accordingly, the technical backbone of ERAV seems to be steady.

Section for Business Administration
Section for Legal Affairs
Section for Electricity Tariffs
Section for Electricity Market Regulation
Section for Planning and Approval
Section for Customer Affairs
Section for Information Technology

7.1.2 Current Status of Inspection based on Technical Standards

Electric power facilities and equipment except for boilers in thermal power plants are not inspected officially by MOI at present, as described in the former section. In this section, current situation is described about by whom and how necessary inspection is carried out to secure safety for facilities and equipment.

1) Transmission Facilities

In Vietnam, EVN, a state-owned company solely manages and operates transmission and distribution facilities. However, 4 Power Transmission Companies (hereinafter PTC) and 9 PCs, which are under the umbrella of EVN, conduct practical maintenance work. PTCs are responsible for transmission lines and substations over 220kV, while PCs are in charge of those under 110kV. Table 7-1 shows name and maintenance areas of PTCs and PCs. They are maintenance companies, thus do not implement any construction work other than small repairs. IE and PECC, both of which are also under the umbrella of EVN, and other consulting companies conduct design work, while PMB within EVN mainly perform construction work. After completion, PMBs hand over the facilities to PTCs and PCs. The handover is based on completion inspection and other field inspection records. PMBs commission these inspections to ETCs, which are subordinate organizations of PCs. After the handover, PTCs and PCs commission

periodical inspections also to ETCs. ETCs need to obtain inspection certificates of subject equipment from ERAV. This kind of regulation is for ensuring and improving the inspection qualities. The MOI neither performs on-the-spot examinations over the periodical inspection results nor mandates power companies to report them. However, EVN occasionally conducts the on-the-spot examinations to check relevant documents including periodical inspection results and reports annually to the MOI. This kind of check by EVN is for maintaining functions of power facilities of PTCs and PCs.

Table 7-1 Maintenance Areas of PTCs and PCs

Company Name		Maintenance Area
PTC	PTC1	Northern region including Ha Noi
	PTC2	Middle northern region
	PTC3	Middle southern region
	PTC4	Southern region including Ho Chi Minh
PC	PC1	Northern region excluding maintenance areas of PC Hanoi, PC Hai Phong, PC Ltd. Ninh Binh, PC Hoa Binh HPP
	PC2	Southern region excluding maintenance areas of PC Ho Chi Minh, PC Dong Nai
	PC3	Middle region
	PC Ha Noi	Capital district of Ha Noi
	PC Ho Chi Minh	Urban district of Ho Chi Minh
	PC Hai Phong	Urban district of Hai Phong
	PC Dong Nai	Urban district of Dong Nai
	PC Ltd. Ninh Binh	District of Ninh Binh coal-fired power plant
	PC Hoa Binh HPP	District of Hoa Binh hydropower plant

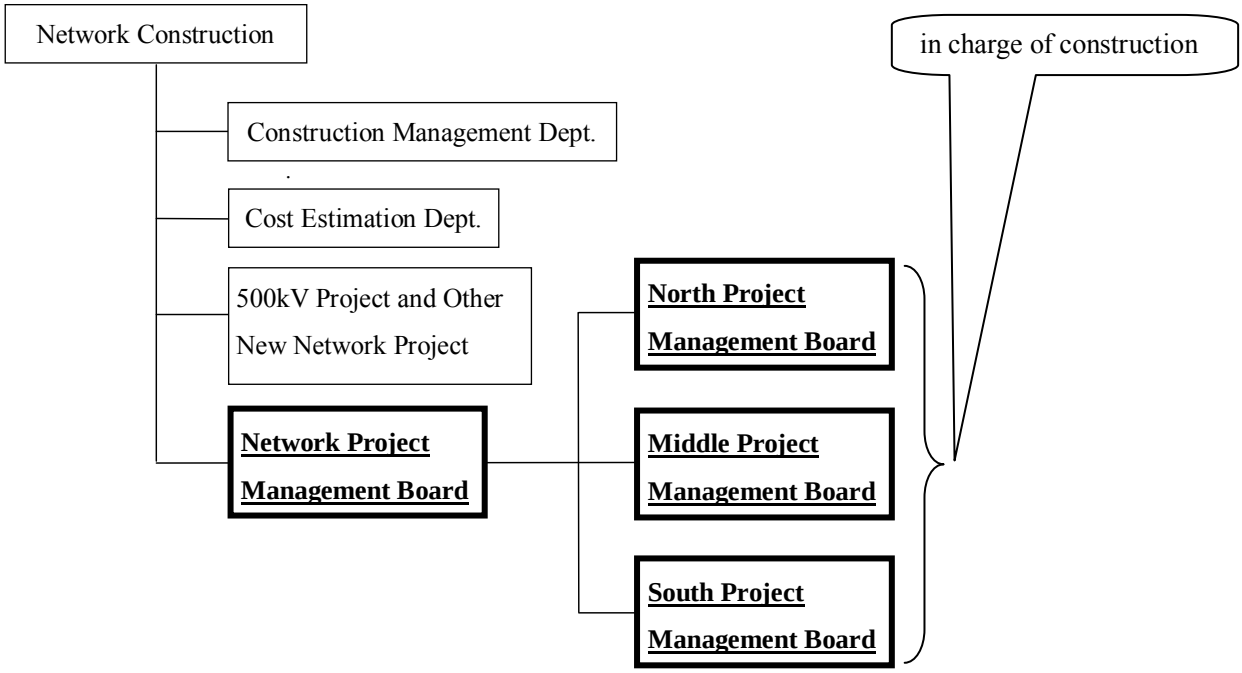


Figure 7-2 Organizational Structure of EVN (Construction Section)

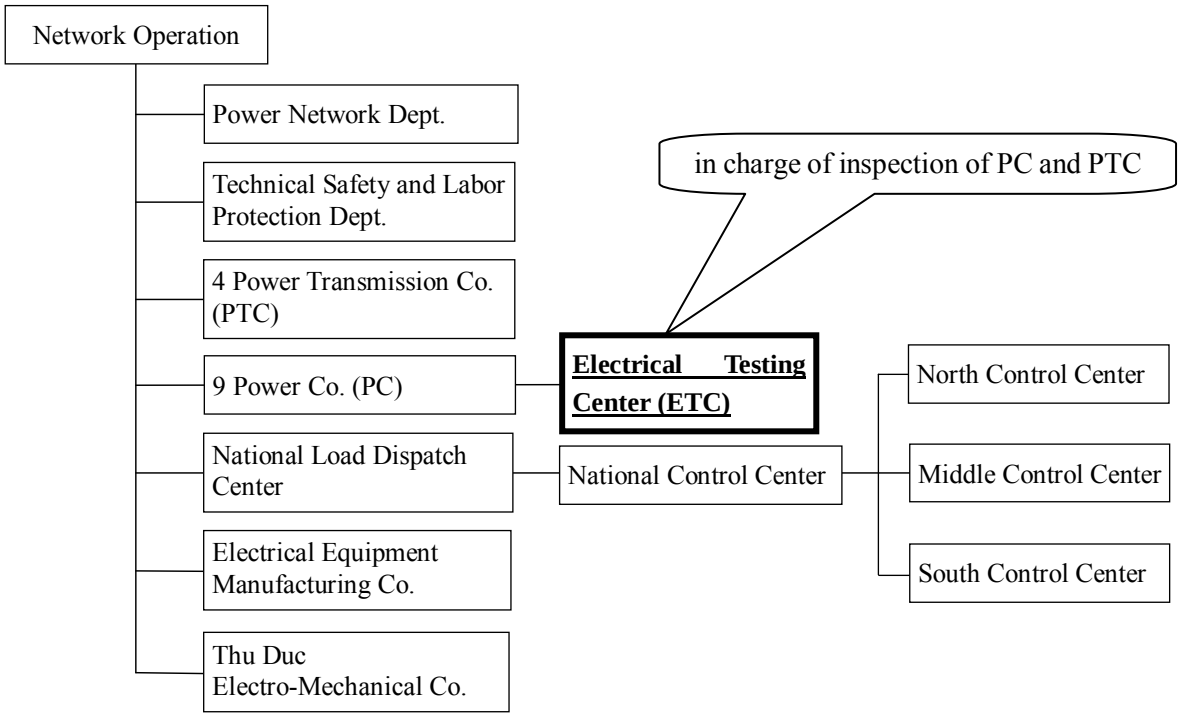


Figure 7-3 Organizational Structure of EVN (Transmission Section)

2) Hydropower Facilities

(1) General

As of 2006, ten hydropower plants of 50MW or more are in operation in Vietnam. A few of those power plants are owned and managed by joint stock enterprises or IPPs. However most of them are owned by EVN and operation of all hydropower plants are substantially under the control of EVN.

In current Vietnamese regulatory system, it is not mandatory for electric power companies such as EVN to establish principles to secure safety as in Japan. Accordingly operation, maintenance and inspections are carried out by staffs of power plants based on the rules determined by each hydropower plant in principle. Because company rules of EVN on operation and maintenance are very limited in point of functional completeness.

Considering those circumstances, site survey was carried out for two typical hydropower plants: one is Hoa Binh HPP and the other is Thac Ba HPP. Hoa Binh HPP is very important powerplant from viewpoint of electricity supply and safety reasons. Distance from Hoa Binh Dam to Hanoi is about 45km. In case of emergency in dam safety, the capital would be exposed to the danger immediately. Therefore dam safety of Hoa Binh is successively investigated and checked by the state committee as a national issue. As for Thac Ba HPP, it is oldest hydropower plant in Vietnam and owned by a joint stock company of EVN and Russian firm at present.

(2) Case Study

A. Hoa Binh Hydropower plant

a) Outline

- Hoa Binh HPP is located most downstream in the cascade development of Da River.
- Two dams and power plants are scheduled more upstream of Hoa Binh: Son La and Lai Chau, and the major development program of Da River will be finished at the completion of those two dams.
- Hoa Binh HPP is the largest capacity in Vietnam as single powerplant. Rated output is 1,920 MW, annual electricity production is 8.16 TWh.
- Design and construction supervision were carried out by former Soviet Union. Start of construction was November of 1979; commencement of operation of the unit No.1 was December of 1988. Whole units were completed in December of 1994.

b) Major specifications

a. Dam and Reservoir

- Dam type: Rockfill dam with impervious core
- Dam height: 123m
- Crest length: 743m
- Dam volume: 22,000,000 m^3
- Total volume of reservoir: 9.45 billion m^3
- Design flood: 35,400 m^3/sec
- Spillway: 15m x 15m x 6 gates

- Bottom outlet works: 6m x 10x 12 gates

b. Waterway and Powerhouse

- Penstock: diameter 8m x length 210m x 8
- Generator: 240MW x 8 units
- Effective head: 88m
- Rated speed: 125 rpm
- Turbine type: Francis

c) Inspection System

a. Completion Inspection

- The committee composed of Authority concerned, EVN and consultant from former Soviet Union carried out completion inspection without established technical standards.
- Completion inspection was executed by comparing with design specification and confirming test operation.
- Documents related with completion inspection are preserved in good condition. Language is Vietnamese and Russian.

b. Periodic Inspection

- This "periodic inspection" means not routine inspection during operation but official one.
- Periodic inspection at Hoa Binh HPP is very special. Considering peculiarity described below, the state committee organized by the order of the Prime Minister takes charge of safety check at Hoa Binh HPP.
    - Not so far from the capital (Dam breach may cause serious damages to the Capital.)
    - Reservoir capacity is very huge.
    - Rated output is very large in Vietnam.
- The state committee consists of the following authorities. MOST is in charge of the leader of the committee.
    - MOST
    - MOI
    - MOC
    - Ministry of Agriculture and Rural Development (hereinafter MARD)
    - National Center for Hydro-Meteorological Forecast（NCHMF）
    - Global Geography Institute
    - EVN
    - Hoa Binh Hydropower plant
- Outlines of inspections carried out by the State Committee are as follows:
    - Inspection covers whole civil works (reservoir, dam, intake, waterway, powerhouse, and outlet). However electric equipment such as generators is excluded.
    - Frequency of the committee inspections is twice a year, i.e. before and after flood season.
    - Hoa Binh HPP compiles results of daily inspections and several measurement or

instrumentation in advance, and submits them to the committee.

- The committee judges the safety of dam and other civil works, and reports it to the Prime Minister.
- The committee takes care of Hoa Binh HPP so far. When large-sized hydropower such as Son La starts operation in future, this committee will inspect them like as Hoa Binh HPP.

B. Thac Ba Hydro Power Plant

a) Outline

The Thac Ba Hydro Power Plant is the most ancient hydro power plant in Vietnam.

It was the first hydro power plant constructed on Chay river, Yen Binh District, Yen Bai province with the support of the former Soviet Union. The power plant started its construction on August, 1964. On October, 1971, started the commercial operation of the Unit No.1 with connection to the national Power Grid. Continuously Unit 2 and Unit 3 were started commercial operation on March, 1972.

The power plant is now on going the rehabilitation work. After completion the work, Out-puts will be raised up to 120 MW from 108MW. Annual production energy will be 400 million kWh.

b) Features of Power Plant

Mainly the rehabilitation works are as follows:

□Replace of the Rotor

□Inspection and rehabilitation (if necessary) of Stator coil

□Rehabilitation of Water turbine

□Replace of bearing metal

□Replace of Control Cubicles of Control Center

□Replace of Circuit Breaker

Regarding Cubicles in Control Center, the meters and control devises are replaced.

The Circuit Breakers have been replaced to New GCB.

The Specifications of Major Equipment are as follows:

c) Specifications of Power Plant Equipment

Generator

Rated Out-put：108MW（36MW×3units）

Rated Capacity：42,350kVA×3units

Rated voltage：10500V

Water turbine

Type：Kaplan

Water quantity：120 m^3/s

Turbine out-put：42,336 k W／unit（at Max.）

Max. Effective Head：36m
Min. Effective Head：20.7m
Average Effective Head：30m

Switchyard Equipment
Line Voltage 110 k V, and 35 k V
Porcelain type GCB

d) Inspections

a. Acceptance Inspection

As the result of hearing from engineers of the power plant, the commissioning board of acceptance is organized and taking over finally as follows:

Organization of commissioning board:

- Deputy Director of power plant organize the Commissioning Board
- Commissioning Board is composed of the member of Technical department and Contractor.
- Commissioning board will conduct and decide the work schedule, work contents.

Commissioning test:

- Commissioning test is conducted by the Contractor mainly.
- Commissioning test result is prepared by the Contractor and submitted to the Commissioning board.

Taking over:

- Taking over of the rehabilitated power plant is done after 30 days trial run.

b. Periodic Inspection

Periodic inspection standard which is used at Thac Ba power plant are：

- QUY CHE
  SUA CHUA LON TAI SAN CO DINH
  CUA TONG CONG TY DIEN LUC VIET NAM　2004.12

- QUI DINH
  NGHIEM THU VA BAO HANH
  SUA CHUA LON TAI SAN CO DINH
  NHA MAY THUY DIEN THAC BA　2005.1

This standard is prepared for periodical inspection according to the experiences of Thac Ba power plant itself.

