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Power Cell
Ministry of Power, Energy & Mineral Resources
Govt. of the People's Republic of Bangladesh

**Consultancy Services for Setting Up Electrical Testing
Laboratory**
(Contract Package: S-10)



Deliverable	5
Document	1 – Executive Summary of the Project
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1. Summary

This document first describes the framework on which the activity was assigned to the DeMEPA - ECBL Team, the approach followed and the main challenges that the electricity sector must overcome to develop a high-quality Testing Laboratory that becomes of reference for the Bangladesh market.

Starting from the VISION 41 Plan defining the developments of Bangladesh's electrical sector in the next 20 years, the reference testing market for the Testing Laboratory is given.

Furthermore, the configuration of the Testing Laboratory resulting from the Stakeholders' needs (in particular of the Electricity Companies and Manufacturers) is explained in terms of the equipment to be tested, testing facilities and proposed layout.

The financial sustainability of the Laboratory is considered on the basis of the capital expenditures, the operating costs, the turnover trend over the first 15 years and the corresponding Profit and Loss accounting.

The direct and especially the indirect benefits achievable through the Testing Laboratory are taken into consideration as they justify the required capital expenditure for Laboratory establishment.

Following the document summarizes the main results of the different issues analysed in depth during the development of the project: organization, staff recruitment, commercial policy, quality system and accreditation and the institutional aspects.

The last part of the document summarizes the main results achieved by the project and the next action that needs to be taken for the National testing Laboratory establishment.



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2. Rationale

Ministry of Power, Energy & Mineral Resources Government of the People's Republic of Bangladesh, assigned to the Joint Venture DeMEPA (Design and Management of Power Assets, Italy) - ECBL (Engineers and Consultants Bangladesh) the activity for **Consultancy Services for Setting Up Electrical Testing Laboratory** (Contract Package: S-10).

The activity has the **financial support of Word Bank** being **Power Cell** (Power Division of the Ministry) as the Beneficiary.

The Contract was signed on May 11th, 2023 and ends on December 17th, 2023, after 36 day of extension of the duration. From an operational point of view, **5 on-site missions were performed** to present and discuss the **5 Deliverables** of the project with Power Cell and the main Stakeholders. The final version of each Deliverable, incorporating suggestions and requests for additions coming from the discussions in the meetings, was submitted.

The Electrical Testing Laboratory, named **NTL-National Testing Laboratory**, has to designed and organized as a **world class testing laboratory** able to:

- **perform type tests according to the International Standards (IEC, IEEE) on the main electromechanical equipment,**
- **conduct research and development tests** on new components and equipment developed by the domestic manufacturers,
- **constitute an open and fruitful environment for know-how development of the scientific & technical point of view and business development (market & technology evolution, Standard evolution).**

NTL will allow the local electromechanical sector to **qualify the new products** or the enhancement of the existing ones (higher operating voltage, higher performances, etc.) **at lower costs than those required for testing in a foreign laboratory** (even only for the reduced transport costs to and from the foreign laboratory) and avoiding disbursements in foreign currency. Local manufactures can thus improve **their competitiveness in the market of Bangladesh and in perspective in the international one.**

The availability of qualified and competitive (both technically and economically) equipment by the local industry **can progressively reduce the import from abroad with significant savings of foreign currency.**

This synergic framework, surely generating a positive impact on employment, is placed in a context of strong development of the national power system: **a strong expansion of power generation** (62 GW over a period 2021-2041) and the related **reinforcement of the transmission and distribution networks** (1.4 billion USD per year) involving the installation of a considerable number of new lines, power stations, power and distribution transformers, Circuit Breakers and Switchgears.

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3. Involvement of key stakeholders

In compliance with ToRs indications and the requests of Power Cell, the **project has been developed with a continuous involvement with the main Stakeholders.**

In the first phase of the project with the aim to collect information and share their needs to improve the quality and reliability of the electricity system and strengthen the local manufacturing sector.

In the following the **results of all the project phases were discussed with the Stakeholders** during the 5 on-site missions in order to **better direct the activity**, like: the required Laboratory testing capability and the services to be supplied by NTL (testing, inspections and engineering).

There was a **strong dialogue in defining the configuration of the Laboratory** (Stage 1, Stage 2A and Stage 2B) as well as in the evaluation of OPEX and CAPEX and on the return on investments.

In conclusion it can be stated that the Stakeholders played a fundamental role in the conceptual design of NTL.



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4. Survey on electrical sector

The first activity addressed was to evaluate with the Stakeholders how the significant investments planned by VISION 41 could be satisfied by the local manufacturing industry.

Questionnaires were prepared for the different type of Stakeholders (electricity companies, manufacturers, technical bodies) and the collected information was integrated with interviews with individual stakeholders in order to acquire as much as possible **a complete picture of the situation of the electricity sector in Bangladesh.**

It emerged that the local manufacturing industry have necessarily start to develop new and better performing equipment in order to meet the demand of electricity companies according to international standards.

At the same time, it immediately became apparent that the **lack of a National Testing Laboratory was becoming a major critical issue for the overall development of the electricity sector** of Bangladesh.

The project activities were then dealt with according to the following guidelines:

- Bangladesh needs to have an **Accredited Testing Laboratory capable of providing world-class tests** capable of supporting the country's electromechanical industry **to strengthen the development of its product portfolio,**
- NTL must be established as an **Independent Organization capable of operating in a highly competitive** and rapidly changing market,
- **NTL has to be focused to perform Type Tests** as Routine Tests can be conveniently carried out in the Manufacturers' factories,
- To strengthen the aid to the country's electromechanical industry, **NTL must also offer Development Tests and engineering services** supporting the Manufacturers in the development of new equipment as well as **inspection services** on type tests carried out at accredited Manufacturers' test facilities.



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5. The main Challenges and proposed Solutions

The initial analysis made clearly defined the objectives of the project which turned out to be wider than the design (technical, economic and organizational) of a large testing laboratory of electrical equipment. But the goal has become **to design a tool for the development of the electrical sector** (higher quality and reliability) and of **the electromechanical manufacturing industry of Bangladesh**, through the development of a Testing Laboratory.

Therefore, the **challenge that must be overcome** includes various types of equally important issues: market trend (competition, customers, influencers), technical (Standards, special components knowledge, how to perform and organize the tests), economic/financial (evaluation of CAPEX, OPEX and return on investment). But also the commercial organization (and communication), the management of human resources, the procurement (especially in the initial phase of purchasing the equipment), the development of adequate quality plans for obtaining the necessary accreditations. Finally, the challenge of identifying the employees to be hired in the Laboratory and the Organization of Capacity Building was highlighted.

The set of **5 Deliverables goes into detail into the solutions to face and overcome these challenges**. One of the main aspects was to try to have **a vision as open and transversal as possible**, able to perceive all the nuances that could influence the progress of the project.

NTL will be operating in a highly competitive market, so it will be important that it is organized, accordingly, paying attention to the commercial (through the creation of a strong brand) and technical accreditations.



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6. Reference testing market

The Government of Bangladesh intends to invest in the period 2021-2041 an average value of 1.8 billion dollars per year¹ to strengthen the Transmission and Distribution infrastructures for an effectively use of the planned additional 60 GW of generation plants.

Based on International Energy Agency evaluation of the worldwide investments for Distribution networks (around 65% of the total investment in T&D infrastructure and up to 70% in countries needing to strengthen the rural distribution) and international studies on the breakdown on the investment for different equipment, Table D5-1-1 lists the expected amount of the investment in the Bangladesh power system in the period 2021-2041.

Table D5-1-1: Breakdown of the equipment annually purchased for T&D infrastructure on average during period 2021-2041 by the Bangladesh power system (Million USD)

Type of equipment	Distribution networks	Transmission Networks
Transformers	177	113
Other Station equipment	152	97
Towers, Insulator & Fittings	142	91
Cables & Lines	222	141
Communication, Control & Automation	83	52
Total	776	494

Considering the Bangladesh Testing Laboratory will take into consideration tests on equipment used in the MV/LV and HV/MV Station (such as Distribution and Power Transformers, Circuit Breakers, Disconnectors, Switchgears, Busducts, Instrument Transformers, Insulators and Power Cables) the annual investment of interest for the Laboratory becomes the ones listed in Tab. D5-1-2 for a total amount of 689 Million USD.