(3) Present General Inspection System

A. Acceptance Inspection

- As for Large Power Plant (such as Hoa Binh class), the State Committee is organized for inspection.
- The State Committee is composed of the members of each ministry (MOI, MOC, MOST, etc.,) and judge the final decision of acceptance the power plant, however the organization is not steady and modified in accordance with the scale of organization.
- The mid scale of hydro power plant, Taking Over Committee is organized and held the inspection of acceptance.
- Below the Committee, the PMB is usually organized. PMB will check the inspection data and make report officially, however the Contractor will support its check and treatment of the data.
- PMB is composed by the member of EVN.
- As for the Electrical Inspection Standards, previously issued the "KHOI LUONG VA TIEN CHUAN THU NGHIEM. NGHIEM THU BAN GIAO CAC THIET BI DIEN:1987" is used

B. Periodic Inspection

- There is no regulated Periodical Inspection System of the law for Hydro Power Equipment on Electrical enterprises in Vietnam
- Basically the Periodical Inspection is executed in accordance with the inspection standards issued by each Power Plant and the standards and results of the inspection are approved by each superintendent of the Power Plant.
- Before and after of the flood season, the Board is organized in each Power Plant and inspects Spillway Tail race and Intake facilities. This is the inspection under the present MOI standards Vol.6. The members of this Board is limited the personnel of Power Plant except literates of Ministry or the persons concerned.
- As for Establishment of Inspection standards, there is no matching with other Power Plant. It is established as the specific standards reflected the features of each Power Plant.
-

3) Thermal Power Facilities

Since the inspection for thermal power plant is carried out by the utilities on their responsibility, MOI isn't presently involved in completion and periodic inspection except pressure vessel.

As for completion inspection, the items and methods are decided by the PMB of EVN with manufacturer and consultant. After that, the equipment is handed over to power plant. At present, No. 1 and No. 3 of PMB exist. No. 1 is in charge of Uong Bi power plant and No. 3 is in charge of O Mon power plant. Figure 7-4 shows organization chart.

As for periodic inspection, power plants plan and conduct them. The items, contents, method, and time of inspection are decided at each power plant in accordance with the instructions of manufactures, manual and existing technical standards Vol. 6. Vol. 5 includes standards of inspection for generator, etc., but since those standards are not suitable for actual equipment, most of power

plants don't use Vol. 5.

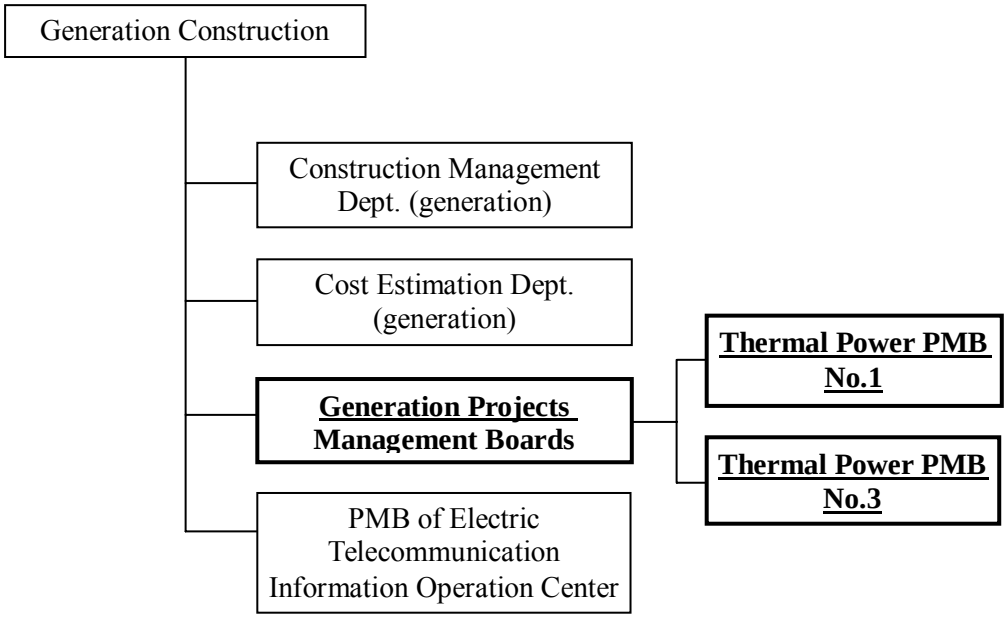


Figure 7-4 Organizational Structure of EVN (Completion inspection for Thermal Power plant)

As for the pressure vessel and the like, the inspection is conducted by State Department of Industrial Safety Techniques in MOI. Specifically, State Department of Industrial Safety Techniques conducts the total management, training and issue of license and Inspection centers under the State Department of Industrial Safety Techniques conduct the inspections. Figure 7-5 shows organization chart.

There are two inspection centers and a technical support section for supports concerning the inspection. Inspection center 1 in Hanoi is in charge of northern Vietnam and Inspection center 2 in Ho Chi Min is in charge of southern Vietnam.

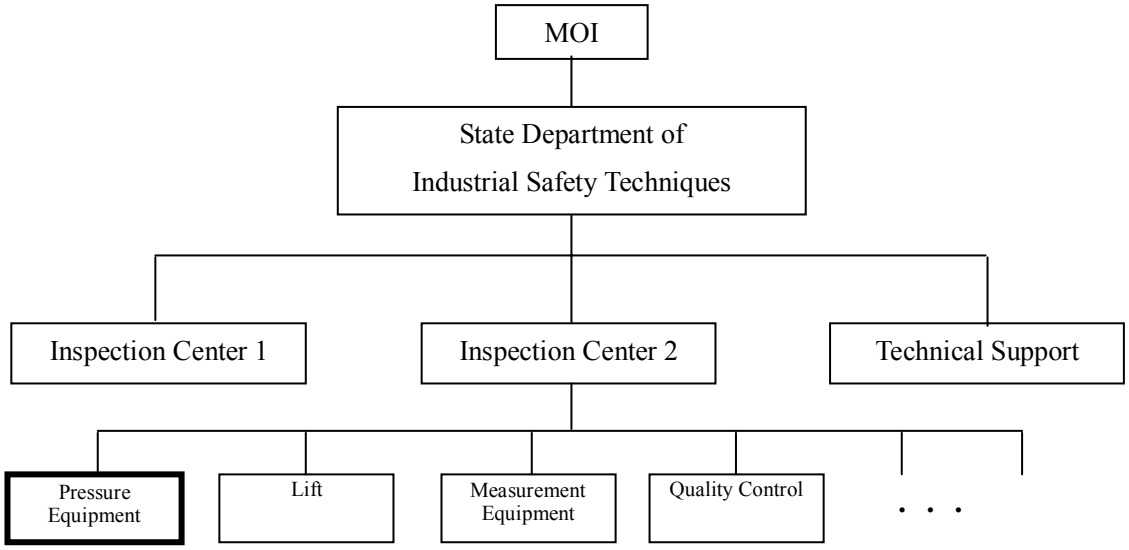


Figure 7-5 Organizational Structure of inspection for pressure vessel

The inspection is conducted under Labor law and its standards are stipulated in TCVN. As for inspection interval, hydraulic test is conducted every six years, external and internal inspection is conducted every two or three years, and operation test is conducted every year.

All the inspectors are trained every two years by trainers in State Department of Industrial Safety Techniques, but sometimes experts are invited for it. The inspectors need Industrial Inspector License issued by State Department of Industrial Safety Techniques.

At present, other inspections are also conducted by government agencies in thermal power plant. They are meanwhile shown in Table 7-2.

Table 7-2 Inspections presently conducted (by government agencies)

Facilities to be inspected	Organization responsible
Pressure vessel	State department of industrial safety, MOI
Fire protection equipment	Ministry of Police
Crane	Ministry of labor, war invalids & Social Welfare
Environmental equipment	Department of Natural Resources and Environment

7.1.3 Current Inspection System for Safety Standards

The DIST, MOI performs the following inspections based on the Safety Standards required to secure the safety for electric works, and its staff.

- The DIST conducts on-the-spot inspections on companies that incur many accidents, in order to confirm their safety management and compliance with safety standards. In some cases, companies ask for safety instructions from the DIST.
- All companies are mandated to submit the safety program report including the content and the method of the inspection, the DIST then checks the report.
- The DIST addresses the investigation of the cause of an accident concerning its administration when it happens. For that purpose, the DIST checks the report submitted by the person in charge of the electrical equipment, or dispatches its examining officer to the site of the accident, depending on the content and level of the report.

7.1.4 Problems in Current Inspection System

Inspection described in this section includes two categories: one is inspection of electric power facilities and equipment based on technical standards, the other is inspection based on safety standards.

Official inspection based on technical standards for electric power facilities and equipment is not performed in network, hydro and thermal power, excluding boilers in thermal power plants. This means that the public safety is secured presently only by independent effort of the Owners such as EVN. However,

although it is expected that new entrepreneurs will have a share in electric sector in future, especially in power-generation, it will be very difficult for newcomers to own steady management system and trained engineers and technicians as in EVN or its subsidiaries. Resultantly it is anticipated that safety level of electric power facilities and equipment may decline because of uneven distribution of skilled staff and pursuit of profits under competitive principles. This can be why an official periodic inspection was newly prescribed in this amendment as mandatory requirements to secure minimum safety level. On the other hand, importance of MOI's inspection for abidance of laws and technical standards will become emphasized more and more, because various electric companies participate with various technical capabilities in this sector. Accordingly it will be one of main issues for MOI in near future that MOI has no inspection system and human resources to allocate for this task at present. This is basically common to all categories, i.e. network, hydro and thermal power. But it shall be paid attention to the difference of necessity of official inspection in each category. Outline of this circumstance is described below.

As for network, it is expected that safety level will not easily lower in the future, because newcomers will hardly be expected in this field and EVN group has steady maintenance and inspection system of ETCs that have facilities necessary and fulfill requirement of the current technical standards in terms of inspection items and frequency. Moreover the magnitude of anticipated public hazard caused by the troubles of facilities are relatively small in case of network, and in this regard there are no specific inspection items that always necessitate MOI's participation and inspections can be left to owner's responsibility. It is a matter of course that MOI should enter as need be such as in case of severe accidents, and the system and organization should be established in the long run. Considering all these, necessity of establishment of MOI's inspection system is not so urgent in network compared to other fields.

As for thermal power, boilers which have the largest risk for public safety among equipment in thermal plants have been officially inspected by DIST. Accordingly it can be said that substantial public safety has been secured by MOI. On the other hand, official inspection for electric equipment such as generators has not been performed so far. However, as failures of such electric equipment hardly cause enormous influence on public safety, necessity of establishment of MOI's inspection system for thermal power plants is not very important relatively as in network.

As for hydro power, a very large or important hydro power plant such as Hoa Binh is checked by the national committee, but the others are checked only by staff of the power plants based upon their own standards. Though severe dam breach accidents have not occurred in Vietnam so far, it is necessary that experienced engineers shall check safety of dams and appurtenant structures for hydro power comprehensively, considering worldwide practices. Such a societal demand for safety is not only for hydro power but also dams for irrigation and flood control as described in the section 7.2.1. It can be said that this leads to the government decree on dam safety issued on May 7 in 2007.

Generally quantitative safety indexes for structures and foundation are limited in civil works of hydro power. Thus in many cases, it is very necessary that experienced engineers or technicians detect some symptoms or changes for unfavorable events visually, and clarify the problems based on experiences, tests and analyses. Accordingly cultivation of capable inspectors will be one of main issues for MOI as well as organization.

As for inspection system based on the safety standards, the DIST conducts the inspections as mentioned in the section 7.1.3, and there would be few prospective organizational problems after the revision of the Safety Standards.

7.2 Recommendations for Inspection System

As described in the former section, inspection based upon safety standards has been carried out successfully by Department for Industrial Safety Techniques so far. Therefore there are no particular recommendations for existing inspection system for safety standards.

On the other hand, there is no official inspection by MOI based upon technical standards, excluding pressure vessels of boilers in thermal power plants. Inspection for electric power facilities and equipment is limited to that of the Owners of facilities. Considering such a circumstance, inspection system based upon technical standards is referred hereinafter.

MOI has responsibility to check the electricity sector administratively and technically. Therefore it is indispensable for MOI to establish an effective administrative organization such as inspection system for electric power facilities and equipment specified in the technical standards. If this system would not be organized properly or not functioned well, important tasks to secure public safety based upon technical standards will be failed substantially, and MOI's responsibility on administration of electric sector will be nominal practically.

Ideally it is desirable to establish a proper inspection system inside or outside of MOI, together with enforcement of amended technical standards. However, necessity of official inspection system depends on categories such network, hydro power and thermal power. Furthermore, as there are many problems to be solved in reorganization from viewpoint of budget, inspection techniques, inspection personnel and inter-unit coordination, it is rather difficult to establish an ideal and necessary organization for inspection immediately.

On the other hand, after amended technical standards become enforced, completion and periodic inspection will be required in near future, considering developing status of electric power facilities in Vietnam. Therefore it will be realistic that the inspection system be organized in sequence according to the order of priority determined in advance by judging failure hazard risk of facilities.

Recommendations on establishment or improvement of official inspection system based upon technical standards are described hereinafter.

7.2.1 Inspection System and Characteristics of Electric Power Facilities

In the technical standards amended in this study, roles of MOI and the Owners to secure public safety are different depending upon categories, i.e. network, hydro power and thermal power. Although the keynote in securing public safety is independent effort of the Owner, MOI has responsibility to check it. However, it is recognized to be practically adequate that the contribution of MOI differs depending upon risks for public hazards and characteristics such as numbers and extent of the facilities as described in the section 6.1.2.

Pressure vessels of boilers in thermal power plants have been already inspected periodically by MOI based on TCVN6004 to 6007, considering public hazard risks in case of failure. In this study, dams and appurtenant structures in hydro power are regarded as in similar position to pressure vessels in point of hazard risks. MOI is expected not only to evaluate results of independent inspection performed by the Owners but also to carry out on-site inspection by himself. This tendency can be seen also in Vietnamese regulations in another sector for dam safety as well as in the electricity sector. In the government decree for dam safety (Government Decree No. 72/2007/ND-CP) issued on May 7 2007, responsibility of MOI and MARD is stipulated as well that of the Owners. MOI has a responsibility such as issuing technical standards and administrating etc. for hydro electric power plants. MARD also has a similar responsibility for dams for irrigation and flood control, including multi-purpose dams.

As a current situation, legal requests of the government and technical standards amended in this study need MOI that establishment of inspection system to check abidance of regulations and technical standards shall be indispensable and urgent.

As for risks for public hazard as mentioned above, boilers in thermal power and dams with large reservoir are very influential. On the other hand, network facilities and electric equipment such as generators in hydro and thermal power can be operated and maintained safely with self-imposed inspection by the Owners, considering past records in Vietnam and precedent examples in foreign countries. Boilers have been already inspected as pressure vessels by DIST of MOI. Therefore the urgent task shall be establishment of official inspection system for hydropower, especially dams and appurtenant facilities. It can be realistic and indispensable that resources of MOI be concentrated on it for the time being.

7.2.2 Recommendations for Inspection System

In the technical standards modified in this study, inspections stipulated in the technical standards shall be carried out by the Owners of facilities, and its results shall be submitted to MOI in principle in network, hydro and thermal power plants. Thus pertinent MOI staff shall have expertise enough to assess safety and reliability of facilities and equipment based on documents submitted by the Owners. Furthermore as on-site inspection is also stipulated for hydro civil works, such an expertise is also required.

There are following options to establish inspection system, considering current status of MOI.

1) Establish a new organization for inspection inside or outside MOI

Presently extent of the legal inspection to electric power facilities is very restrictive in Vietnam. But it seems that the safety level is maintained sufficiently by EVN and their subsidiaries at present, and this implies that there exist experienced engineers and technicians who are capable to execute necessary inspection practically in this sector. Considering this circumstance, it seems to be possible to create a new inspecting organization by rearranging human resources or restructuring existing organizations.

2) Enhance the function of DIST

DIST has already carried out inspection of boilers, and an attitude which conducts inspection in

accordance with technical standards is considered to have been produced inside. So it may be possible for them to carry out inspection of overall facilities specified in the technical standards. However, even in this case, it is indispensable to post capable inspectors to this department by rearranging human resources in this sector.

3) Utilization of ERAV

ERAV carries out approval of license of electric power activities, update and cancellation of license as one of peculiar tasks. Although ERAV does not execute any inspection based on technical standards because of lack of staff, but conformity with technical standards is one of conditions in approval for licensing. Therefore, in the light of tasks and objectives of ERAV defined by No.285/2005/ND-CP, a governmental decision that was approved on Oct. 19, 2005, it will be very natural to manage the electric power sector with competence of licensing and corresponding inspection based on the technical standards on the assumption that ERAV is reinforced with capable staff. Thus it may be one of the weighty options to add function of inspection to ERAV in future.

As described above, PC No.1, No.2 and No.3, which are subsidiary companies of EVN, have ETCs respectively, and carry out independent inspection for electric power facilities and equipment. Institute of Energy which is also subsidiary of EVN has also experienced engineers who have sufficient knowledge of electric power facilities. Therefore it will be very possible to establish a permanent organization for inspection by rearranging those engineers or restructuring those organizations.

On the occasion of selecting or creating inspection organization, the following items shall be key words considering further liberalization of electric power sector in the future:

- Clarity of responsibility regarding legal a inspection and its follow-up;
- Easiness in framing a legal inspection system;
- Easiness and flexibility in practical activities of inspection;
- Compatibility of main tasks of the competent organization;
- Transparency and impartiality in inspection activities.

It is very desirable that the inspection system shall be established so as to satisfy the above-mentioned key words, in addition to recruitment and cultivation of staff.

Chapter 8 Current Status and Recommendation for the Organizational Structure to Revise the Technical and Safety Standards

It is a matter of course that the technical and safety standards have to be properly revised taking technology progress and change of regulatory situation and safety consciousness into account. In this chapter we will review the current system for revising the technical and safety standards and will make some recommendations taking it into account.

8.1 Current Status of the Organizational Structure to Revise the Technical and Safety Standards

8.1.1 Current Status of the Organizational Structure to Revise the Technical Standards

The organization for revising the technical standards is at present very much limited in its scale and quality. This is due to the following three facts.

1. Major revision has not been given to the technical standards since their enactment.
2. There is no staff dedicated to the revision of technical standards secured in the MOI.
3. Budgetary for systematic revision of technical standards is not easy in the MOI.

So far, when the MOI intended to revise the contents of technical standards even in small scale, parties concerned including EVN and distinguished academics such as retired engineers were invited to set up a working group to deal with the matter. The members of such working groups were not permanent and in principle adequate engineers were invited each time. This was because the budgetary for securing permanent members was, as described above, difficult. In such a situation, the revision work had to be dependent on continuous participation of specified persons, and this will be one of the serious matters to be solved in the future revision of standards.

8.1.2 Current Status of the Organizational Structure to Revise the Safety Standards

As for the safety standards, they have not been revised since their enactment in 1984. The revision in this Study was the first case and the revision work was carried out with the Technical Safety Depart playing the leading role supported by EVN. Judging from the performance of the revision work, we can expect that the future revision will adequately be carried out by this system. Depending on the contents of revision, it may be necessary to invite experts form IE, universities and so on.

8.2 Recommendations for the Organizational Structure to Revise the Technical and Safety Standards

The Standards Law was enacted on January 1, 2007, and this requires the existing TCNs to be revised towards the suitable contents as "regulations". The first step of such work is, as described in Chapter 3, to sort out the descriptions of TCVN and those of QCVN which now coexists in TCN.

This work may be implemented in about four years' time by 2010. This Study was carried out as its first step of such revision in the form of technical cooperation, however, hereafter the MOI has to move the task

forward by itself. In this regard the revision in this Study was done to prepare the draft of QCVN as mentioned in Chapter 3, it will become possible to separate some part as TCVN from this QCVN draft in the future taking the development of relevant TCVNs into account.

However, there remains the problem of system for promoting such work. As described in the previous section, the Technical Safety Department in charge of the safety standards has more or less system for revising along with that for inspection, on the other hand it is difficult to say that the Science and Technology Department in charge of the technical standards is equipped with system for future revision. Considering such current situation, the Study Team make the following recommendations concerning development of system which the MOI needs in order to keep revising the technical and safety standards and to keep it efficacious in future.

8.2.1 Security of neutrality through the discussion of a technical committee

The existing TCN, which is the basis for the revision work of the study, was drafted by the EVN instead of the MOI due to the history of Vietnam's electric power industry.

The EVN had been a government organization (i.e., the Ministry of Electricity) and was corporatized in 1995. Because of this historical background, the electric power industry was synonyms with the EVN in the past, and technical evaluation and rulemaking had to depend wholly on the EVN. In practice, there was no organization other than the EVN, which was able to perform such duties.

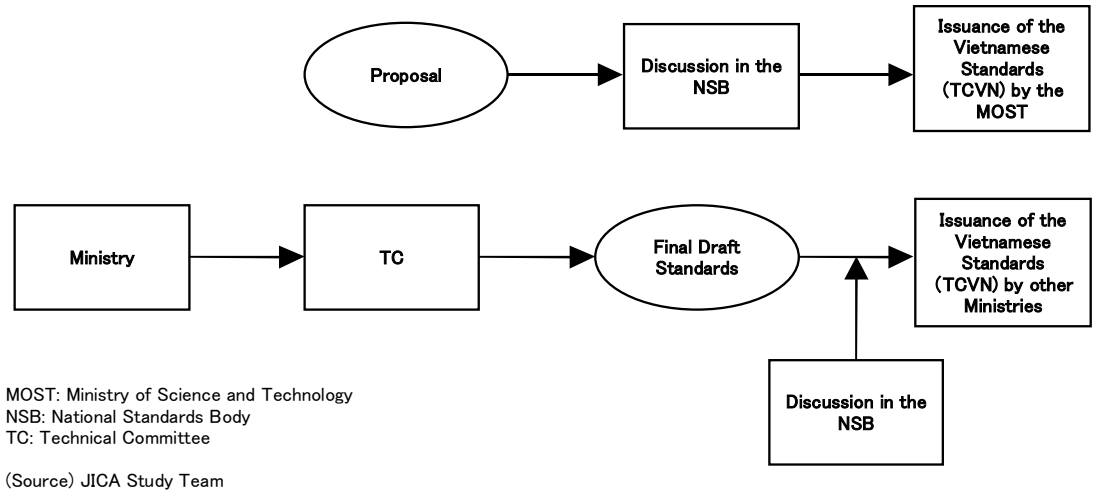
In the future, however, it is obvious that new comers will participate in the power market along with the existing IPPs, and it is also inevitably necessary for the government to set up transparent and fair technical and safety standards. In other words, it will be impossible for the electric power industry to accept conditions such that the rules of the EVN become the national standards without any alteration.

To revise the standards in the future, therefore, it is recommended to establish a third-party organization under the MOI to evaluate the contents of the revised one and compile the final draft of the revision. Such an organization, e.g., the technical committee established under the MOST for the purpose of assessing the draft TCVN, will be a good model.

TCVN will be established in accordance with the procedure shown in the Figure 8-1. Those who propose new TCVN or revision of existing TCVN may apply to MOST directly or to the ministry concerned. MOST has a permanent organization of National Standards Board which is in charge of reviewing the draft, while other ministries set up ad hoc technical committee to review the draft as required.

Conversely, QCVN as regulations (or codes of practice) must be drafted by the relevant responsible ministry. It is necessary for the competent ministry to set up a technical committee under it, and for all stakeholders to participate in the committee and discuss the appropriateness of the draft. The membership of the committee must be selected from among all stakeholders including relevant industries, scholars, and users as well as the government.

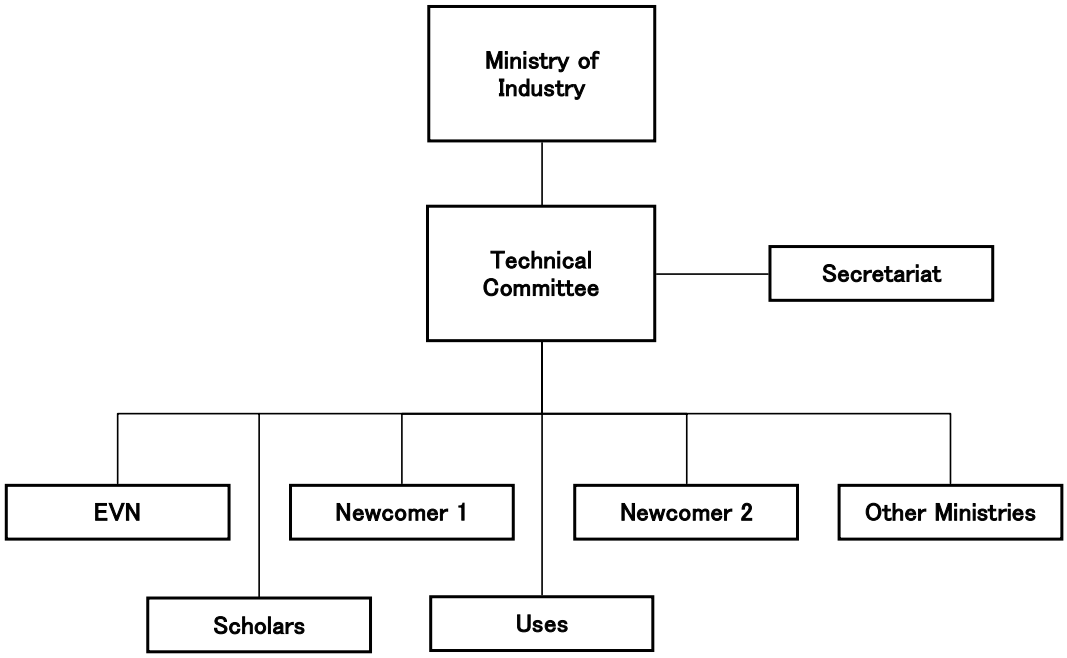
This is the most desirable way to secure the neutrality and transparency of the work of revising the technical and safety standards. This kind of committee is not a permanent one, and its member will be changed according to the issues to be discussed. Moreover the members from stakeholders shall participate as the representative of association and the membership shall not be personally decided.



MOST: Ministry of Science and Technology
NSB: National Standards Body
TC: Technical Committee

(Source) JICA Study Team

Figure 8-1 Flow of the Procedures for Setting up New TCVN



(Source) JICA Study Team

Figure 8-2 Draft Idea of an Organization for Setting up New QCVN

8.2.2 Necessity of establishing a skillful secretariat

The most serious problem is that of the party which is to draft the revised technical and safety standards for the discussion in the technical committee. As a matter of fact, it is almost impossible for the committee to prepare the draft from scratch. This points to the need for establishment of a skillful secretariat, which will conduct the committee and prepare the draft for the discussion of the committee. In developed countries,

an academic society or an industrial association assumes this role, but it is questionable whether such an organization capable of this task exists in Vietnam.

Therefore, it is necessary for the MOI to play the role of secretariat by itself. Meanwhile, there are several institutions under the MOI umbrella. One of them is the IE. Although it might be capable enough to be assigned to the secretariat, the neutrality of the IE is still questionable because it is still a subsidiary of the EVN. It seems to newcomers (i.e., private companies) that the EVN continues to be involved in the work of revising the technical and safety standards.

To avoid such conflict of interest between the newcomers and the EVN, the most acceptable way would be to have the MOI set up a new organization (e.g. Office of Technical Standards), which will function as the secretariat. However, there still remains a question of how to recruit skilled personnel to undertake the task. Needless to say, extensive knowledge and experience are definitely required for the secretariat. Although we could not ignore the talent of the IE personnel in this context, it is also inevitable to secure their neutrality and shield them from the influence of the EVN.

One possible measure to this end is to have the necessary personnel transferred from the IE to the secretariat while they are engaged in the task of revising the technical and safety standards. To put this idea into practice, the MOI must prepare the organizational setup and budget necessary for employing staff.

Bibliography

Construction Law (No. 16/2003/QH11 of November 26, 2003)

Decree on Detailed Regulations and Guidelines On Implementation of the Electricity (Decree No. 105/2005/ND-CP)

Electricity Law (No. 28/2004/0H11 of December 3, 2004)

Labor Code

Law on Water Resource (No. 8/1998/QH10/of May 20, 1998)

Standards Law (No. 68/206/QH11)

Appendices

The Result of Review for Technical Standards Vol.1～4

Final

August, 2006

JICA Study Team

Note

1) This review for Vol.1 to Vol.4 is carried out based on English version of 2004 version.

2) The mark in the rightmost column titled "#" shows the following meaning:

#	Definition
1	**Unsuitable for ministerial ordinance**
1(a)	Prescription that might have great influence on construction of facilities
1(b)	Prescription that should be in-house rules
2	**Reflection of new knowledge and technology**
3	**Correspondence to specification of existing facilities**
4	**Should be added as prescription**
5	**The background of the prescription should be clear**
6	**Need to check relative material (Need to make the reason clear)**

Transmission Line（Overhead）

Volume 1

Article	Subscription	Question	Conclusion	#
Annex I.3.B	Checking power transmission capacity of conductor h_w: Convection heat dissipation factor calculated by experimental Rice formula.	CIGRE formula is used as general method in IEEE also Japan. This formula is conducted by recent experimental data.	JICA Study Team show the CIGRE formula method (Attachment OHTL(1)). Vietnamese side shall consider adoption of CIGRE formula.	2

Volume 2

Article	Subscription	Question	Conclusion	#
II.4.18	When conductors are arranged at different heights, neutral conductor is always placed under phase conductors. Outdoor lightning line conductors on the same poles of power overhead lines can be arranged under the neutral conductor.	Usually lightning conductor is arranged on the top of pole. Is the situation different in Vietnam?	In this article, prescription is mentioned lighting wire, not lightning.	3
II.4.25	Earthing points must be arranged on power overhead line. Distances between earthing points must not be more than: ・200 m for areas with 10 - 40 thunderstorm hours in a year.	・ What is this meaning of “distances between earthing points” on overhead line? ・ What is the basis of thunderstorm hours?	・Eathing point is not every tower or pole. Usually every 4 or 5 tower. The meaning of “distances” is distances from the earthing point to next point. ・Thunderstorm hours map is based on MOST standards. JICA Study Team checked and recognized it appropriate map.	3
II.5.11	In design of 500 kV power overhead line, there must be part on operation maintenance organization in compliance with organization chart of Vietnam power sector and national power grid operation organization chart	This is the matter of each company. This prescription is not suitable for regulations.	This prescription is already deleted on Version 2006.	1(b)

Article	Subscription	Question	Conclusion	#
II.5.13	In order to manage operation and maintenance of 500 kV power overhead line, roads with at least minimal width of 2.5 m and far from line route not more than 1 km must be arranged for transport means to access the line route.	The roads might be necessary but the width might be each company's rule. This prescription is not suitable for regulations.	Vietnamese Side insisted that this prescription is important for maintenance work. Therefore it would be maintained.	1(b)
II.5.14	Flood occurrence frequency of 5 % for power overhead lines with voltage to 35 kV is chosen (repeatable in 20 year cycle), 2 % for 110 kV and 220 kV power overhead lines (repeatable in 50 year cycle) and 1 % for 500 kV power overhead lines (repeatable in 100 year cycle).	What is the basis of flood occurrence frequency?	MOST established flood occurrence frequency map. When they select the way of transmission line, they take the affect of flood based on the map. The numerical criteria should be based on Vietnamese side decision. JICA Study Team conclude the method of design might be suitable.	6
II.5.18	Poles of power overhead line which have height of 80 m in normal places and over 50 m in special places, must be painted with warning sign (daily warning) and warning lamps (for night) in order to ensure security for air planes and ships in compliance with the State regulation.	This prescription is harmonized with "Air safety law" ? EPCo. have to apply for installation of warning sign to Ministry of Land and Transportation based on Air safety law.	This prescription is consistent with Air Low. Tower that is from 50m to 80m should be painted, and over 80m should be additionally installed lighting equipment.	6
II.5.19	The fault locating equipment must be installed on power overhead lines with voltage of 110 kV and above at 500 kV substations	Does F.L. equipment need to be installed at 500kV substation for all voltage over 110kV?	In 2006 Version, It is prescribed that F.L. should be installed in over 110kV line, not at 500kV substation. Here, F.L. means distance relay in the case of 110kV, and locator for 500kV. Vietnamese side would like to install locator on over 110kV. They requested to explain situation in Japan. JICA Study Team explained based on Attachment OHTL (2)	3
II.5.21	Determination of climate conditions for calculation and selection of structure of power overhead line must be based on results of multi-year observed data	Is the result sorted out by some organization officially?	MOST establish these climate condition map. JICA Study Team concluded that it was suitable one.	6