Table D5-1-2: Breakdown of the equipment annually purchased for T&D infrastructure on average during period 2021-2041 to be taken into consideration (Million USD)

Type of equipment	Distribution networks	Transmission Networks
Transformers	177	113
Other Station equipment	152	97
Insulator	35.5	22.7
Cables	77.2	14.1
Total	442.2	246.8

¹ VISION 41 - Perspective Plan of Bangladesh 2021-2041



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Taken into consideration the average costs for tests execution on the prototype referred to the selling price of each sample of the new product:

- 7.5 % for the development tests
- 2.5% for the type tests

and that a significant part of the development tests and some type tests (for instance the dielectric tests) are carried out at the manufacturer's testing laboratory, in Table D5-1-3 is reported the reference testing market in the case of all the performed tests are related to new products.

Table D5-1-3: Reference testing market in the case of all the performed tests are related to completely new product (Million USD/year)

Type of equipment	Distribution networks	Transmission Networks	Other Sectors
Total yearly investments	442.2	246.8	111.0
Development test	3.32	1.85	0.83
Type test	12.3	6.85	3.08
Total	15.62	8.70	3.91

Given that part of the installed equipment will be supplied by foreign manufacturers (that will probably carry out tests in abroad laboratories) and the installation of already existing equipment without need of new prototype to be developed, the reference testing market for NTL during the first 5 years of commercial operation is shown in Figure D5-1-1 for three possible share (10% or 20% or 30%) of the total investment related to new equipment produced by local manufacturers at the 5th year.

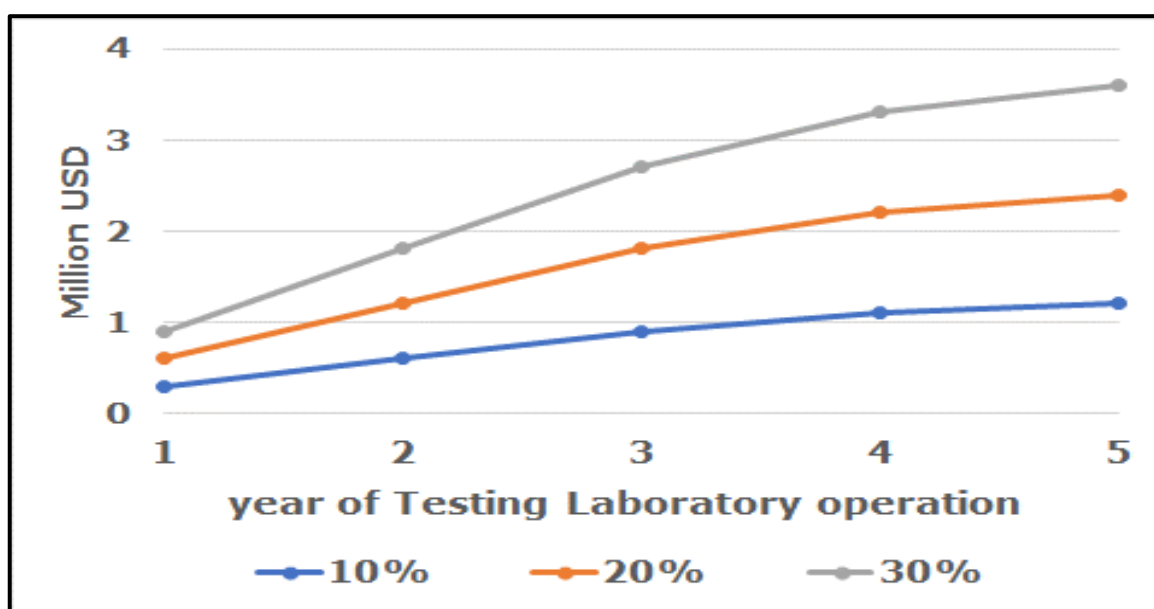


Figure D5-1-1: Reference market trends for the Testing Laboratory

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The achieved share of the reference testing market of the above Figure is strongly related to:

- the political support from the Government to the development of the Testing Laboratory,
- the decision of the Electrical Utilities to request the execution of type tests on the prototype of the purchased equipment,
- the development of new components, or the re-engineering of the existing ones, by the existing manufacturers and by new players favoured by the considerable internal market.



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7. The proposed configuration of the National Testing Laboratory

Two different NTL configurations have been considered:

- Stage 1: The Laboratory is supplied by an external power line at 230 kV and having 250 MVA short-circuit power; in this configuration requires around three years to get fully operational;
- Stage 2: The Laboratory is equipped with a 2500 MVA Short-circuit Generator and its complete build takes approximately 6 years; for this configuration two options have been considered: Option A and Option B, having the latter a wider testing capability for Power Transformers.

These two configurations allow different test ratings in connection with their different level of the available short-circuit power. **They may be built in parallel** in order to enable an initial period of operation of the laboratory of about three years. From the seventh year onwards, the Laboratory can operate at its maximum testing capability.

Testing Laboratory at its maximum capability will be able to perform type tests on the following families of equipment:

- LV equipment** (Circuit breakers, Switches, Disconnectors, Fuses, Switchgears and Controlgears, Busbar Trunking) with rated voltage up to 690 V;
- MV equipment** (Circuit breakers, Generator Circuit breakers, Disconnectors and Earthing Switches, Switches and Switches-Fuse combination, Expulsion and Current limiting Fuses, Surge Arresters, Metal Enclosed and Solid insulated-enclosed Switchgears, Gas Insulated Switchgears, Busduct) with rated voltage from 3.6 kV up to 36 kV;
- Distribution transformers:**
 - with voltage ratio 11/0.4 kV or 13.8/0.4 kV and rated power up to 2.5 MVA,
 - with voltage ratio 33/0.4 kV having rated power up to 5 MVA;
- Power Transformers:**
 - with voltage ratio 33/11 kV and 66/11 kV, having rated power up to 28 MVA,
 - with voltage ratio 132/11 kV and 132/33 kV, having rated power up to 50 MVA,
 - with primary voltage up to 230 kV and secondary voltage higher than 65 kV, having rated power up to 160 MVA;
- Current transformers and Inductive Voltage Transformer** up to 400 kV;
- Ceramic, glass and polymeric insulators** up to 400 kV;
- Power Cables with extruded insulation** from 1.6 kV up to 400 kV.

The Testing facilities, the Auxiliary facilities and the other building of NTL in Stage 1 and Stage 2 configurations are listed in Tables D5-1-4 and D5-1-5, respectively.

Figure D5-1-2 display the proposed layout for the Testing Laboratory.

Table D5-1-4: NTL Buildings in Stage 1 configuration

Testing facilities	Sizes [m]	Surface [m ²]	Heigh [m]
230 kV Substation	95x15	1425	-
HV/MV Transformer Bank and Ratio Changer	20x15	300	-
	20x15	300	10
MV Switchgears and MV Reactors	40x15	600	10
MV and LV test cells and Control rooms	40x30	1200	10
High Voltage testing facility	65x30	1950	25
Temperature rise testing facility	30x15	450	8
Mechanical testing facility	30x15	450	8
Auxiliary facilities and other buildings	Sizes [m]	Surface [m ²]	Heigh [m]
A/D Hall for Distribution and Power Transformers	40x30	1200	15
Calibration	20x15	300	4
Workshop	25x8	200	5
Warehouse	65x15	975	15
Utilities building	50x30	1500	6
Direction	20x15	300	4
Offices	[40x15]x2	1200	10
Canteen	d=20	314	6
Residential Facility	[20x20]x2	800	10
Auditorium	30x30	900	10

Table D5-1-5: NTL Buildings in Stage 2 configuration

Testing facilities	Sizes [m]	Surface [m ²]	Heigh [m]
Short-circuit Generator Auxiliaries	30x20	600	10
Short-circuit Generator House	40x20	800	20
MV/MV Transformer	45x20	900	-
Ratio Changer and MV Reactors	45x13	585	20
MV Busbar system, MV load and TRV circuit	45x20	900	15
High Power MV test cells	[15x10]x2	300	10
A/D Hall for MV equipment	[15x10]x2	300	10
High Power MV Control Room	40x15	600	5
Transformer testing facility	50x30	1500	-
HV Power Cable testing facility	140x50	7000	-
	20x20	400	8
MV/HV Transformer for Option B	30x15	450	-