Article	Subscription	Question	Conclusion	#
II.5.42	Protection against fatigue for conductors is performed fixing frames installed on conductors instead of dampers	What kind of equipment is the fixing frame?	Steal spacer is installed as fixing frame. JICA Study Team concluded it was no problem.	3
II.5.53	Power overhead lines with voltage of 110 kV and above must use only suspended insulators.	Not only suspended insulators also standing insulator shall generally be installed in JAPAN.	In Vietnam, standing insulator have not been installed in over 110kV transmission line. Because they do not need to use support insulator. However, JICA Study Team recommend to modify this restriction, there might be chance to install standing insulator in the future.	3
	For compact poles with appropriate composite arms, insulators are not required.	What is composite arm?	Composite arm means the arm using polymer insulator. Actually the arm has been installed in 220kV transmission line. If so, this prescription is no problem.	3
II.5.68 a)	For metal and steel reinforced concrete single pole must hang one lightning conductor, with protection angle not bigger than 30^{o}.	Is it possible to keep this 30^{o}?	Generally the angle is smaller than 30°. If so this prescription is no problem.	3
II.5.68 d)	When power overhead line is arranged with two lightning conductors, distance between them must exceed 5 times of distance between power conductor and lightning conductor.	Is not 5 time too big to keep?	Generally the distance keeps 5 times. If so this prescription is no problem.	3
II.5.70	Lightning conductor without optical fiber cable on all poles of power overhead lines with voltage of 220 kV and above must attached to insulators arranged in parallel with electricity sparking gap of 40 mm.	Why does lightning conductor must be attached to insulators?	In Vietnam, lightning conductor is attached to insulators and earthed every several km. The reason is to reduce induced loss. If so this prescription is no problem.	3
	500 kV power overhead lines which use lightning conductors as communication conductors, lightning conductors must be insulated at least on insulator with two bowls	Do you use lightning conductor as communication conductors?	Vietnamese side use lightning conductor as communication line. Generally relay signal for back-up.	3

Article	Subscription	Question	Conclusion	#
II.5.83	Bamboo or wooden poles must not be used for power overhead lines in all cases.	Is there no bamboo or wooden pole in your country?	In Vietnam, there is no bamboo or wooded pole. However they would like to use it because it is cost effective. Vietnamese side requested to explain Japanese situation. The study team showed the situation (Attachment OHYL(5))	3
II.5.107	Distance from the lowest conductor of power overhead line to water surface must not be less than values given in Table II.5.6.	Table Ⅱ .5.6 is correspondent to Transport Agency prescription?	Yes, this matter is regulated by Transport Agensy.	6
II.5.108	At places power overhead lines crossing river, canal etc. where ships, boats pass through, signs, signal must be arranged at both banks in compliance with the State regulation.	What is state regulation? What kind of signal?	Signal is amounted on the both tower.	6
II.5.115	Arrangement of power overhead line going over houses and structures is prohibited, except State structures which are permitted in Article 10 of the Governmental Decree No. 54 on safety protection of high voltage power network.	This might be obstruction of development of transmission line system.	Vietnamese side answered this prescription would be revised soon.	1(a)
II.5.121	・・・,but used insulators must be of double and standing type.	Why? Actually do so in existing facilities?	Actually so.	3
II.5.127	Arrangement of communication and signal lines under 500 kV power overhead line is prohibited.	This might be obstruction of development of transmission line system. In Japan we calculate induced current on communication line and check to the criteria. Ex) Criteria: 2 μ A/12km (<60,000kV)	Vietnamese side understand the situation of Japan, and shall son cider revision of this prescription.	1(a)
II.5.142	For electrified railway, crossing angle must not be less than 40^{o}.	Why? This might be obstruction of development of transmission line system.	This prescription is not consistent with present situation. So Vietnamese side shall revise this prescription.	1(a)
II.5.149	Based on design standards for car roads, TCVN 4054-1985,	What kind of standards is TCVN4054?	One of the MOC standards.	6
II.5.170	The places where 500 kV power overhead line crosses with on-ground pipelines and aerial transport cable lines	Do you protect it by fence actually?	Meshed net is usually installed. No problem.	3

Transmission Line (UGTL)

Volume 1

Article	Subscription	Question	Conclusion	#
I.3.8	For some loads which require highly stable voltage, if conductor cross sectional area is selected according to permissible voltage drop, the conductor is too big and too expensive. In this case, it needs to make comparison with alternative to increase voltage of the power line together with installation of low voltage transformers at the end of the line or alternative ensuring normal voltage drop together with installation of automatic voltage stabilizers at the end of the line.	View of planning. It just shows the importance of cost performance only.	This article shall be removed	1(b)
1.3.10	All conductors shall meet permissible heating conditions, not only in normal working condition but also in the system fault condition. That means some elements have been separated from the system which make increased currents of elements being considered. Considered maximal load is the average maximal load in half hour which is considered for development in 10 future years for overhead power line and after 20 years for underground cable line.	View of planning. The plan for power system development depends on the in-house policy	This article shall be removed	1(b)
I.3.18	For underground cables, permissible continuous currents given in Tables I.3.10, I13,16-21 are calculated for cables placed in canals at the depth of 0.7-1 m, earth temperature of +15 oC and earth thermal resistivity of 120 cm.oK/W. If earth resistivity is other than the above value, the permissible continuous current of underground cable will be multiplied with the coefficients given in the following Table:	Earth temperature should be higher than 15℃. That figure is 25℃ in Japan. It was decided by practical data had been collected for a long time. The condition is that depth for cables is from 1.2m to 1.4m. The figure is decided based on average value added some margin. Reference; IEC 60287(1994)、IEC 60853(1989)、IEC 60986(1989)	Earth temperature of +15 oC shall be modified according to practical data in Vietnam	3
I.3.19	For cable placed in water, permissible continuous currents given in Tables I.3.11,14,16-21 are calculated with water temperature of +15 oC.	Water temperature should be higher than 15℃. Japanese figures (practical data) are shown below:	Water temperature of +15 oC shall be modified according to practical data in Vietnam	3

Article	Subscription	Question	Conclusion	#
		22℃: Cable is on the bed of the sea. 20℃: Cable is below the bed of the sea. Source: Electric Technology Research Association Report 53-3		
I.3.20	For cables placed in the air, permissible continuous currents given in Tables I.3.12,14-23 are calculated with distance between cables placed indoor, outdoor and in tunnel not less than 35 mm and in canals not less than 50 mm, for any number of cables and air temperature of +2 oC.	2 ℃ of Air temperature must be strange. This figure should be the highest one, which has been recorded so far. 40.8 ℃ is the highest figure among the recorded ones in Japan.	Air temperature of +2 oC shall be modified according to practical data in Vietnam	3
I.3.24	Permissible currents of oil, gas, XLPE and EPR cables, one core-steel banded cables will be selected according to the manufacturer's documents (see annex I.3A). Table I.13.13	Condition of calculation for XLPE should be described here. In the 3.17 section, conditions for other cables are descried.	Condition of calculation for XLPE shall be described in this article.	2
Annex 1.3B	New contents	Calculation formula for permissible current of underground cables should be described here. Reference (continuous current): IEC 60287(1994) Reference (short term overloaded current): IEC 60853(1989), IEC 60986 (1989)	After studying relevant IEC materials, Vietnam side will decide.	2,4

Volume 2

Article	Subscription	Question	Conclusion	#
II.2.16	Selection of cross section area of conductor of power line with voltage over 1 kV must ensure permanent permissible current under normal conditions and after fault conditions and must take load increase possibility into account but not higher than 25-30 % of calculated current.	View of planning. Overloaded operating pattern depends on the in-house policy	Statement with underline has been already removed from Vietnamese Version.	1(b)
II.2.23	For power line, it needs to use insulating materials made of fire resistant materials (ceramic, composite etc.).	What is the ceramic insulated cable? What is the composite insulated cable? Ceramic is used as insulator	No problem Just translation mistake.	3
II.2.29	1. Width of working corridor of power line without protection cover must be wider than 1 m when being arranged at one side and wider than 1.2 m when being arranged at both sides. When power line is longer than 150 m, the width of working corridor must be increased in comparison to the above mentioned values at least by 0.2 m for all power lines arranged at one side or both sides.	This statement just shows the width of the corridor for maintenance.	This article is needed because it is used to design tunnels	1(b)
II.2.29	3. At beginning and end of electrical power lines as well as points in between, the fixed earthing switches or mobile earthing mechanism must be arranged. Number of places for mobile earthing connection must be so selected that when short circuit happens between two adjacent points of earthing mechanism, induced voltage must not exceed 250 V.	Induced voltage under the normal stage should be added. The figure about induced voltage in the Industrial safety and health law in Vietnam should be checked. 50V is the acceptable value in Japan under the normal stage.	The basic idea why 50V is adopted in Japan will be explained during second work in Vietnam by the Study Team. Please see the Attachment “UGTL_1”	4
II.3.12	Construction of cable lines must comply with requirements specified in the Governmental Decree No. 54 on safety protection of high voltage electric power networks.	Could you give us Decree No.54?	Decree No.54 was modified to the No.105 and 106. The Study Team has them.	6
II.3.13	The cable line route must be so selected that its length is shortest and safety is ensured in terms of chemical damage, vibration, corrosion, over heating, arcs caused by cable lines. It needs to avoid placing cable lines crossing on each other or on other pipelines.	View of cable route plan.	This article is necessary.	1(b)

Article	Subscription	Question	Conclusion	#
	When selecting routes for oil pressure cable lines, the attention must be paid on topographical conditions in order to arrange and use oil tanks in best way.			
II.3.16	When carrying out calculation of construction of underground cable projects, the cable weight, soil layer, covering soil layer for making road and loads of transporting means passing through must be taken into account.	View of temporary road for construction work.	This article is necessary.	1(b)
II.3.22	Openly arranged cable and cable connection boxes must have nameplates. On the nameplates, type, voltage, cross sectional area, number or name must be written. Date and name of installing agency etc. must be also written on the nameplate. The nameplates must be firmly fixed in distance from each other not exceeding 50 m and not being affected by action of surrounding environment. On the underground cable route, the cable route marks must be arranged, also for areas not being constructed yet.	View of attachment of the nameplate on the connection boxes.	This article is necessary.	1(b)
II.3.23	Route of each underground cable line in the ground or water must be sufficiently mapped with coordinates corresponding to marks of the already constructed project or compared to special landmarks. Locations of cable connection boxes must also be marked on the map.	View of maintenance after construction.	This article is necessary.	1(b)
II.3.43	Cable line installed along with railways bridges and other bridges, the cable with steel sheath and aluminum cover must be used.	Not only material for sheath and storage system for cable but setting method should be added. /Private bridge for cables /Bridge attached with cables	Japanese standard will be explained during second work in Vietnam by the Study Team. Please see the Attachment “UGTL_2”	4
II.3.46	For oil pressure cable lines with voltage up to 110 - 220 kV, type and structure of cable shall be specified in design	It’s obvious.	This article is necessary.	1(b)
II.3.57	At each section of low pressure oil cable line, at least 2 sets of pressure sensors must be installed,	View of maintenance.	This article is necessary.	1(b)

Article	Subscription	Question	Conclusion	#
	but at high pressure oil cable line, sensor must be installed at each oil supply machine. The fault signal must be transferred to station with person in duty at all time.			
II.3.58	The stations supplying oil to oil cable lines must have telephone for communication with regional power dispatch center.	View of maintenance.	This article is necessary.	1(b)
II.3.65	Quantity of connection boxes in one km of newly constructed cable line must not exceed : · 4 boxes for 3-core cable with voltage 1-10 kV, cross section area up to 3 x 95 mm2 · 6 boxes for 3-core cable with voltage 1-10 kV, cross section area up to 3 x 120 mm2- 3 x 240 mm2 · 6 boxes for 3-phase cable with voltage 22-35 kV. · 2 boxes for 1-core cable .	In rare cases that joint boxes are needed due to special route, cable installation is not available.	This article shall be discussed in Vietnam side later.	1(a)
II.3.74	Reserve cables (power cable, operation cable, control cable, signal cable, fire fighting cable etc.) must be so installed that when fire happens, they must not be damaged at the same time. Therefore, combination of cables must be divided into sub-groups and isolated from each other. Division into groups depends on local conditions.	View of maintenance.	This article is necessary.	1(b)
II.3.106	In places with high level of underground water, floating cable installation (in cable trough or in box) method must be applied for outdoor switch yard. The cable trough and covering plates must be made of reinforced concrete. Cable trough must be placed on concrete support columns with tilt at least 0.2 % for easy water drainage. If on floating cable line there are water drainage holes arranged, tilt is not necessary.	This prescription is water drainage system not electrical equipment. It is not matter of technical standard for electricity.	No problem Just translation mistake. This article is necessary.	1(b)
II.3.108	Doors of cable structures must be automatic type with sealing washers. The doors of exits must be externally openable and lock which can be opened from inside of cable structures without using key.	It is needlessly detailed. Far from technical standard matter.	This article is necessary.	1(b)

Article	Subscription	Question	Conclusion	#
	Doors between compartments, tunnel sections must be openable toward direction of the nearest exit and they must be self-closing. Cable bridges and racks with technical platform must have access ladder. Distance between entries must not exceed 150 m. Distance from the foot of stairs, cable racks to entry must not exceed 25 m. Entry doors must be arranged so that strange people cannot enter freely. Doors must have lock sockets and can be openable from inside without key.			
II.3.108	The other statement in the II.3.108.	They are also needlessly detailed.	This article is necessary.	1(b)
II.3.109	In cable tunnels and cable canals, measures must be applied to prevent industrial effluents, oil flowing into and pumping discharge soil-sandy water out. Their bottom slope must not be less than 0.5% toward water pit or to water discharge canal. For people going from compartment to compartment at different elevation, slope roads with tilt angle not more than 15 o must be arranged. Construction of stairs in compartments of tunnel is prohibited. In cable canal, trenches constructed outdoor and at elevation higher than underground water level their bottoms are allowed to be constructed from compacted soil covered with 10-15 mm thick pebble layer. In cable tunnels there must be drainage water pumps automatically operational depending water level. The starting control equipment and electric motors must have structure meeting operation requirements in wet conditions. Between cable racks and cable corridors at different elevations, there must be roads with slope not exceeding 15o. In special case, stairs with slope 1:1 are allowed to be constructed.	It is needlessly detailed. Far from technical standard matter. Contents of maintenance	This article is necessary.	1(b)

Article	Subscription	Question	Conclusion	#
II.3.111	Weight of cover plate must not be heavier than 50 kg. Each plate must have hook for lifting.	It is needlessly detailed. Far from technical standard matter. Contents of maintenance	This article is necessary.	1(b)
II.3.124	Cable terminal boxes of high pressure oil cable must be placed in rooms with auto-heating equipment when temperature of environment is below 5oC.	What is the basis of this temperature? There is no design temperature in Japan.	This article shall be discussed in Vietnam side later.	3
II.3.138	When 3 or more cables with voltage up to 35 kV are installed in water, there must be one reserved cable line arranged. For one cable line, reserve must be one phase, for two cable lines, reserve must be 2 phases for 3 cable lines and more, reserve must be specified in design but not less than 2 phases. Reserved phases must be so placed that when necessary they can replace any working phase.	View of planning.	This article is necessary.	1(b)