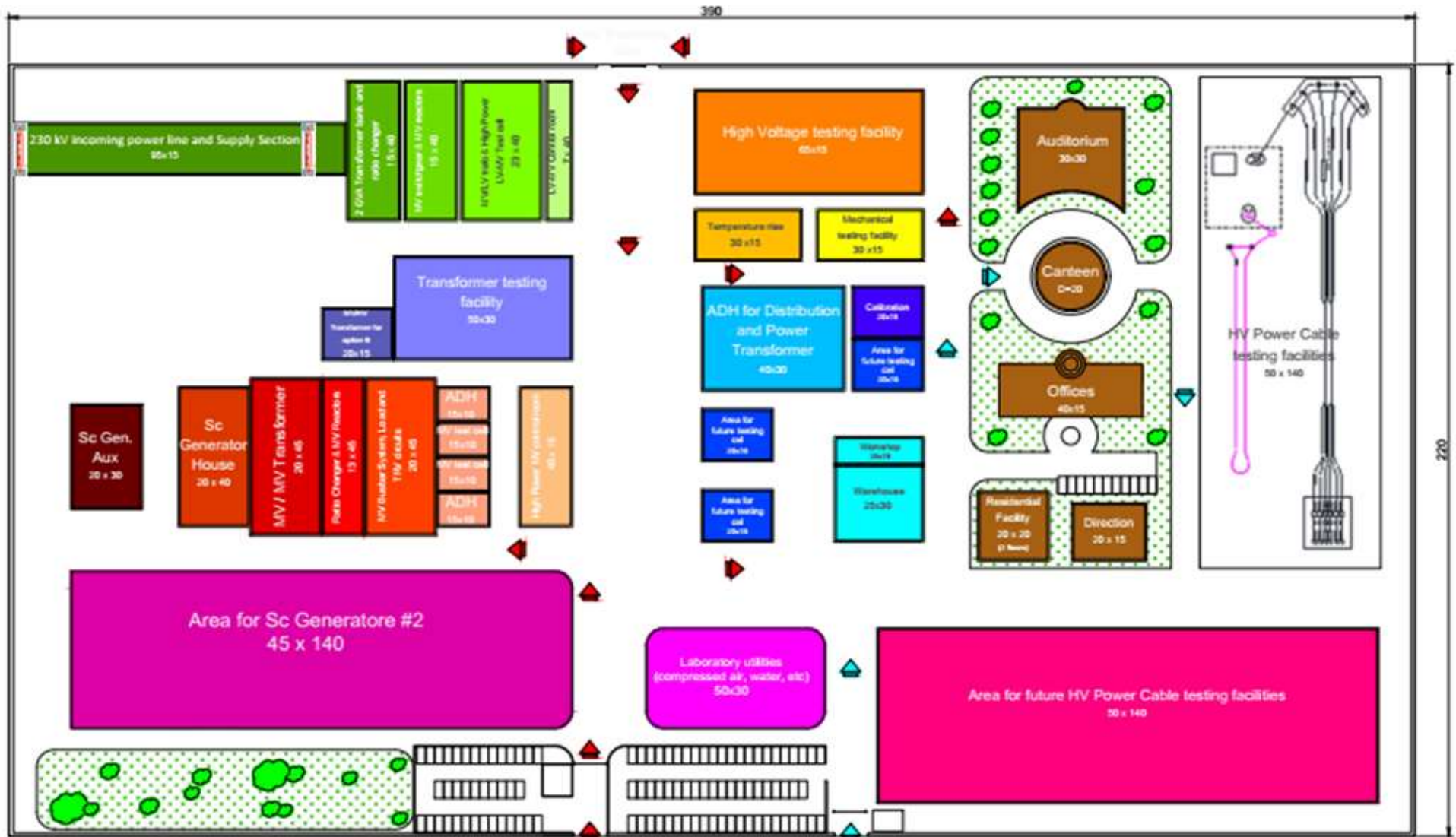


Figure D5-1-2: NTL layout including Stage 1 and Stage 2 configurations

8. The financial sustainability of the National Testing Laboratory

8.1 The required capital expenditure

As shown in Figure D5-1-2, the designed Testing Laboratory covers an area of 85,800 square meters (21.2 acres) and includes all facilities listed in Tables D5-1-4 and D5-1-5.

The needed investment for Testing Laboratory is summarized for the two development Stages of the Laboratory in Table D5.1.6 considering separately the testing equipment and the civil works (excluding land costs and land development costs related to the Laboratory location which is not yet defined).

Table D5–1–6: Testing Laboratory CAPEX

Capital Expenditure [Million USD]	Stage 1	Stage 2	
		Option A	Option B
Testing equipment	23.664	42.411	10.518
Civil works	17.433	3.440	0.173
Total	41.097	45.851	10.691

8.2 The turnover trend of the Testing Laboratory

The Testing Laboratory was designed to be developed through two configurations:

- **Stage 1** requiring around three years to get fully operational,
- **Stage 2** whose complete building takes approximately 6 years.

The two configurations allow different test ratings in connection with their different level of the available short-circuit power. They may be built in parallel in order to enable a first commercial operation of the Laboratory after 3 years from the beginning of its building.

From the seventh year onwards, the Laboratory can operate at its maximum testing capability. **Overall, in the 15 years following the beginning of its construction, the Laboratory will be in operation for 12 years, from the fourth to the fifteenth year.**

The turnover of the Laboratory during these 12 years, shown in Fig. D5-1-2, has been assessed on the basis of the reference testing market (see Chapter 6) and the turnover trend of laboratories in country with a development rate of the local electromechanical industry similar to that expected in Bangladesh.

Considering that the Laboratory will operate in a highly competitive market, for the assessment of the turnover the Consultant adopted prices for the testing services 20% lower than those practices by CPRI and about 35% lower than those of the most important international laboratories (such as CESI-Kema and KERI).



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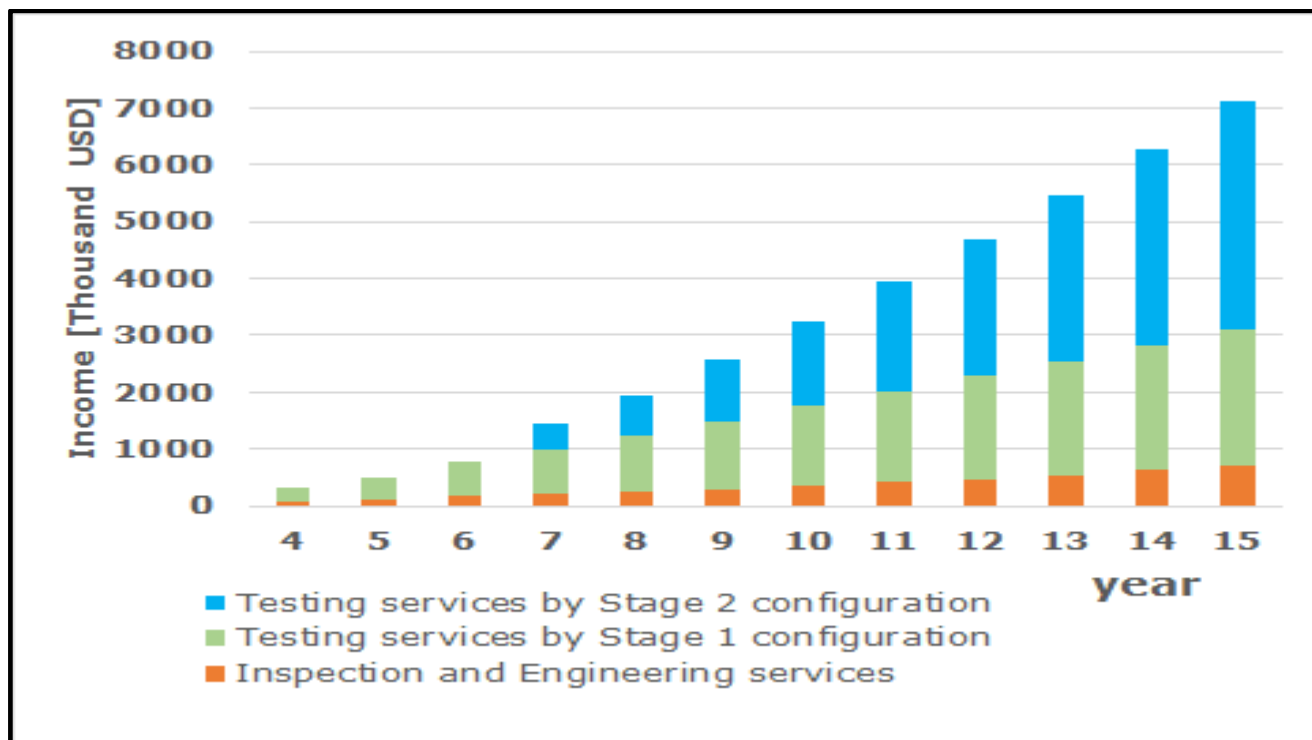