Substation

Volume 1

Article	Subscription	Question	Conclusion	#
I.2.8	Gas insulated substation (GIS) is a substation where switching equipment are put in the enclosures and internal electrical insulation is performed by gas at atmospheric pressure.	Gas pressure is not only atmospheric pressure also high pressure.	"at atmospheric pressure" shall be deleted.	3
		AIS should also be defined.	Definition of AIS shall be added in this article.	3
I.2.29	At branching point, disconnector should be installed.	Does this mean that DS should be installed at all T-branches? DS should be installed at substation.	This sentence shall be revised.	3
	The substation electrical simple diagram without circuit breaker at inlet and without bus-bar at the high voltage side or with only single bus-bar system is recommended to be used.	In this case, fault within substation will spread to the whole power system.	This sentence shall be revised.	3
I.3.16	$\Delta U_{max} = [\Delta U_{cp}]$	What is the meaning of this formula?	Definition of ΔU_{max} and $[\Delta U_{cp}]$ shall be added in this article.	1
	heating temperature of + 65 ^{o}C	Unit of temperature rise should be K (65K).	^{o}C shall be changed into K .	5
	atmospheric temperature is +25 ^{o}C	Transmission capacity is affected by atmospheric temperature. Therefore atmospheric temperature should be higher than 25℃. In Japan, that figure is set to 40 ℃ in consideration of maximum temperature of summer.	Atmospheric temperature of 25 ^{o}C shall be modified according to practical data in Vietnam.	1
I.4.2.2	Checking short circuit current for current transformer is not necessary.	Why is not checking short circuit for CT necessary?	This article shall be revised.	3
I.5.14	and have accuracy class of 0.5; 1 or 2 for active electricity meters and 2 or 2, 5 for reactive electricity meters.	Accuracy class should be defined in this article.	Definition of accuracy class shall be added in this article.	5
I.6.25	It is allowed to use voltmeter to periodically test insulation of each pole to earth of excitation circuit of rotating electric machines.	Is it possible to test by Voltmeter?	This article shall be revised.	5

Volume 3

Article	Subscription	Question	Conclusion	#
III.1.13	Screw-socket typed fuse must be placed･･･	Is it possible to install fuse to protect generator independently of current capacity? Do you use actually?	No problem Just translation mistake.	3
III.2.17	The structure on which equipment are placed and installed as stipulated in Item III.2.16 must be strong enough to sustain gravity force caused by equipment weight, wind force	Does seismic force need to be taken into account?	No problem Earthquake is few and slight in Vietnam.	5
III.2.77	In the substation of voltage level from 35kV to 110kV where transformer rated less than 63MVA, it is not required the installation of water supply system or fire extinguisher	Extinguisher system is not need? How is Fire Service Law?	This article shall be revised as follows In the substation of voltage level up to 110kV where transformer rated less than 63MVA, it is not required the installation of water supply system for fire extinguisher.	5,6
III.2.86	Beneath or above the room that gathers over 50 persons in more than 1 hour. This requirement is not mandatory for transformers that are dry or contain non-flammable substance.	This prescription will become the obstruction of construction of substation inside a complex building in city area.	This matter shall be discussed in Vietnam side later Study team will inform Vietnam side about the example of indoor substation adopted in Japan after second work in Vietnam. Please see the Attachment “Substation”	1(a)
III.2.88	Table Ⅲ.2.5	Is prescription for 500kV needed or not?	This matter shall be discussed in Vietnam side	3
III.2.147	Ground wire of overhead lines at voltage level of 35kV shall not be allowed to connect to the grounded structures of the outdoor distribution system.	Ground wire of overhead lines at voltage level of 35kV should also be connected to grounded structure similarly to 110kV facilities.	This matter shall be checked later in Vietnam side.	3
III.2.150	The part nearby lightning arrester of this cable line must be buried below the ground surface at least 10m of length.	Is not it difficult to bury this cable below 10m?	This article shall be revised as follows. The part near lightning arrester of this cable line must be buried at least 10m long.	3
III.2.152	it shall be allowed to install no ground wire in the last sections of 35kV overhead lines connected into the	It should not be allowed to install no ground wire to prevent direct lightning.	No problem Capacity of 35kV substation is small and	3

Article	Subscription	Question	Conclusion	#
	substations		direct-lightning is few. Therefore cost performance is low even if ground wire is installed in the sections.	
III.2.155	Distance along conductor from lightning valve to transformer and other equipment must not exceed 10m and so short so good.	Is not it difficult to keep the distance 10m and below? The distance should be decided by insulation coordination.	This article is necessary. This is prescribed based on GOST.	3
III.2.169	If the overhead line section is already protected against direct lightning strikes thanks to buildings, trees or other high structures that situate at least 300m far away,	This kind of protection should not be expected. The protection may be removed later. Ground wire should be installed independent of the circumstances.	This matter shall be discussed in Vietnam side later	3
	If the overhead line is connected to the bus bar of distribution station where rotation machine is placed through reactor and cable of more than 50m length, it shall not be required to install protecting device against direct lightning strikes.	Why is the protecting device against direct lightning not required?	This matter shall be discussed in Vietnam side later	3
	appropriate lightning valve must be placed at position of 150m away from the power plant	What is the reason of 150m?	This article is necessary. This is prescribed based on GOST.	3
	Grounding resistance of the lightning arrester must not exceed 3Ω. In such cases, ground wire is not required to be installed for the overhead line.	Why is ground wire not required if grounding resistance of the lighting arrester is below 3Ω?	This matter shall be discussed in Vietnam side later	3

Volume 4

Article	Subscription	Question	Conclusion	#
IV.2.5	Using simple main electric diagram with automatic isolator in line or in MBA,	What does MBA short for? It is better not to use local abbreviation.	TBA shall be changed into transformer.	5
IV.2.50	Transformer must be equipped partially or entirely protective relay to be kept from all kinds of fault as follows: Partial discharge at input insulator of 500 kV.	What is input insulator? Is it possible to detect partial discharge on real time?	This article shall be revised.	3
IV.2.52	It is necessary to equip Buchholz relay for faults which create air inside transformer, and for keeping oil level from decreasing and oil pressure from increasing for:	To avoid error action of Buchholz relay by earthquake, earthquake detect relay should be installed to lock the action. Will earthquake happen frequently?	No problem Earthquake is few and slight in Vietnam.	5
IV.2.98	Single-pole earth fault short circuit protector often trips for sending signals. To carry out the protection it'd better to use insulation tester.	What is insulation tester?	This article shall be revised.	5
IV.2.105	Overhead line of 110 kV upwards should be equipped with fault detector.	In this case, what kind of equipment is referred to as fault detector?	This article shall be revised.	5
IV.2.117	In case where one-phase earth fault short circuit occurred, in particularity, 2-phase earth fault short circuit, only one phase is sure to be disconnected.	In the case of 2-phase earth fault, is it possible to trip only 1-phase? Even if possible, 1-phase earth will be continued.	This article shall be revised.	5
IV.2.133	4-level zero sequence directional current protector for earth fault short circuit protection.	Do you install 4-level zero sequence directional current protector?	This article shall be revised.	3
IV.3.5	It is necessary to speed up the trip of protective relay after the failure of operation of auto-recloser.	Why? If so, is speed-up sequence is installed?	This article shall be revised.	5
IV.3.16	It is necessary to implement 3-phase auto-reclosing at one terminal of line with dead test on line with increasing time level.	What kind of test is referred to as dead test?	This article shall be revised.	5

Attachment for OHTL

Comments
on
Questions about Review of Vol.1 to 4

（Overhead Transmission Line）

[1] Formula to calculate "hw" 【Calculation of Current Capacity (Safety Current)】 (Vol.1 Annex Ⅰ.3.B)

(1) Formula

$$I_C = \sqrt{\frac{K_C \cdot \pi \cdot D \cdot \theta}{R_{ac}}}$$

I_c : Current Capacity [A]
K_c : Heat Diffusion Factor [W/℃・m^2]
D : Diameter of Conductor [mm]
θ : Increase of Conductor Temperature against surround Temperature [℃]
R_{ac} : AC Resistance under use temperature [Ω/km]

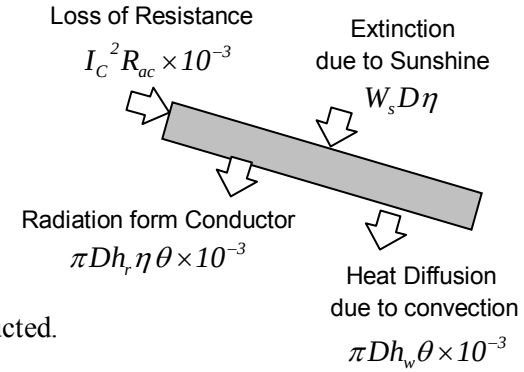
Here,

$$K_C = h_w + \left(h_r - \frac{W_S}{\pi\theta} \right) \eta$$

h_w : Heat Diffusion due to convection Factor [W/℃・m^2]
h_r : Heat Diffusion due to radiation Factor [W/℃・m^2]
W_s : Energy of Sunshine (1.0[kW/m^2])
η : Extinction Ratio or Radiation Ratio(0.9)

［Explanation］

(1) Temperature of conductor is estimated based on the balance between heat radiation and heat extinction. Here, heat radiation means "Radiation from conductor", "Diffusion due to convection" and heat extinction means "Loss of Resistance", "Sunshine".



Based on this ides, following relation is conducted.

$$I_C^2 R_{ac} \times 10^{-3} + W_s D \eta = \pi D h_r \eta \theta \times 10^{-3} + \pi D h_w \theta \times 10^{-3}$$

（Sec.6-2） （Sec.6-3） （Sec.6-4） （Sec.6-5）

Current Capacity Formula is conducted by transformation of this relation.

(2) Loss of Conductor

Loss of Conductor : $I^2 R_{ac} \times 10^{-3}$ [W/m]

AC Resistance of Conductor R_{ac} [Ω/km] : $R_{ac} = R_{dc} \times \beta$

R_{dc} : DC Resistance at Temperature of Conductor T_1℃ [Ω/km]

β : Ratio of AC to DC

(a) DC Resistance R_{dc}

$$R_{dc} = R_{dc(20)} \times \{1 + \alpha(T_1 - 20)\}$$

$R_{dc(20)}$: DC Resistance at Temperature of Conductor 20℃ [Ω/km]

α : Factor of Resistance Temperature [℃$^{-1}$]

(b) Ratio of AC to DC (β)

$$\beta = \beta_1 \cdot \beta_2$$

β_1 : Factor of Skin Effect

$$\beta_1 = 0.99609 + 0.018578x - 0.030263x^2 + 0.020735x^3$$

$$x = \frac{D_1 + 2D_2}{D_1 + D_2} \times 0.01 \times \sqrt{\frac{8\pi \cdot f(D_1 - D_2)}{(D_1 + D_2)R_{dc}}}$$

D_1 : Diameter of Conductor [mm]

D_2 : Diameter of Steel [mm]

f : Frequency (60[Hz])

β_2 : Iron loss

$$\beta_2 = 0.99947 + 0.028895y - 0.0059348y^2 + 0.00042259y^3$$

$$y = \frac{I}{S}$$

I : Current [A]

S : Cross section area [mm^2]

[Explanation]

(1)In the case of AC resistance, ratio of AC to DC (β) calculated from factor of skin effect(β_1) and iron loss factor(β_2) should be taken into account. Skin effect means the phenomenon that current flows at the surface of conductor due to enlargement of inductance at the center part of conductor result from magnetic flux. On the other hand iron loss means the loss caused by magnetic flux inducted at steel wire of conductor. Iron loss is not generated in HDC conductor that does not have steel core. Iron loss that is generated at aluminum conductors that has even number of layer is negligible because magnetic flux is canceled.

The example of Ratio of AC to DC (β) is shown in next table

Table. Ratio of AC to DC (β)

<table>
<tr><th colspan="2">Type of conductor</th><th>Factor of skin effect (β_1)</th><th>Factor of Iron Loss (β_2)</th></tr>
<tr><td colspan="2">Conductor that does not have steel core</td><td>calculated by formula</td><td>1</td></tr>
<tr><td rowspan="3">Aluminum Stranded Steel core</td><td>Single aluminum later</td><td>Experimental number</td><td>Experimental number</td></tr>
<tr><td>Even number of aluminum layer</td><td rowspan="2">calculated by formula</td><td>1</td></tr>
<tr><td>Odd number of aluminum layer
(Over 3 layer)</td><td>calculated by formula</td></tr>
</table>

6-3. Extinction due to Sunshine

Extinction due to Sunshine : $W_s D\eta$ [W/m]

6-4. Radiation form Conductor

Radiation form Conductor : $\pi D h_r \eta \theta \times 10^{-3}$ [W/m]

Factor of heat radiation h_r (Law of Stefan-Boltzman)

$$h_r = 0.000567 \times \frac{\left(\frac{273+T+\theta}{100}\right)^4 - \left(\frac{273+T}{100}\right)^4}{\theta} \times 10^4 \quad [\mathrm{W/^{\circ}C \cdot m^2}]$$

6-5. Heat Diffusion due to convection

Heat Diffusion due to convection : $\pi D h_r \eta \theta \times 10^{-3}$ **[W/m]**

Factor of Heat Diffusion due to convection h_w **(CIGRE Formula)**

$$h_w = \frac{\lambda_f \cdot Nu}{D} \times 10^{-3} \quad [\mathrm{W/℃ \cdot m^2}]$$

λ_f **: Ratio of heat conductivity of Air** 〔W/m・℃〕

Nu**: Nusselt Number**

(a) Ratio of heat conductivity of Air (λ_f)

$$\lambda_f = 2.42 \times 10^{-2} + 7.2 \times 10^{-5} (T + (\theta / 2))$$

T : ambient temperature 〔℃〕

(b)-1 Nusselt Number *(Nu)* （over 0.5m/s）

$Nu_{\phi=0} = \beta_1 (Re)^n$ ($\phi = 0$: angle of wind direction 0°)*

In consideration of the affect due to angle of wind direction

$$Nu = Nu_{\phi=0} \left\{ 0.42 + 0.58 (\cos\phi)^{0.90} \right\} \quad (0° \le \phi \le 66°)$$

$$Nu = Nu_{\phi=0} \left\{ 0.42 + 0.68 (\cos\phi)^{1.08} \right\} \quad (66° \le \phi \le 90°)$$

* In case that the angle of between wind direction and conductor is right angle $\phi = 0°$

(i) Reynolds number（*Re*）

$$Re = \frac{\rho_r \cdot V \cdot D}{\nu}$$

ρ_r : relative air density

$$\rho_r = \rho / \rho_0 = exp(-1.16 \times 10^{-4} Z)$$

ρ : Air density at the point of targeted altitude [g/m^3]

ρ_0 : Air density at see level 〔g/m^3〕

Z : Altitude from see level 〔m〕

V : wind velocity 〔m/s〕

ν : Stickiness 〔m^2/s〕

$$\nu = 1.32 \times 10^{-5} + 9.5 \times 10^{-8} (T + (\theta / 2))$$

(ii)B_1,n（Reynolds number(*Re*), Constant Number calculated by coarse of conductor's surface (R_f)）

B_1, n

Re	surface	B_1	n
$100 \leqq Re \leqq 2{,}650$	strand	0.641	0.471
$2{,}650 < Re \leqq 50{,}000$	*Strand* $R_f \leqq 0.05$	0.178	0.633
	Strand $R_f > 0.05$	0.048	0.800

(iii) Coarse of conductor's surface (R_f)

$$R_f = \frac{d}{2(D-2d)}$$

d： Diameter of conductor 〔mm〕

(b)-II Nusselt Number (Nu) （Under 0.5m/s）

In the case of under 0.5m/s, there is no prominent wind direction, so maximum number of Nu that is calculated case (i) , (ii) and (iii) should be used.

(i) Angle of wind direction is 45°

$$Nu = Nu_{\phi=0}\left\{0.42 + 0.58\left(\cos 45°\right)^{0.90}\right\} = Nu_{\phi=0} \times 0.8446$$

(ii) calculated by Revised Nusselt Number Nu_{cor}

$$Nu = Nu_{cor} = 0.55 Nu_{\phi=0}$$

(iii) calculated by Nu under the condition of natural convection

$$Nu = A_2 (G_r \cdot P_r)^{m2}$$

A_2, m_2 : Constant Number based on Raily Number (product G_r and P_r)

A_2, m_2

Raily Number $G_r \cdot P_r$	A_2	m_2
$100 \leq G_r \cdot P_r < 10{,}000$	0.850	0.188
$10{,}000 \leq G_r \cdot P_r < 1{,}000{,}000$	0.480	0.250

G_r： Glasshoph Number

$$G_r = \frac{D^3 \cdot \theta \cdot g}{(T + (\theta/2) + 273) \cdot V^2}$$

g： gravity acceleration (9.80665 [m/s^2])

$$P_r = \frac{c\mu}{\lambda_f} = 0.7154 - 2.5 \times 10^{-4}(T + (\theta/2))$$

P_r : Prantle Number

c : Slight fever of air under constant pressure [J/kg･℃]

μ : Stickiness of Air [kg/m･s]

[Explanation]

(a) It emerged that heat diffusion from conductor due to convection is calculated with more accuracy by using CIGRE Formula than Rice Formula that has been used generally. This accuracy was proved by experiment that was carried out in Japan in 1998. Now CIGRE Formula is used worldwide generally when heat diffusion is calculated.
The difference between Rice Formula and CIGRE Formula is as follow.

Rice Formula :

Surface temperature is treated same as fluid film around object in Rice Formula. Rice Formula is conducted by cylinder model based on Langmuir's film theory that assumes that the variations of object's temperature sympathize with fluid film.

CIGRE Formula :

CIGRE Formula is based on experiment that provide the affect for heat diffusion from Reynolds. Number that shows the condition of conductor's surface and coarse.

Rice Formula

$$h_w = 0.000572 \frac{\sqrt{\frac{v}{d}}}{\left(273 + T + \frac{\theta}{2}\right)^{0.123}} \quad (W/°C.\ cm^2)$$

V: Calculated wind speed (m/s)
d: Diameter of conductor (cm)
T: Air temperature (℃)
θ : Permissible temperature increase

CIGRE Formula

$$h_w = \frac{\lambda_f \times N_u}{D \times 100} \quad (W/°C.\ cm^2)$$

λ f: Heat conductivity (W/m･K)
Nu: Nusselt constant number

Table. Comparison of Heat Diffusion

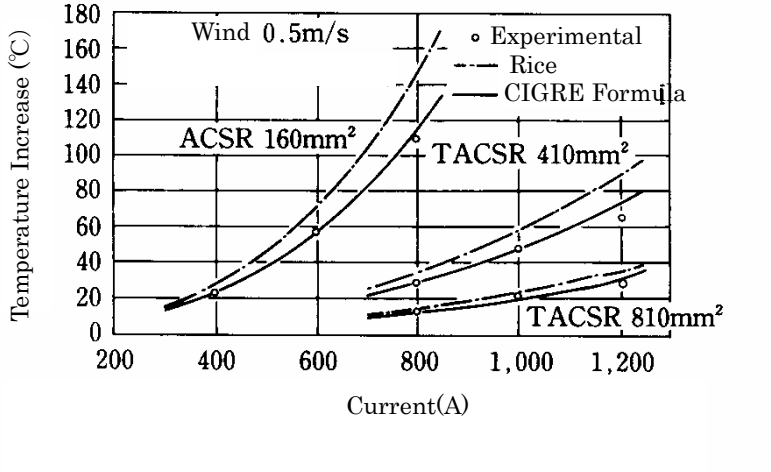
Wind 0.5m/sec Unit (W/cm)

	Rice Formula	CIGRE Formula	IEEE	IEC
ASCR 160mm2	0.4188 (100%)	0.5272 (126%)	0.4961 (118%)	0.4895 (117%)

Table. Comparison of Current Capacity

Wind 0.5m/sec Unit (A)

	Rice Formula	CIGRE Formula	IEEE	IEC
ASCR 160mm2	454 (100%)	503 (111%)	490 (108%)	487 (107%)



(2) <u>The fault locating equipment (Vol.2 Ⅱ.5.19)</u>

Install Condition : 1) Over 77kV. Circuit length is over 10km. Transmission line that supplies city area. Power source line. Transmission line connecting to heavy load are.

2) All line over 275kV

3) Over 77kV line that experience fault several time.

4) Over 77kV line that is difficult to patrol

(Ex. mountain area)

(3) Minimum Size of Conductor (Vol.2 Ⅱ.5.34)

Voltage	Minimum	Reason
Under 77kV	160mm^2	Minimum size of standard conductor. However conductor supplying to customer is 80mm^2.
154kV	160mm^2	To decrease Corona Noise
275kV	410mm^2×2	〃
500kV	410mm^2×4	〃

※ Fuse characteristic depend on cut time and fault current should be taken into account.

(4) The points of examination for the line arranged on the same tower (Vol.2 Ⅱ.5.52)

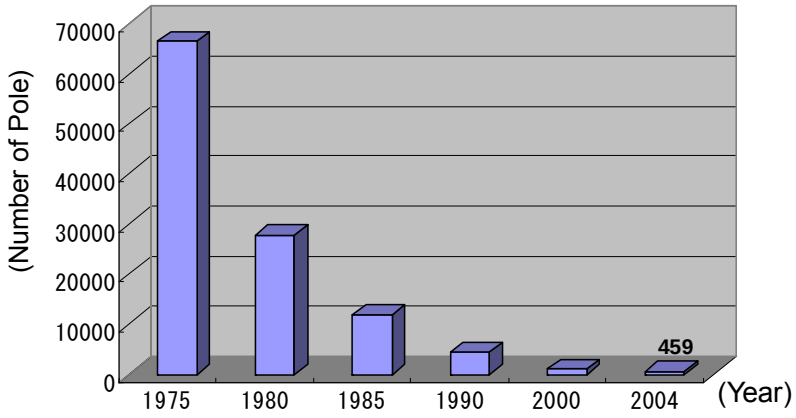
Following problem that might be caused by the line arrangement on the same tower (here in after jointly arrangement tower) must be examined. The problems are resulted from over voltage or induced current caused by static or electric-magnetic induction on the jointly arrangement tower.

1. Jointly arrangement tower is higher than standard type tower. Therefore frequency of lightning shot and the current get bigger, and lightning surge voltage get bigger especially on the lower voltage line. In this case, the LIWV of the lower voltage substation should be checked.
2. The switching equipment, disconnecting equipment or ground equipment (Include mobile) on lower voltage system should be check by taking the induced current into account.
3. It might be afraid that zero-sequence current resulted by induced current may cause fault of ground protection relay.

(5) Usage of Wood Pole for Transmission and Distribution Line (Vol.2 Ⅱ.5.83)

In Japan, a lot of wood pole have been used as T&D Line pole once ago. However, wood pole has been replaced to concrete pole gradually as shown in Fig. One of the reason is lacking in endurance or harmonize with scenery. Now wood pole is only 0.1% of T&D Line pole. Bath injected pole has been usually used as countermeasure against lacking in endurance. But the bath (Creosote) is considered to be harmful for health. Therefore the usage is limited or permitted mainly in EU countries. As a result wood pole would decrease gradually in worldwide scale.

However wood pole is still allowed to use as T&D Line pole in Technical Standards of Electric Facilities in Japan.



Number of Wood Pole in JAPAN (Purpose for Electric Power)

Conductor of mobile earth (The other)

Conductor size is 22mm^2 (copper wire covered by polyethylene). Permissible current is 100A (conductors temperature is 60℃ (surrounding temperature is 35℃, wind 0.5m/s)) .

Attachment for UGTL

Comments
on
Questions about Review of Vol.1 to 4

（Underground Transmission Line）

Attachment_UGTL 1

Contents of II.2.29

Induced Voltage Issue

August , 2006

Contents of II.2.29

Number of places for mobile earthing connection must be so selected that <u>when short circuit happens</u> between two adjacent points of earthing mechanism, induced voltage must not exceed 250 V.

Induced Voltage is regulated in only case of fault

⇩

Regulation under the normal state is also important.

JICA Study Team recommends you add this content to the present standard

Japanese Technical Standard Case

The Industrial safety and health law

In article 329

Electrical Equipment shall be covered not to cause human disaster when workers maintenance or pass through them.

Exception In article 36

Electrical equipment whose induced voltage is less than 50V against ground.

Protection can be omitted.

3

Base of the Figure, 50V

Purpose: No Human disaster

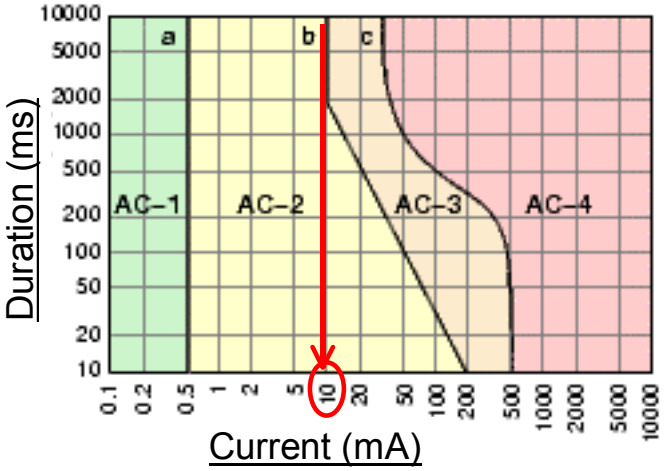
Three main contents have a decisive influence on this issue

1. The relationship between current and duration
2. The disengageable current
3. Resistance of human and contact resistance

4

Base of the Figure, 50V Cont'd

1. The relationship between current and duration



AC-1 Insensitive

AC-2

No life-threatening issue

AC-3

Muscular spasm

Breathing difficulty

AC-4

Fatal problem

Breath-holding

5

Base of the Figure, 50V Cont'd

2. The disengageable current

10mA ~ 15mA

However, it depends on body weight mainly.

6

Base of the Figure, 50V Cont'd

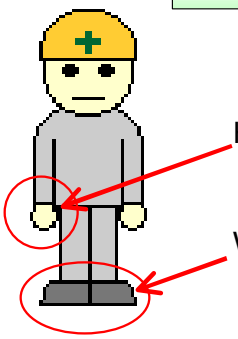
3. Resistance of human and contact resistance

IEEE: 1000Ω

Inside human body

It is authorized all over the world as the safe side value under wet hand wet feet condition

However



Human has skin. More than 1000Ω

Workers are usually wearing a pair of shoes.

7

Base of the Figure, 50V Cont'd

3. Resistance of human and contact resistance

Condition	Resistance
Dry hand to Ground with shoes	More than 30kΩ
Dry hand to Dry hand	5kΩ
Wet hand to Ground without shoes	3kΩ
Wet hand to wet hand	2kΩ

✓ Operation or maintenance is usually conducted under good condition, dry condition.

✓ Workers are usually wearing a pair of shoes.

Human body resistance must be more than **5kΩ** at least with these conditions.

8

Conclusion

50 V / 5kΩ = 10 mA

- Disengageable current
- No life-threatening current regardless of time period

50V is reliable as maximum induced voltage against workers.

End

August , 2006

Reference

- IEEE 80-2000
- IEC 479-1
- Safety hand book published by research institute of transmission lines construction (Japan)
- Safety rule at the Yokohama university in Japan

Attachment_UGTL 2

Contents of II.3.43

UGTL installed along the Bridge

August , 2006

Contents of II.3.43

Cable line installed along with railways bridges and other bridges, the cable with steel sheath and aluminum cover must be used.

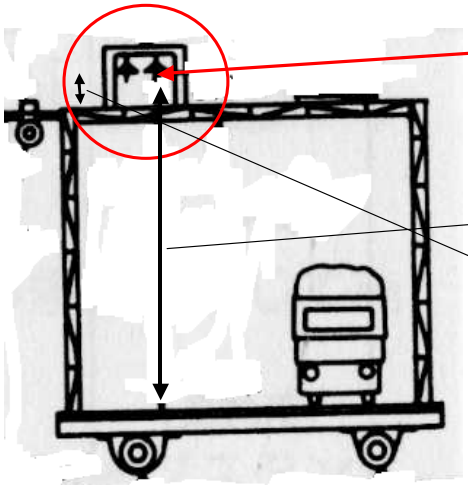
Content is not sufficient.

Regulation for layout especially must be needed like II.3.92.

JICA Study Team recommends you add some content to this article.

Japanese Technical Standard Case

1. UGTL over the bridge



✓Less than 7.0kV
✓Naked wire (OHTL) is available

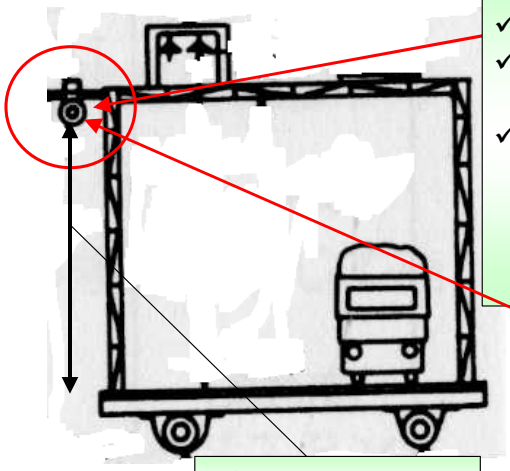
✓More than 5m

✓ More than 0.3m: Distance between line and support

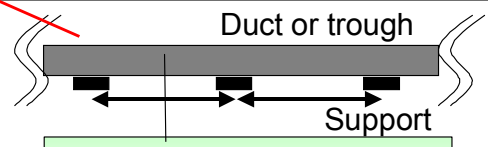
3

Japanese Technical Standard Case

2. UGTL on the ceiling or wall of the bridge



✓ Less than 100kV.
✓ Lines should be cables.
✓ Cables shall be installed inside ducts or troughs
✓ Ducts or troughs and cable shield shall be connected to the earth (Grounding resistance shall be less than 10Ω, 100Ω in case that there is no possibility for people to touch them)



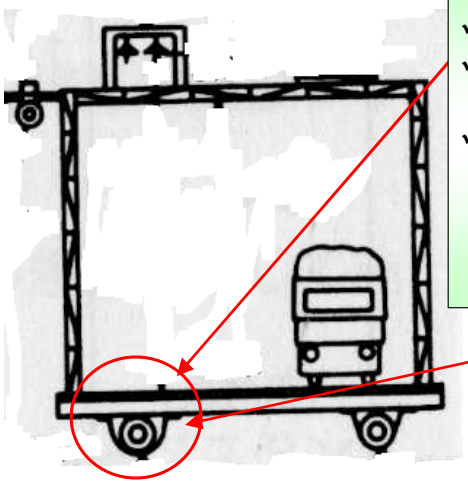
✓More than 5m

✓ Less than 2m: Distance between supports

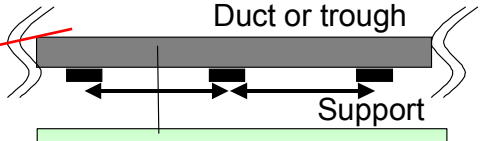
4

Japanese Technical Standard Case

3. UGTL under the bridges



- ✓ Less than 100kV.
- ✓ Lines should be cables.
- ✓ Cables shall be installed inside ducts or troughs
- ✓ Ducts or troughs and cable shield shall be connected to the earth (Grounding resistance shall be less than 10Ω, 100Ω in case that there is no possibility for people to touch them)