Figure D5–1–3: Turnover of the Testing Laboratory

8.3 The operating costs of the Testing Laboratory

They may be grouped into three broad categories:

- **staff cost**, evaluated on the basis of professional figures of each operating function (Testing and Inspection, Commercial, Human Resources, General Services and Administration) of the Laboratory and the relevant annual cost (basic salary and all the additional bonus and allowances);
- **maintenance costs** related to the spare parts and the repairing or replacing works of testing equipment and buildings;
- **consumables**, mainly determined by the energy consumption (powering testing facility, lighting of buildings and the areas of the Laboratory, energy for air conditioning of the buildings) and other costs (water consumption, fuels for vehicles, protective clothing, office supplies).

The overall operating costs for the considered fifteen years of Laboratory operation are shown in Figure D5-1-4.



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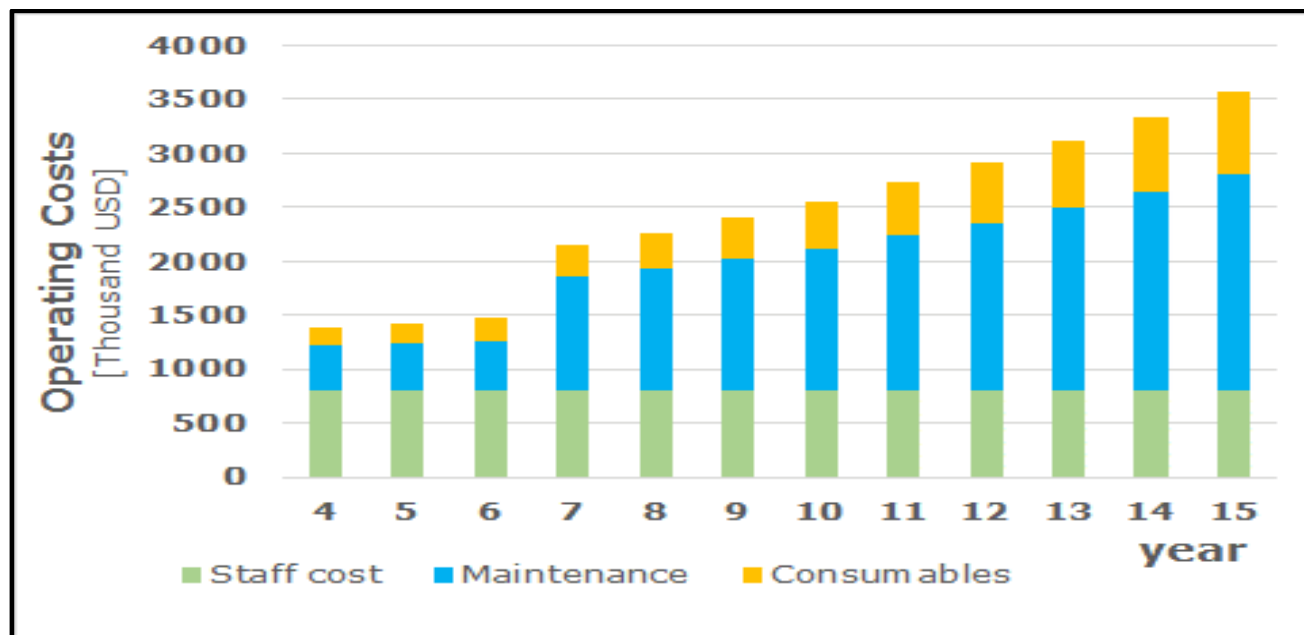


Figure D5–1–4: The operating costs of the Testing Laboratory

8.4 The Profit and Loss account and the financial indexes

The Gross Operating Margin (or EBIDA- Earnings Before Interests, Taxes, Depreciation and Amortization), that is the difference between the Income and the Operating Costs, resulting at the last of the 15-year period considered is displayed in Figure D5-1-5.

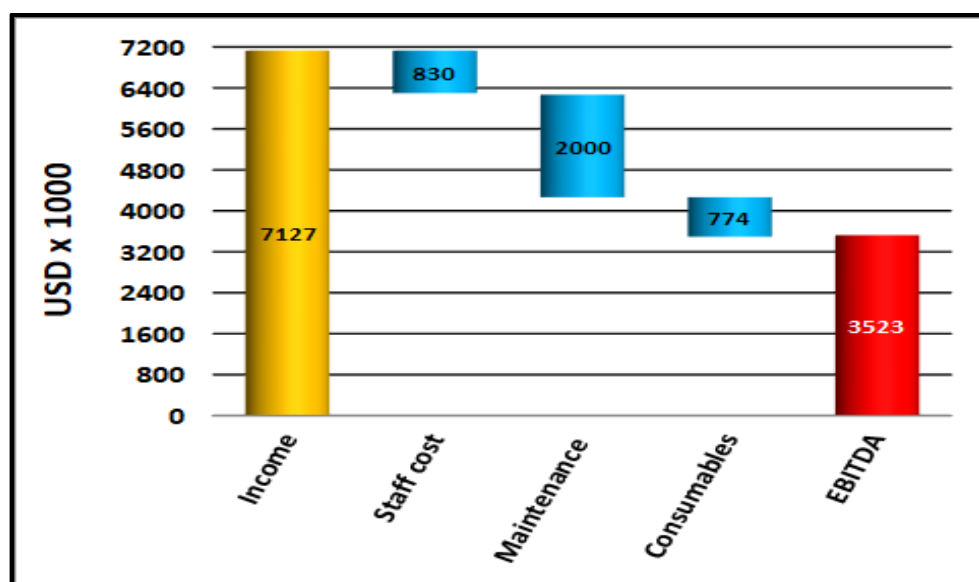


Figure D5–1–5: The Gross Operating Margin at the 15th year of the considered operation period of the Testing Laboratory



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What is shown in the above figure is definitely positive. However, it should be outlined that only from the 9th year the turnover of the Laboratory is slightly higher than the total operating costs.

To achieve positive values of EBIT (Earnings Before Interest and Taxes)², at least after an initial period of the Laboratory commercial operation, **it is necessary that 70% of the initial capital injection required for the establishment of the Laboratory is covered by grant** and only the remaining 30% be awarded as Equity.

Under this condition the EBIT trend in the considered period is shown in Figure D5-1-6.

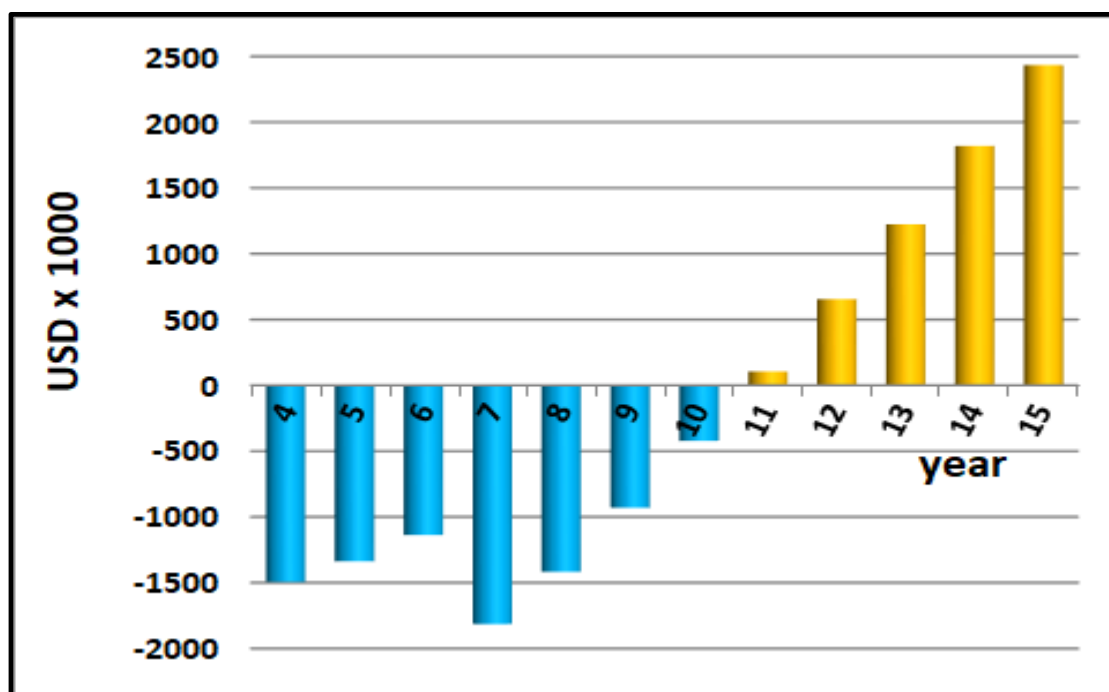


Figure D5–1–6: EBIT trend with grant equal to 70% of capital expenditure

The grant may be given by the Government or other public institutions or donors (such as the World Bank, the Asian Development Bank, the Japan Development Bank).

A grant equal to 70% of the total investment should not be surprising: all existing laboratories, including those internationally known, have received grants even 100% of the required capital expenditure.

² EBIT= EBITDA – Depreciation

³ ROA= (EBIT – Taxes)/ NET Capital Employed, being the Net Capital Employed equal to initial value of assets deducted the annual depreciation



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The **Return on Assets (ROA)**³ proves the financial sustainability of the Laboratory when a significant share of the capital expenditure is covered by grants.

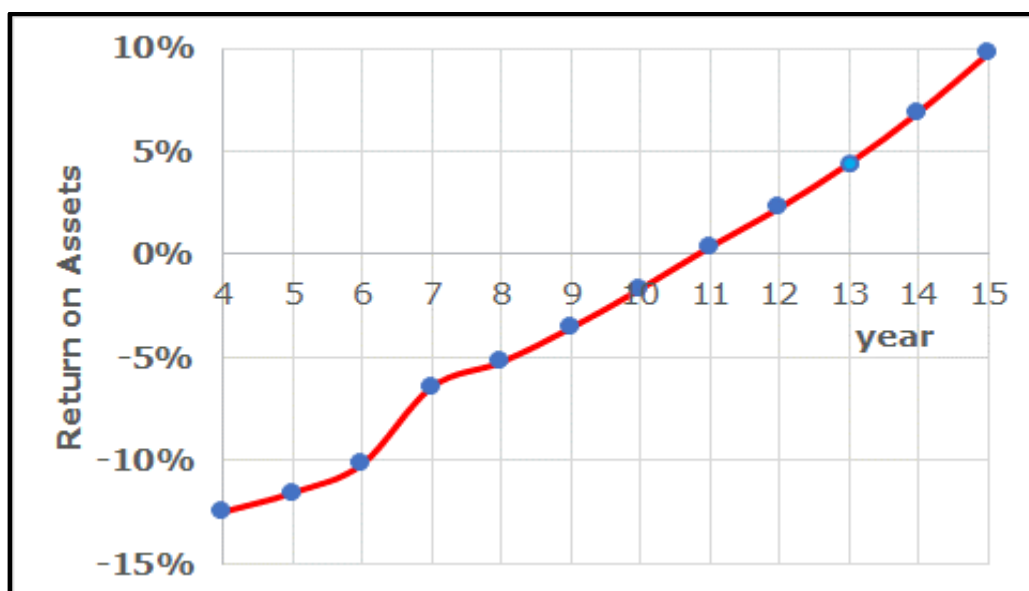


Figure D5-1-7: ROA trend with grant equal to 70% of capital expenditure



9. The benefits brought by NTL justify the required capital expenditure

The testing laboratory are capital intensive infrastructure. The capital invested is justified by the significant benefits for the country related to the testing laboratory operation.

As already mentioned, all the main large testing Laboratories (CESI, Kema, CPRI, KERI and Chinese laboratories) have benefited from significant investments and grants precisely because they are able to determine a positive impact under several aspects.

These benefits may be classified as:

- *direct benefits*
 - developing the business of the testing (and the related inspection services) having the first reference market of Bangladesh and in perspectives the neighbouring countries,
 - developing the business of the engineering services (such as supporting Manufacturers during equipment development, fault analysis, equipment design review, specification of special equipment) taking advantages from the knowledge and references deriving from the testing activities;
- *indirect benefits*
 - **increased quality and performance** of the equipment installed on networks and then able to **improve the Power Quality and Reliability Factor (PQRF)** of the national power system,
 - supporting the **National Electromechanical Manufacturing Industry** in the enhancing of the equipment performances and then improving their competitiveness in the market of Bangladesh and in the international one,
 - **strengthening the capacities of the national electrical sector**, thus reducing dependence on foreign countries in purchasing equipment with consequent saving of foreign currencies (USD, Euro, Yen),
 - **creation of new employment** in the national electromechanical sector (manufacturing, commercial, distribution).

It is above these indirect benefits that can lead Government and Donors to financial interventions (including grants) for the development of the National Testing Laboratory.

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10. Organizational issues

Organizational issues are a key to NTL's success, as they are technical and commercial aspects.

NTL has to be an organization able to operate on a very competitive market, while tackling very demanding technical issues.

This means that attention will need to be paid **to the Technical Functions** (Testing, Inspection and Engineering) but also to the **Commercial Functions** (Market Monitoring, Promotion, Offer Preparation, Commercial Follow-up, and Negotiation), **Procurement** and **Human Resources Management**.

The **Quality Management function** must be independent from the Technical and Commercial Functions and has to organize, in the framework of Laboratory **Quality System**, **periodic and in-depth audits** on all the operating functions of the Laboratory.

During the first three years of NTL's operation, in which the testing facilities are under construction, in addition to the activities concerning the procurement, installation and commissioning, it is crucial to start with:

- the hiring of the staff,
- training activities,
- communication and promotion activities aimed to develop the Laboratory brand.



11. Hiring employees and the need of Capacity Building

The recruitment of NTL's technical and commercial employees, who necessarily come from other, albeit similar, sectors is a crucial issue.

Referring to previous similar experiences, the table below identifies the sectors from which to hire the critical professionals, being the traditional ones (Administration, Human Resources and Procurement) more readily available on the market.

Table D5–1–7: Professional figures and provenience

Experts	Provenience
Test Engineers	Laboratories of manufacturers.
Inspectors	Measurement and inspection services of: • Electrical utilities, and • Inspection Bodies.
Engineers supporting Manufacturers in developing equipment	• Engineering companies, and • Universities.
Quality systems engineers	Quality system department of: • Manufacturers, and • Utilities.
Commercial Engineers	Commercial Department of: • Manufacturers, and • EPC.

As regards **Capacity Building**, a **program was proposed** adopting the UNDP (United Nations Development Program) approach. The Skills Targets to be achieved for each professional figure, the teachers, the list of courses to be held and the schedule of **30 training sessions on topics technical, commercial, and organizational** have been proposed.

It was also recommended that **Stakeholder experts**, coming from Electricity Companies, Laboratories, Manufacturers and Inspection Bodies, **are invited to some of these initiatives** with the aim to increase skills across the whole testing environment.