- ✓ Less than 2m: Distance between supports

5

Conclusion

Description shown below must be added

- Lay out
- Earth System
- Distance to the another objects

6

End

August , 2006

Reference

- Technical standard in Japan

Comments
on
Questions about Review of Vol.1 to 4

（Substation）

Slide 1: Proposal of JICA Study Team

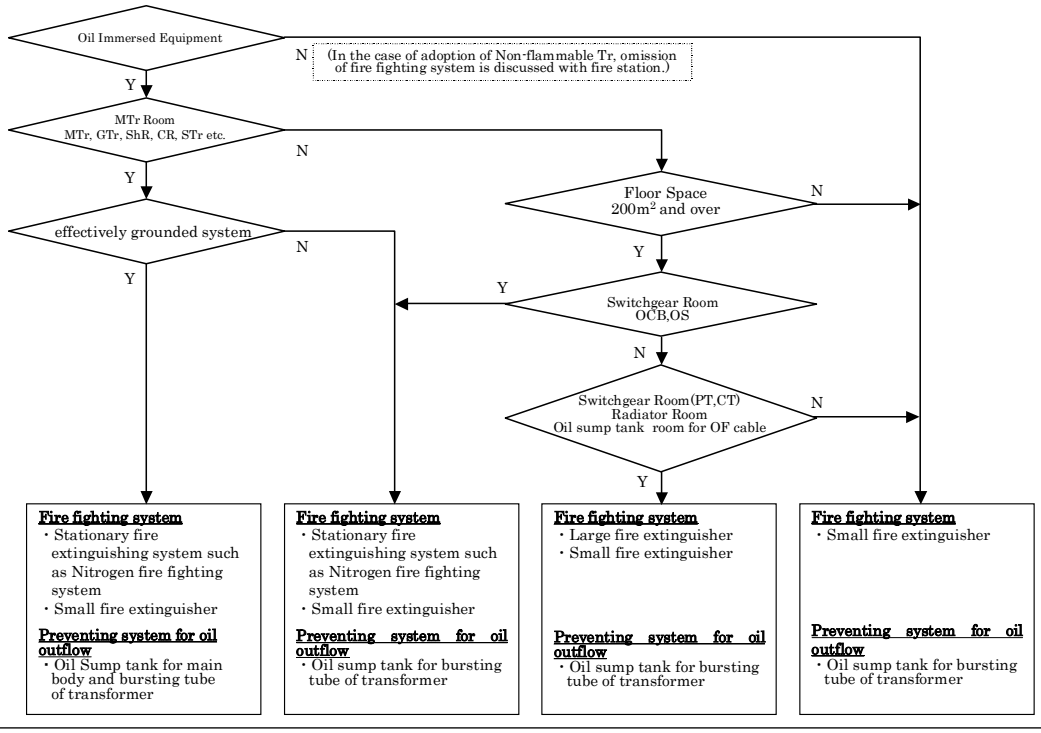
The following article should be removed.

Vol.Ⅲ Article Ⅲ.2.86
Transformer and distribution system shall not be allowed to place: Beneath or above the room that gathers over 50 persons in mo than 1 hour. This requirement is not mandatory for transformers that are dry or contain non-flammable substance.

This prescription will become the obstruction of construction of substation, inside a complex building in city area.

In Japan, if the provision for fire is made adequately, it is acceptable to adopt oil-immersed transformer as well as dry-type and non-flammable transformer in underground substation inside a complex building.

Slide 2: Standard for Installation of Fire Fighting System for Indoor Equipment



Slide 3:
Fireproof or Fire-resistant Structure for Indoor Equipment

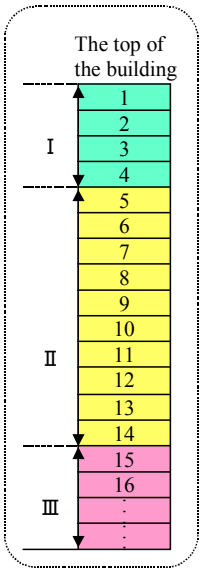
A part of the fireproof or fire-resistant design for indoor equipment is shown in the following list.

Item \ Room		MTr, ShR etc.	Switchgear (include GIS)	Control, Relay Communication	STr Battery Oil sump tank for OF Cable Radiator for MTr
Structure of building	Structure	Refer to Slide 4	Fireproof or Fire-resistant		
	Interior materials	Nonflammable, or Semi-nonflammable			
	Doorway	Doorway of two and over	Fire door or other fireproof		
	Window	No establishment		As necessary	No establishment
Section for Fireproof (Prevention of Fire-Spread)		Separating each unit of by fire-resistant wall (Refer to Slide5)			
Ventilation facilities		Effective ventilation facilities leading to outdoor (Fan for ventilation shall be stopped automatically when fire occurs.)			

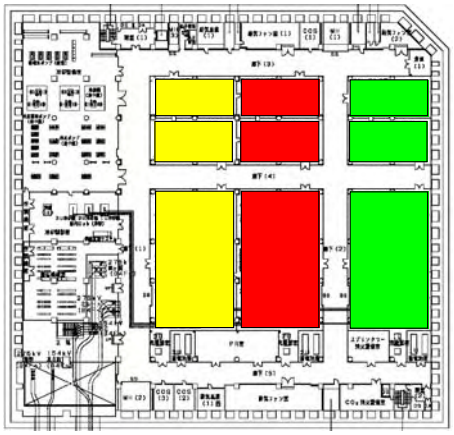
Slide 4:
Fireproof or Fire-resistant Structure for MTr room , ShR, etc.

The structures of the room for MTr, ShR and so on shall be fire-resistant. They shall have fire-resistant capability shown the below list.

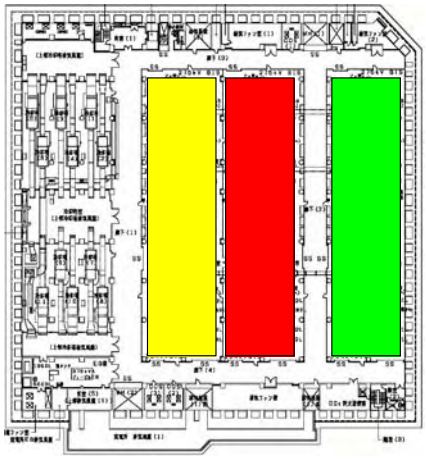
Structure of Room for Equipment \ Floor of Room for Equipment				Ⅰ	Ⅱ	Ⅲ
Wall	Partition			1h	2h	2h
	Outer walls	Bearing Wall		1h	2h	2h
		Curtain wall	A part with fear of spread of a fire	1h	1h	1h
			except the above	0.5h	0.5h	0.5h
Pole				1h	2h	3h
Floor				1h	2h	2h
Beam				1h	2h	3h
Roof				0.5h	0.5h	0.5h



Slide 5: Unit Separation Design (Example)



Main Transformer & Shunt Reactor



275 & 154kV GIS

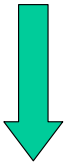
Slide 6:
Consideration for Installation of Substation in Complex Building

- The main structure of each room of substation shall be fire resistant
- Ventilation and air-conditioner shall be installed for the exclusive use of substation
- Discharge system for smoke and stationary fire extinguisher system shall be installed.
- The measures to prevent water leak and submergence from other area of complex building
- The installation of stationary fire fighting system in switchgear room, control room and so on as well as MTr room.

etc.

Slide 8:Conclusion

It should be acceptable to adopt oil-immersed transformer as well as dry-type and non-flammable transformer in underground substation inside a complex building.



It is necessary to take proper fire-prevention measures at Fire Service Law

The type of transformer should be selected by each company in consideration of total cost including fire-prevention measures cost.

Quotation or Reference Materials

for Technical Standards

Appendix Table2.1 Quotation or Reference Materials

Article	Reference Material
Part 2 Transmission & Distribution Line and Substations	
Chapter 4 In Progress Inspection **- Section 2 Overhead Transmission Line**	
Article 2-7. Earth Resistances of Supporting Structures and Buried Earth Wires	CEPCO (※1) Company Manual "Manual of Inspection for field work" (1998)
Article 2-8. Overhead Wire Inspection	Ditto
Article 2-9. Wire Connection Inspection	Ditto
Article 2-10. OPGW Inspection	Ditto
- Section 3 Underground Transmission Line	
Article 2-14. Inspection of Cable Joint	CEPCO (※1) Company Manual "Manual of Inspection for field work" (2004)
Article 2-15. Phase Check	Ditto
Article 2-16. Earth Connection	1. CEPCO (※1) Company Manual "Manual of Inspection for field work" (2004) 2. Technical Standards for Electrical Equipment in Japan
Article 2-17. Conditions of cable supporters	CEPCO (※1) Company Manual "Manual of Inspection for field work" (2004)
Article 2-18. Cable Installation	1. CEPCO (※1) Company Manual "Manual of Inspection for field work" (2004) 2. JEAC 601 (※2) "Technical Standard for Underground Transmission Lines"
Article 2-19. Insulation Resistance of Cable Jacket	1. CEPCO (※1) Company Manual "Manual of Inspection for field work" (2004) 2. JEC (※3) 3402 "Electric Power Cable Jacket"
Article 2-20. Cable Snaking	CEPCO (※1) Company Manual "Manual of Inspection for field work" (2004)
Article 2-21. Grounding Points	Ditto
Article 2-22. Clearance from Other Cables, Pipes, etc	1. CEPCO (※1) Company Manual "Manual of Inspection for field work" (2004) 2. Technical Standards for Electrical Equipment in Japan
- Section 4 Substation Equipment	
Article 2-23.-1.-(1) Measurement of insulation resistances of windings.	EVN Regulation for Inspection and Repair of Transformer (1998)
Article 2-23.-1.-(2) Measurement of Insulation resistances for control circuits	1.JEAC (※2) 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-23.-1.-(3) Measurement of tan δ	EVN Regulation for Inspection and Repair of Transformer (1998)
Article 2-23.-2. Measurement of Transformer Ratio	1. CEPCO Company Manual "Manual of Inspection for field work" (2003) 2. CEPCO Standard Specifications "Transformer" (2003)
Article 2-23.-6. Insulation Oil Test	1.EVN Regulation for Inspection and Repair of Transformer (1998)

	2.Electric Technology Research Association (No.53-4,1997).
Article 2-23.-7. Oil Tightness Test	Electric Technology Research Association "Rationalization of Dielectric Strength Test on Site for Transmission Line and Substation Facilities " (No.53-4, 1997)
Article 2-23.-8. Tap Changer Inspection	CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-24.-1.-(1) Measurement of Insulation resistance of primary windings	1.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-24.-1.-(2) Measurement of Insulation resistances for control circuits	
Article 2-25.-1.-(1) Measurement of Insulation resistance of primary windings	Ditto
Article 2-25.-1.-(2) Measurement of Insulation resistances for control circuits	
Article 2-25.-4. Measurement of Excitation Characteristics	CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-26.-1. Measurement of Insulation Resistance	1.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-26.-2. Measurement of Contact Resistance for Direct Current	This content is same as OCB prescribed in "Volume and Standards for Test, Acceptance and Hand Over of Electrical Equipment (TCN-26-87, 1987)".
Article 2-26.-3. Tightness Test of Pneumatic System	Electric Technology Research Association "Standardization of Gas Insulated Switchgear (No.39-6, 1983) "
Article 2-26.-4. Slow Leak Test of Oil Pressure System	CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-26.-5. Gas Density Detectors Test	Ditto
Article 2-26.-6. SF6 Gas Analysis	1. Electric Technology Research Association "Standardization of Gas Insulated Switchgear (No.39-6, 1983) " 2. JEAC 5001"Technical Standards for Power Station and Substation"(2000)
Article 2-26.-7. Opening and Closing Operations Test	1.CEPCO Company Manual "Manual of Inspection for field work" (2003) 2.JEC (※3) 2300 "AC Circuit Breaker" (1998)
Article 2-26.-8.-(1) Contact opening time and closing time	Ditto
Article 2-26.-8.-(2) Minimum operational voltage (pressure)	1.JEC2300 "AC Circuit Breaker" (1998) 2.IEC60694 "Common specifications for high-voltage switchgear and control-gear standards" (2002)
Article 2-26.-8.-(3) Three-phase imbalance	1.CEPCO Company Manual "Manual of Inspection for field work" (2003) 2.CEPCO Standard Specifications "AC Circuit Breaker" (2005)

Article 2-26.-8.-(4) Operational timing of auxiliary switches	CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-26.-9. Phase Missing Timer Test	Ditto
Article 2-26.-10. Associated Tank Capacity Test	JEAC 5001"Technical Standards for Power Station and Substation"(2000)
Article 2-26.-11. Interlocking System Test	Ditto
Article 2-26.-12. Operation Test of Safety Valve	Ditto
Article 2-27.-1. Measurement of Insulation Resistance	1.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-27.-2. Measurement of Contact Resistance for Direct Current	This content is same as OCB prescribed in "Volume and Standards for Test, Acceptance and Hand Over of Electrical Equipment (TCN-26-87, 1987)".
Article 2-27.-3. Air Tightness Test of Pneumatic Systems	Electric Technology Research Association "Standardization of Gas Insulated Switchgear (No.39-6, 1983) "
Article 2-27.-4. Gas Density Detectors Test	CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-27.-5. SF6 Gas Analysis	1. Electric Technology Research Association "Standardization of Gas Insulated Switchgear (No.39-6, 1983) " 2. JEAC 5001"Technical Standards for Power Station and Substation"(2000)
Article 2-27.-6. Opening and Closing Operations Test in Disconnector	CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-27.-10. Sequence and Interlock Tests	Ditto
Article 2-27.-11. Phase Check	Ditto
Article 2-28.-1. Measurement of Insulation Resistance	1.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-28.-2. Opening and Closing Operations Test	1.CEPCO Company Manual "Manual of Inspection for field work" (2003) 2.JEC2300 "AC Circuit Breaker" (1998)
Article 2-28.-3.-(1) Contact opening time and closing time	Ditto
Article 2-28.-3.-(2) Minimum operation voltage	1.JEC2300 "AC Circuit Breaker" (1998) 2.IEC60694 "Common specifications for high-voltage switchgear and control-gear standards" (2002)
Article 2-28.-3.-(3) Three-phase imbalance	1.CEPCO Company Manual "Manual of Inspection for field work" (2003) 2.CEPCO Standard Specifications "AC Circuit Breaker" (2005)
Article 2-29.-1. Measurement of Insulation Resistance	1.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Inspection for field work" (2003)

Article 2-29.-2. Measurement of Contact Resistance for Direct Current	This content is same as OCB prescribed in "Volume and Standards for Test, Acceptance and Hand Over of Electrical Equipment (TCN-26-87, 1987)".
Article 2-29.-3. Opening and Closing Operations Test	1.CEPCO Company Manual "Manual of Inspection for field work" (2003) 2.JEC2300 "AC Circuit Breaker" (1998)
Article 2-29.-4.-(2) Minimum operation voltage	1.JEC2300 "AC Circuit Breaker" (1998) 2.IEC60694 "Common specifications for high-voltage switchgear and controlgear standards" (2002)
Article 2-29.-4.-(3) Three-phase imbalance	1.CEPCO Company Manual "Manual of Inspection for field work" (2003) 2.CEPCO Standard Specifications "AC Circuit Breaker" (2005)
Article 2-30.-1. Measurement of Insulation Resistance	1.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-30.-3. Opening and Closing Operations Test	1. CEPCO Company Manual "Manual of Inspection for field work" (2003) 2. JEC2310"AC Disconnector"(2003)
Article 2-31.-1. Pressure Gauge Test	CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-31.-2. Safety Valve Test	JEAC 5001"Technical Standards for Power Station and Substation"(2000)
Article 2-31.-3. Automatic Start and Stop Test	Ditto
Article 2-32.-1. Measurement of Insulation Resistance	1.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-32.-2. Sequence and Interlock Tests	CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-32.-3. Phase check	Ditto
Article 2-33.-1. Measurement of Insulation Resistance	1.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-33.-3. Sequence Tests	CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-34.-1. Measurement of Insulation Resistance	1.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-35.-1. Measurement of Voltage	CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-35.-2. Equalizing charge test	Ditto
Article 2-36. The Inspection Item for Protection Relays and Control Equipment	CEPCO Company Manual "Manual of Inspection for field work" (2003)
Chapter 5 Completion Inspection - Section 2 Overhead Transmission Line	
Article 2-38.	CEPCO (※1) Company Manual