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12. Commercial Policy

The main Stakeholders all agreed on the importance of a commercial and communication policy that positions NTL on the market as an organization of high technical quality, but also **capable of offering competitive prices** and **shorter response timing** (e.g. reaction times to an offer request, execution of tests, times for delivery of test documents after tests have been carried out).

To achieve a good level of competitiveness it is necessary to carefully monitor the market, know the customer's needs in detail and, above all, the practiced prices, at least at an early stage, have to be lower than those of the competition (e.g., 20% less than those of CPRI).



13. Quality System and Accreditation

This aspect has been discussed and explored in various meetings to understand what steps to follow to **accompany NTL towards a competitive positioning in the market.**

NTL shall work under the rules of a Quality System, managed by a Quality Manager, and that has to be compliant with the ISO/IEC Standard 9001: "Quality management systems – Requirements".

In addition, as independent and referenced laboratory, an accreditation according to ISO/IEC Standard 17025: "General requirements for the competence of testing and calibration Laboratories" is strongly required.

Considering the inspection activity, the accreditation according to ISO/IEC 17020: "Conformity assessment - Requirements for the operation of various types of bodies performing inspection" is recommended.

The above accreditations must be carried out with **the Bangladesh Accreditation Board (BAB)**; being BAB member of the Asia Pacific Accreditation Cooperation (APAC) **and of the International Laboratory Accreditation Cooperation (ILAC) the accreditation will be internationally recognized.**

Moreover, it may be convenient that NTL should also consider a certification complying with the following standards, relevant to "safety" and "environment":

- OHSAS 18001: "Occupational Health and Safety Assessment Series - Occupational Health and Safety management Requirements".
- ISO/IEC standard 14001: "Environmental management systems - Requirements with guidance for use".

The above group of certifications and accreditations will impact on the organization of NTL in many ways, typically implementing **an organizational structure for the management of the Quality System and a consistent set of procedures and tools.**

Technical Accreditation is a sufficient but not necessary condition to obtain Commercial Accreditation.

To do this, NTL will have to **strengthen its Brand** in Bangladesh among potential Customers (Manufacturers) and main Stakeholders who influence the Business (e.g. Electricity Companies). It will also have to make itself known to the main development banks (such as World Bank and Asian Development Bank).

In perspective, commercial accreditation will also have to concern neighbouring countries.

The Commercial Accreditation aims to **convince the market that NTL's services are of the same quality as its competitors** (starting with CPRI) **and usefulness** (e.g., the Test Documents are recognized in the countries of interest to the local Manufacturers).



14. Institutional issues

The Stakeholders all agreed that **NTL must be** (and appear) **as an independent organization** to be successful.

This means that in all its activities NTL must be able to demonstrate that all their evaluations are based on objective criteria and fairness rather than bias or preference to the benefit one entity over another for improper reasons.

NTL staff must be free from any undue commercial, financial and other pressures which might influence their technical judgement.

Moreover, NTL should not engage in any activities (such as manufacture, construction, assembly, repair, reconstruction) because that may endanger the trust in its confidentiality, independence and integrity of judgement.

The need to "**appear on the market as independent**" has an impact on:

- the **organization**: internal regulations and procedures shall ensure objectivity of the test results; also, confidentiality of the test results between NTL and its clients shall be ensured;
- the **accreditation**: although not explicitly related to the independence, accreditation contributes significantly to a perception of specific skills of staff (recognized expert in their field of operation) and valuable technical structures and organization as necessary prerequisites for a truly independent role;
- a) the **ownership**: the establishment of a **public business company**, in which the **public shareholder** (Ministry of Energy and/or Ministry of Industry and other public institution) **holds more than 50% of the shares** seems the more effective solution; **the participation of electrical utilities and Manufacturers' Organization** is to be considered positively (the participation of a single or a limited number of manufacturers has to be avoided because could reduce the perception of the Independence of the Laboratory).

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15. Results achieved by the Consulting activity

The activities carried out resulted in the following main outcomes:

- NTL conceptual organization,
- NTL electrical, mechanical and civil architecture on the basis of a detailed, and shared with Stakeholders, list of equipment to be tested, type test to be performed for each class of equipment and relevant reference Standards,
- required capital expenditure and evaluation of the operating cost of NTL,
- the market accessible to NTL and the corresponding trend of turnover over the first NTL operation period of 15 years,
- the condition assuring a financial sustainability of NTL and an adequate return on investment,
- the road map for a Capacity Building program.

The main contextual aspects and challenges have been analyzed in-depth, proposing the **best solutions for the electrical sector** (both utilities and manufacturers) **of Bangladesh**.

Ministry of Power, Energy & Mineral Resources therefore now has **all the information necessary to decide whether and how to move forward** the National Testing Laboratory establishment.



16. Consultant's Recommendations

Once the decision to establish the National Testing Laboratory will be taken, a **Bankable Technical and Financial Plan must be prepared**, starting from the available results, and integrating them with an economic evaluation of the **Indirect Benefits** able to justify the required investments.

The outcomes of this plan will have **an impact on the development of NTL**, leading to a configuration of the Laboratory suited to the Government's political choices regarding the electricity sector and the available financial resources. Considering the last item, the **Government choice may consider the more suitable scheduling concerning the building of the testing facility for the Stage 1 and Stage 2 of Laboratory configuration**.

In this project it has been considered **the simultaneous startup of both the configurations** in order to begin the commercial operation of the Laboratory in Stage 1 configuration (Laboratory supplied by an external power line at 230 kV and having 250 MVA short-circuit power operation) after 3 year and the testing facilities belonging the Stage 2 (Laboratory equipped with 2500 MVA Short-circuit Generator) after 6 years.

The **Government could therefore choose to minimize the investment risks**, starting with the implementation of NTL's business related the First Stage configuration. The main drawback would be related to **the lack of long-term support for the development of the country's electromechanical sector in a period in which Bangladesh is making maximum efforts to increase the quality of service in the electricity sector**. The lack of Test Facilities would therefore push Manufacturers to incur expenses that are not always sustainable (Tests outside Bangladesh), but above all to not have the necessary technical support.

Whatever the adopted configuration of NTL, **a Bankable Technical and Financial Plan must be prepared**, starting from the following activities:

a) *Technical Aspect*

- Development of Basic and Detailed design of NTL starting from the outcomes of this project. If this activity will be carried out by an External Consultant, attention must be paid to the **preparation of the ToR clearly indicating the inputs** (chosen configuration, timing, investments, etc.). This ToR must also include, among the various outputs, the **preparation of the purchase specifications** of the components and systems, as well as details on the construction aspects of the civil part. Particular attention must also be given to the **automation of test activities** (see document D3-1: Feasibility Study of the National Testing Laboratory). The same care will be taken when requesting attention **to safety-related activities**. The surveillance activity during the construction and assembly phases of the components (in particular the Short Circuit Generator and Short Circuit Transformer), commissioning and first trial operation must not be forgotten.



b) ***Location and land***

- Choice of the location of NTL Test facilities, also considering among the different aspects the availability of an appropriate power line coming from a power station. This activity will obviously have to consider the outputs of the Basic and Detailed Design activities.
- Acquisition of land in accordance with the existing laws and regulations regarding land acquisition.
- Acquisition of a Licensee to establish the Testing Laboratory with all its testing facilities in accordance with the provision of the Electric ACT AND Electricity Grid Code Regulations
- Definition of the mitigation plan for all possible environmental impact of NTL operation. Also, in this case the details will come from the Basic and Detailed Design activity.

c) ***Ownership.***

- A decision about ownership will have to be made. It must be defined whether the company must be 100% state-owned (possibly involving multiple ministries) or with the presence of electrical utilities and manufacturing companies (for example through the Organization of Electromechanical Manufacturers)

d) ***NTL Organization***

- A decision on the organisation, not only for the technical operational aspects will have to be taken, depending on the choices made by the Government and on the Configuration of the Test Facilities and their scheduling.

e) ***Recruitment of technical, commercial, and administrative Top Managers and Staff.***

- A **hiring plan** must be established in a short time, trying to identify as a priority who will **Manage the design, construction, commissioning, and start-up of the test activities**. At the same time, it will be necessary to identify the **Commercial Manager** who will follow the Communication and Promotion aspects, the **Human Resources Manager** who will manage the Recruitment activities, as well as those of Capacity Building. Evidently the **Procurement Manager** will also have to be identified, since it will be precisely in the first years that the main investments will have to be made and therefore the main contracts will have to be negotiated.
- Identify **where to find the staff to hire**, whether all on the local market or for example from international competitors (e.g. CPRI - India).



f) Communication and promotional activities.

- The commercial development activity must be started immediately to promote inspection and engineering activities that can be carried out immediately.
- At the same time, we will have to start working to start the accreditation activity of the laboratories. This technical accreditation will be the basis for obtaining commercial accreditation. Accreditation which must be carried out through the valorisation of the Brand from a commercial and technical point of view at local Electricity Companies and Manufacturers, as well as international players and Donors.

g) Quality system

- A quality and safety system must be in place before the completion of the construction of the NTL Test Facilities.
- This plan must concern not only the technical functions, but also the commercial, organizational, and administrative ones.
- A good plan will be the basis for quickly obtaining technical accreditation.

h) Capacity Building and Training

- Once the staff has been hired, the Capacity Building activity must be conducted which includes an initial phase of understanding the existing skills in the identified staff and the gap to be filled to reach the target skills. On the basis of this activity, the program can be defined and the teachers chosen.

Much attention must then be paid to the financial aspects regarding the following items:

i) Investment return plan and evaluation of Direct Benefits (annual turnover)

- An investment return plan must be made taking into account CAPEX, OPEX and direct benefits of the investment (annual turnover). This analysis will confirm the need for grants by the Government and possibly International Donors, as well as particularly subsidized loans.

j) Indirect Benefits

- A particularly in-depth analysis must be carried out on indirect benefit evaluation on the electricity system (better quality, reliability and access to the network), on the electromechanical manufacturing system (development of the industry and greater exports), on the increase in employment, especially high-quality ones.



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17. Project Deliverables

Table D5–1–8: Deliverables and delivered documents

Deliverables	Delivered Documents
D1: Inception Report	• Project detailed organization • Quality Plan and Risk Management Plan • Consultant Team
D2: Interim Report	• Conceptual configuration of a Testing Laboratory • Existing testing laboratories and Certification & Inspection bodies • Testing market assessment and direct & indirect benefits evaluation • Institutional Organization of National Authority
D3: First Informative Report	• National Testing Laboratory Feasibility Study • National Testing Laboratory Organization
D4: Second Informative Report	• Electric, civil, architectural engineering of the Testing Laboratory
D5: Draft Final Report	• Cost and benefit evaluation • Road Map for Capacity Building • Executive Summary of the Project
D6: Final Report	• Final Report



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18. Project at a glance

Table D5–1–9: Project at a glance

Sl. No.	Title	Description	Reference
1	Proposed Layout and land requirement as per layout plan	390 m x 220 m = 85,800 sqm equivalent to 9,23,544 sft equivalent to 21.20 Acres But future extension needs 25 Acres	Page D5-1-15; Figure D5-1-2 Page D5-1-14; Table D5-1-4 & 5
2	Laboratory Construction	Stage 1: 3 years Stage 2: 6 years	Page D5-1-16; Article 8.2
3	Capital Expenditure (land price and land development cost excluded)	Stage 1: 41.097 MUSD Stage 2: Option A: 45.851 MUSD Option B: 10.692 MUSD Total: 97.639 MUSD	Page D5-1-16; Table D5-1-6 Details: Page D4-64 up to 77
4	Turnover of Testing Laboratory	In the first 15 years following the beginning of the construction	Page D5-1-17; Figure D5-1-3 Details: Page D4-30
5	Testing Laboratory Accreditation	by Bangladesh Accreditation Board (BAB) that is member of: • Asia Pacific Accreditation Cooperation (APAC) • International Laboratory Accreditation Cooperation (ILAC)	Page D5-1-25
6	Consultant' s Recommendations (as per Stakeholders Meeting)	General importance in the National Testing Laboratory	Page D5-1-28 to 30
7	Yearly Operating costs	• At the 1st year = 1,010 MUSD • At the 15th year = 3,634 MUSD	Page D5-1-17; Figure D5-1-3 Details: Page D5-2-17; Art.2.2



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Sl. No.	Title	Description	Reference
8	Gros Operating Margin	- At the 6th year = - 159 MUSD - At the 15th year = 3,523 MUSD	- Page D5-2-11; Figure D5-1-5 - Page D5-2-11; Figure D5-1-6
9	Break event period (corresponding to EBIT=0 over the 15 years period)	- At 15th with 0% Grant of CAPEX - At 10th with 70% Grant of CAPEX	- Page D5-2-13; Figure D5-2-7 - Page D5-2-15; Figure D5-2-9
10	Capacity Building (Short term & Long term)	- Phase 1: Diagnosis of capacities - Phase 2: Development of the Capacity Building Plan - Phase 3: Implementation of Plan	- Page D5-3-10; Art. 3.7.1 - Page D5-3-14; Art. 3.7.2 - Page D5-3-15; Art. 3.7.3 Details: document D5.3
11	Laboratory Block Diagrams and Single Line Diagrams	- Stage 1 - Stage 2 Option A - Stage 2 Option B	- Page D4-9&10; Figures D4-1& D4-2 - Page D4-15&17; Figures D4-6& D4-7 - Page D4-20; Figure D4-9
12	Laboratory Power Sources	- Stage 1: external line 230 kV; 250 MVA short-circuit power - Stage 2: in addition to the external line a Short-circuit Generator with 2,500 MVA short-circuit power	- Page D4-8; Art.2.1 - Page D4-14; Art. 2.2
13	Legal issues	Legal issues related to the setting up of Electrical Testing Laboratory in Bangladesh	Page D4-37 to 41; Art. 7
14	Environmental aspects	Environmental aspects related to the setting up of Electrical Testing Laboratory	Page D4-32 to 51; Art. 8
15	Testing equipment ratings	- Stage 1 - Stage 2 Option A - Stage 2 Option B	- Page D4-52 to 58 - Page D4-53 to 62 - Page D4-63



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Sl. No.	Title	Description	Reference
16	Cost of the Testing equipment	- Stage 1: 23.664 MUSD - Stage 2 Option A: 42.411 MUSD - Stage 2 Option B: 10.518 MUSD - Total: 76.593 MUSD	- Page D4-64 to 71 - Page D4-72 to 76 - Page D4-77
17	Reference prices for testing services	Reference prices for the type test program of some equipment	Page D4-79-Table D4-31
18	Proposed Organization of the Testing Laboratory and Staff yearly cost	- NTL Operating Functions - NTL Staff yearly costs	- Page D3-2-13; Figure D3-2-2 - Page D4-33; Table D4-8 Details: document D3.2
19	Test performed on different type of equipment in Stage 1 and Stage 2 of the Testing Laboratory	- Maximum ratings of equipment to be tested - Tests performed on each type of equipment	Page D3-1-34 to 42
20	Reference Testing Market in Bangladesh	Evaluation of the Testing Market of the Testing Laboratory	Page D5-1-10 to 12; Art.6 Details: Page D2-3-10 to 15; Art. 4.2

MUSD: Million of United States Dollar

EBITDA: Earnings Before Interests, Taxes, Depreciation and Amortization

EBIT: Earnings Before Interests and Taxes



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Ministry of Power, Energy & Mineral Resources
Govt. of the People's Republic of Bangladesh
Consultancy Services for Setting Up Electrical Testing
Laboratory
(Contract Package: S-10)



Deliverable	D5
Document	2 – Cost and benefit evaluation
Revision	1
Date	17/12/2023
Client	Power Cell
Consultant	DeMEPA in JV with ECBL



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1. Summary

After a recall of the main economic data of the Testing Laboratory evaluated in the Deliverable D4-1:

- the turnover
- the operating costs (staff cost, maintenance costs and consumables),
- the required capital expenditure,

the related Gross Operating Margin is assessed over the twelve years of Laboratory operation starting from the commissioning of Stage 1 configuration.

The financial viability of the Testing laboratory is analysed considering the annual values of EBIT and Return on Assets. Based on these results and in order to improve the sustainability of the Laboratory over time the viable solution of a grant from government institution and international donors is taken into account for the coverage of a significant part of the capital expenditure.