Measurement of Insulation Resistance	"Manual of Completion Inspection" (1998)
Article 2-39. Phase Test	Ditto
Article 2-40. Power Frequency Withstand Voltage Test	Ditto
- Section 3 Underground Transmission Line	
Article 2-41. Appearance Inspection (Route Exploration)	CEPCO (※1) Company Manual "Manual of Inspection for field work" (2004)
Article 2-42. Insulation Resistance	Ditto
Article 2-43. Phase Check	Ditto
Article 2-44. Withstand voltage test	Technical Standards for Electrical Equipment in Japan
Article 2-45. Clearance between Live Part and Fence or Wall	Technical Standards for Electrical Equipment in Japan
- Section 4 Substation Equipment	
Article 2-46.-1. State of installation of equipment which generates arc	1.CEPCO Company Manual "Manual of Inspection for field work" (2003) 2.Technical Standards for Electrical Equipment in Japan
Article 2-46.-2. State of installation of charged part	1.Technical Standards for Electrical Equipment in Japan 2.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 3.CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-46.-3. Installation of fence, Wall	1.Technical Standards for Electrical Equipment in Japan 2. JEAC 5001"Technical Standards for Power Station and Substation"(2000)
Article 2-47. Measurement of Grounding Resistance	1.CEPCO Company Manual "Manual of Inspection for field work" (2003) 2.Technical Standards for Electrical Equipment in Japan
Article 2-48.-1. Switching test	JEAC 5001"Technical Standards for Power Station and Substation"(2000)
Article 2-48.-2. On-load tap changer test	Ditto
Article 2-48.-3. Protective device test, Alarm indication test	Ditto
Article 2-48.-4. Actual Loading Test for Protection relay and control equipment	CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-49. Interlock Test	JEAC 5001"Technical Standards for Power Station and Substation"(2000)
Article 2-50. Withstand Voltage Test	Technical Standards for Electrical Equipment in Japan
Article 2-51. Operation Supervision Test	CEPCO Company Manual "Manual of Inspection for field work" (2003)
Article 2-52. Measurement of Noise and Vibration	Noise: Technical Standards in Vietnam Volume I Article I.1.3 "Noise level" Vibration：Vibration Regulation Law and in Japan
Chapter 6 Periodic Inspection **- Section 2 Overhead Transmission Line**	
Article 2-55. The Inspection Item	CEPCO (※1) Company Manual "Manual of Periodic Inspection" (1998)

- Section 3 Underground Transmission Line	
Article 2-56. The Inspection Item for Cable	CEPCO (※1) Company Manual "Manual of Periodic Inspection" (2006)
Article 2-57. The Inspection Item for Cable Terminal	Ditto
Article 2-58. The Inspection Item for Cable Joint	Ditto
Article 2-59. The Inspection Item for Oil Supply Equipment	Ditto
Article 2-60. The Inspection Item for Insulating Oil Analysis of OF Cable	Electric Technology Research Association "Maintenance Technology of OF Cable (No.55-2, 1999)"
- Section 4 Substation Equipment	
Article 2-61.-1. Visual Inspection	CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-61.-2. Measurement of Insulation Resistance of windings	EVN Regulation for Inspection and Repair of Transformer (1998)
Article 2-61.-3. Insulating Oil Test	1. EVN Regulation for Inspection and Repair of Transformer (1998) 2.Electric Technology Research Association (No.53-4,1997)
Article 2-61.-4. Dissolved Gas Analysis	IEC60599 "Mineral oil-impregnated electrical equipment in service - Guide to the interpretation of dissolved and free gases analysis"(1999-03)
Article 2-61.-5. On-load Tap Changer Inspection	CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-61.-6. Inspection of BCT and Protective Device for Secondary Circuit of Bushing CT	1.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-61.-7. Cooling Equipment Inspection	CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-61.-8. Operation Test of Alarm and Indication	1.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-61.-9. Operation Test of Protective Device	Ditto
Article 2-62.-1. Measurement of Insulation Resistance	Ditto
Article 2-62.-2. Insulating Oil Test	1. EVN Regulation for Inspection and Repair of Transformer (1998) 2.Electric Technology Research Association (No.53-4,1997).

Article 2-63.-1. Measurement of Insulation Resistance	1.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-63.-2. Insulating Oil Test	1. EVN Regulation for Inspection and Repair of Transformer (1998) 2.Electric Technology Research Association (No.53-4,1997)
Article 2-64.-1. Measurement of Insulation Resistance	1.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-64.-2. Measurement of Contact Resistance for Direct Current	CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-64.-3. Analysis of Decomposed Gas in SF6 Gas	JEAC 5001"Technical Standards for Power Station and Substation"(2000)
Article 2-64.-4. Opening and Closing Operation Test	1.CEPCO Company Manual "Manual of Inspection for field work" (2003) 2.JEC (※3) 2300 "AC Circuit Breaker" (1998)
Article 2-64.-5. Measurement of Opening and Closing Characteristics	1.JEC2300 "AC Circuit Breaker" (1998) 2.IEC60694 "Common specifications for high-voltage switchgear and controlgear standards" (2002)
Article 2-64.-6. Gas Density Detectors Test	CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-64.-7. Error Measurement of Metering Device	Ditto
Article 2-64.-8. Operation Test of Safety Valve	JEAC 5001"Technical Standards for Power Station and Substation"(2000)
Article 2-65.-1. Measurement of Insulation Resistance	1.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-65.-2. Gas Density Detectors Test	CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-65.-3. Analysis of Decomposed Gas in SF6 Gas	JEAC 5001"Technical Standards for Power Station and Substation"(2000)
Article 2-65.-4. Error Measurement of Metering Device	CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-66.-1. Measurement of Insulation Resistance	1.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-66.-2. Measurement of Contact Resistance for Direct Current	CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)

Article 2-66.-3. Opening and Closing Operation Test	1.CEPCO Company Manual "Manual of Inspection for field work" (2003) 2.JEC2300 "AC Circuit Breaker" (1998)
Article 2-66.-4. Measurement of Opening and Closing Characteristics	1.JEC2300 "AC Circuit Breaker" (1998) 2.IEC60694 "Common specifications for high-voltage switchgear and controlgear standards" (2002)
Article 2-66.-5. Withstand Voltage Test of Vacuum Valve	CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-67.-1. Measurement of Insulation Resistance	1.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-67.-2. Measurement of Contact Resistance for Direct Current	1.CEPCO Company Manual "Manual of Inspection for field work" (2003) 2.JEC2300 "AC Circuit Breaker" (1998)
Article 2-67.-3. Opening and Closing Operation Test	Ditto
Article 2-67.-4. Measurement of Opening and Closing Characteristics	1.JEC2300 "AC Circuit Breaker" (1998) 2.IEC60694 "Common specifications for high-voltage switchgear and controlgear standards" (2002)
Article 2-67.-5. Withstand Voltage Test of Insulating Oil	EVN Regulation for Inspection and Repair of Transformer (1998)
Article 2-67.-6. Operation Test of Pressure Relay	CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-68.-1. Measurement of Insulation Resistance	1.JEAC 5001"Technical Standards for Power Station and Substation"(2000) 2. CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005)
Article 2-68.-3. Opening and Closing Operation Test	1. CEPCO Company Manual "Manual of Periodic Patrol and Inspection" (2005) 2. JEC2310"AC Disconnector"(2003)
Article 2-68.-4. Measurement of Opening and Closing Characteristics	Ditto
Article 2-69. The Inspection Item for Protection Relays and Control Equipment	CEPCO Company Guideline "Guideline for Management of Periodic Patrol and Inspection"
Part 3 Hydro Power Plant	
Article 3-1. Definitions	1. Federal Guidelines for Dam Safety Glossary of Terms (April, 2004), U.S. Department of Homeland Security Federal Emergency Management Agency Glossary of Technical Terms in Civil Engineering, JSCE, JAPAN (in Japanese)
Chapter 3 In progress inspection	
Article 3-5. Grounding resistance measurement	1.JEAC 5001-2000 "Technical Standards for Power Station and

	Substation" 2.Central Research Institute of Electric Power Industry "Guide of Lightning protection in Powerplant"
Article 3-6. Insulation resistance measurement	1.Electric Institute Report No.18 "Standard test procedure of Synchronous Generator" 2.Electric Technology Research Association "Standard of Hydro Powerplant Equipment Installation and Inspection"
Article 3-7. Dielectric test	International Electro-technical Commission 60034-1 "Rotating electrical machines"
Article 3-8. Air gap measurement	Electric Technology Research Association "Standard of Hydro Powerplant Equipment Installation and Inspection"
Article 3-9. Dielectric loss angle and absorption current	Electric Technology Research Association "Standard of Hydro Powerplant Equipment Installation and Inspection"
Article 3-10. Determination of characteristics of Generator	Electric Technology Research Association "Standard of Hydro Powerplant Equipment Installation and Inspection"
Article 3-11. Hydraulic turbine system	Electric Technology Research Association "Standard of Hydro Powerplant Equipment Installation and Inspection"
Article 3-12. Inlet valve	Electric Technology Research Association "Standard of Hydro Powerplant Equipment Installation and Inspection"
Article 3-13. Auxiliary equipment	Electric Technology Research Association "Standard of Hydro Powerplant Equipment Installation and Inspection"
Article 3-14. Vibration measurement	1.JEAC 5001-2000 "Technical Standards for Power Station and Substation" 2.Electric Technology Research Association "Standard of Hydro Powerplant Equipment Installation and Inspection"
Chapter4 Completion inspection	
Article 3-17. Bearing run	Electric Technology Research Association "Standard of Hydro Powerplant Equipment Installation and Inspection"
Article 3-18. Automatic start and stop test	Electric Technology Research Association "Standard of Hydro Powerplant Equipment Installation and Inspection"
Article 3-19. Load rejection test	Electric Technology Research Association "Standard of Hydro Powerplant Equipment Installation and Inspection"
Article 3-20. No load no excitation test	Electric Technology Research Association "Standard of Hydro Powerplant Equipment Installation and Inspection"
Article 3-21. Emergency stop test	Electric Technology Research Association "Standard of Hydro Powerplant Equipment Installation and Inspection"
Article 3-22. Quick stop test	Electric Technology Research Association "Standard of Hydro Powerplant Equipment

			Installation and Inspection"
Article 3-23. Load test			Electric Technology Research Association "Standard of Hydro Powerplant Equipment Installation and Inspection"
Article 3-24. Output test			Electric Technology Research Association "Standard of Hydro Powerplant Equipment Installation and Inspection"
Article 3-25. Pumping operation test			Electric Technology Research Association "Standard of Hydro Powerplant Equipment Installation and Inspection"
Articles 3-28 to 3-30 Concrete Dams and Fill Dams			1. Illustrative rules on Dam Management (2006), Water Resources Environment Technology Center, JAPAN (in Japanese) Safety Evaluation of Existing Dams, U.S. Department of the Interior, Bureau of Reclamation
Article 3-32 Pressurized Waterways			1. Technical Standards for Gate and Penstock (2001), Japan Hydraulic Gate and Penstock Association (in Japanese) Guidelines for Inspection and Monitoring of In-Service Penstocks (1998), ASCE
Chapter 5 Periodic Inspection **- Section 9 Electrical Equipment**			
Article 3-49. Frequency of periodical inspection			JPOWER Company Manual "Manual of Periodical Inspection" (2005)
Article 3-51. Visual inspection			1.JEAC 5001-2000 "Technical Standards for Power Station and Substation" 2.Electric Technology Research Association "Standard of Hydro Powerplant Equipment Installation and Inspection"
Part 4 Thermal Power Plant			
Chapter 3 Completion Inspection **- Section 2 Mechanical Equipment**			
Article 4-5. General inspection			METI's interpretation for Article 73-4 (※4)
Article 4-6. Safety valve test			Ditto
Article 4-7. Alarm device test			(Former mandatory regulation in Japan)
Article 4-8. Interlock test			METI's interpretation for Article 73-4 (※4)
Article 4-9. Speed governor working range test			(Former mandatory regulation in Japan)
Article 4-10. Emergency governor test			METI's interpretation for Article 73-4 (※4)
Article 4-11. Load dump test			Ditto
Article 4-12. Load test			Ditto
Article 4-13. Others			Ditto
- Section 3 Electric Equipment			
Article 4-14. Visual inspection			
	1. Checking of grounding		METI's interpretation for Article 73-4 (※4)
	2. Countermeasure against live part		Ditto
	3. Protective device		Ditto
Article 4-15. Measurement of grounding resistance			
	1) Inspection Method		METI's interpretation for Article 73-4 (※4)
	2) Judgment Criteria		
		10 ohm	(Discussion at Sub-working (thermal) meeting)
		Table	METI's interpretation for Article 73-4 (※4)

Article 4-16. Measurement of insulation resistance		
	1) Inspection Method	METI's interpretation for Article 73-4 (※4)
	2) Judgment Criteria	(Discussion at Sub-working (thermal) meeting)
Article 4-17. Dielectric strength test		
	1) Inspection Method	METI's interpretation for Article 73-4 (※4)
	2) Judgment Criteria	Ditto
Article 4-18. Protective device test		Ditto
Article 4-19. Protective device test for hydrogen and seal oil		Ditto
Article 4-20. Protective device test for the stator cooling system of generator		Ditto
Article 4-21. Unit interlock test		Ditto
Article 4-22. Load dump test		Ditto
Article 4-23. Load test		Ditto
Article 4-24. Measurement of noise and vibration		Ditto
Chapter 4 Periodic Inspection **- Section 2 Mechanical Equipment**		
Article 4-28. Boiler		METI's interpretation for Article 94-3 (※5)
Article 4-29. Boiler auxiliary equipment		Ditto
Article 4-30. Steam turbine		Ditto
Article 4-31. Steam turbine auxiliary equipment		Ditto
Article 4-32. Gas turbine (internal combustion)		
	1. Compressed combustion gas supply equipment and its auxiliary equipment	METI's interpretation for Article 94-3 (※5)
	2. ~ 7.	(Common examples in Japan)
Article 4-33. Gas turbine (external combustion)		METI's interpretation for Article 94-3 (※5)
Article 4-34. Independent superheater		Ditto
Article 4-35. Independent superheater		Ditto
Article 4-36. Trial operation		Ditto
- Section 3 Electric Equipment		
Article 4-38. Generator and synchronous compensator		(Discussion at Sub-working (thermal) meeting)
Article 4-39. Excitation system (directly connected type)		Ditto
Article 4-40. Excitation system (separate placement type)		Ditto
Article 4-41. Excitation system (static type)		Ditto
Article 4-42. Auxiliary equipment of generator		Ditto
Article 4-43. Motor		Ditto
Article 4-44. Trial operation		METI's interpretation for Article 94-3 (※5)

(※1) : Chubu Electric Power Co,.
(※2) : Japan Electric Association Code
(※3) : Japanese Electrotechnical Committee
(※4) : METI's Interpretation for Article 73-4 of enforcement regulations of Electricity Utilities Industry Law
(※5) : METI's Interpretation examples for each paragraph in Article 94-3 of enforcement regulations of Electricity Utilities Industry Law