Finally, the benefits for the country deriving from the establishment of the National Testing Laboratory are recalled as they motivate and justify financial interventions supporting the development of the Laboratory.

2. The economics of the National Testing Laboratory

In this Chapter the main results of the of the Deliverable D4 - Electric, civil, architectural engineering of Testing Laboratory are recalled as a starting point for the Laboratory cost-benefit assessment that will be developed in the following Chapters.

2.1 Laboratory turnover trend

As per Deliverable 3¹, the Testing Laboratory was planned to be developed through **two configurations**:

- **Stage 1:** the Laboratory is supplied by an external power line at 230 kV with 250 MVA short-circuit power and takes around three years to get fully operational;
- **Stage 2:** the Laboratory is equipped with a 2500 MVA Short-circuit Generator and its complete build takes approximately 6 years; for this configuration two options have been considered: **Option A and Option B**, having the latter a wider testing capability for Power Transformers.

These two configurations allow different test ratings in connection with their different level of the available short-circuit power. They may be built in parallel in order to enable a first commercial operation of the Laboratory after 3 years from the beginning of its building.

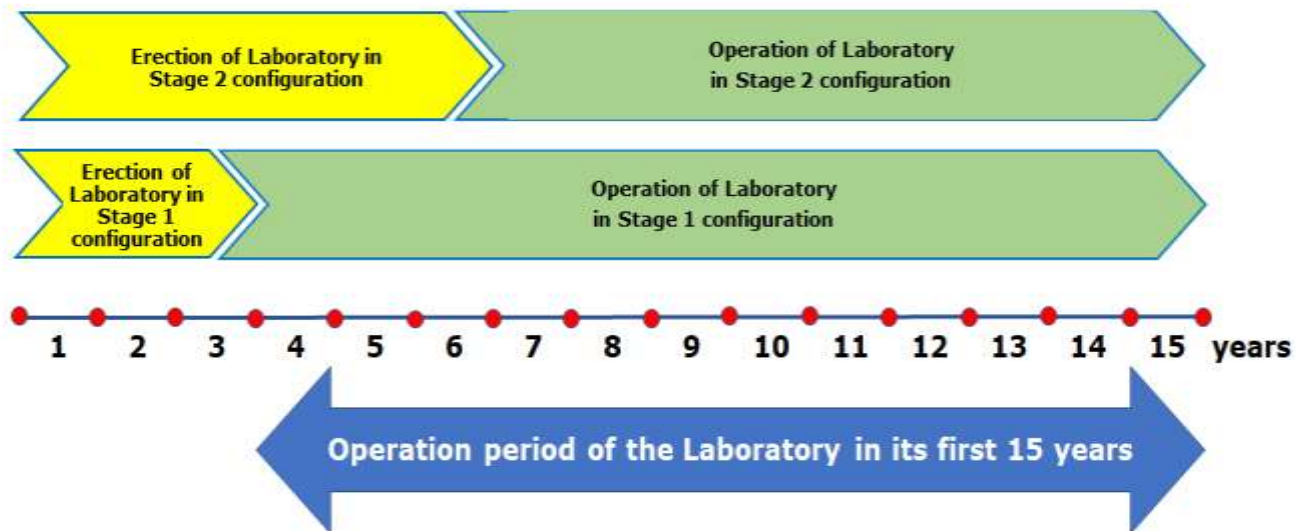


Figure D5-2-1: The operation period of the Testing Laboratory

From the seventh year onwards, the Laboratory can operate at its maximum testing capability. Overall, in the 15 years following the beginning of its construction, the Laboratory will be in operation for 12 years, from the fourth to the fifteenth year.

¹ See D3 – 1 – Feasibility Study of the Testing Laboratory, Chapter 2

The turnover of the Laboratory during these 12 years, shown in Fig. D5-2-2, has been evaluated on the basis of the turnover trend of laboratories in country with a development rate of the local electromechanical industry similar to that expected in Bangladesh.

Considering that the Laboratory will operate in a highly competitive market, for the assessment of the turnover the Consultant adopted prices for the testing services 20% lower than those practices by CPRI and about 35% lower than those of the most important international laboratories (such as CESI-Kema and KERI).

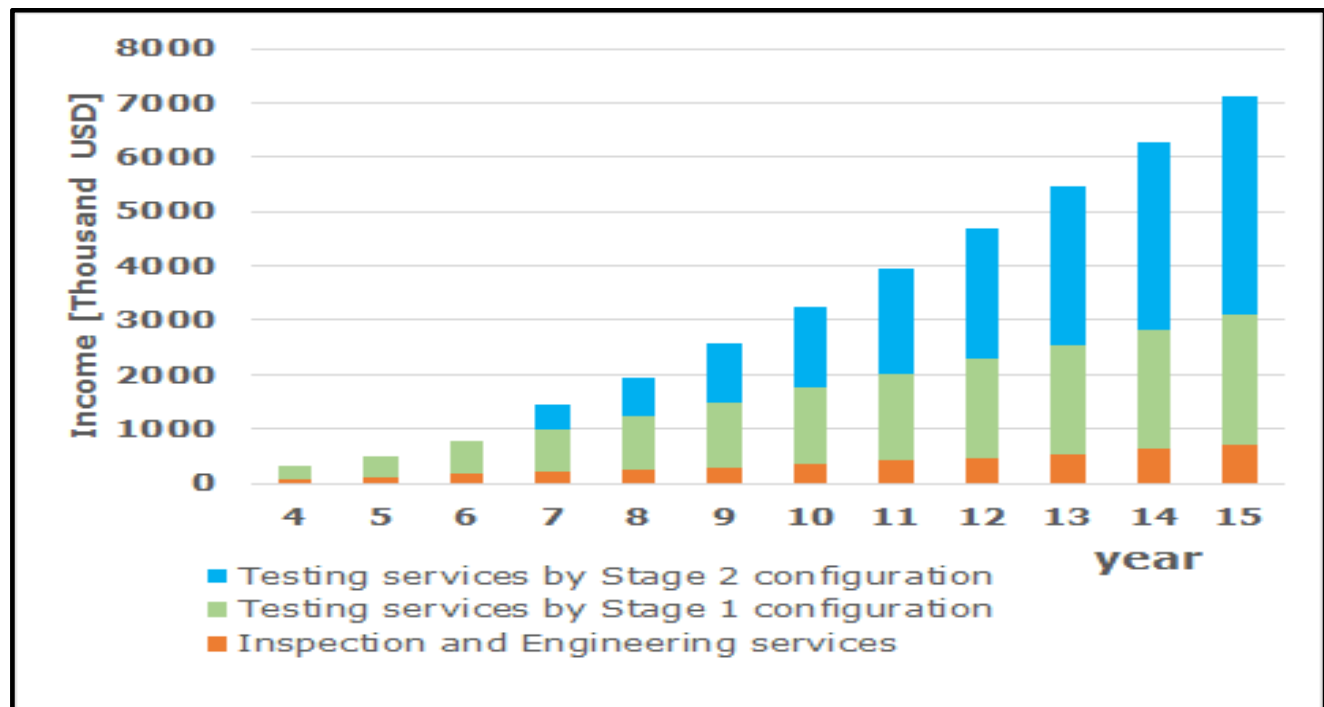


Figure D5–2–2: Turnover of the Testing Laboratory

Therefore, this presented turnover trend has to be considered as a possible target to be achieved through a political, legal and regulatory framework, defined by the public institutions in collaboration with the main Stakeholders (mainly the manufactures and the electrical utilities), pushing the electric utilities to request type tests on the equipment to be installed on the network.

2.2 The operating costs of the Laboratory

They may be grouped into three broad categories: staff cost, maintenance cost and consumables.

The **staff cost** has been evaluated on the basis of:

- the number of persons (managers, engineers, assistants, etc.) and skills for each operating function of the Laboratory that are required to carry out the assigned tasks²,

² See Deliverable D3- 2- National Testing Laboratory Organization

- the annual cost of each professional figure referring of that of three public utilities in Bangladesh, considering the basic salary and all the additional bonus and allowances ((transportation, medical, contributory provident fund, educational).

The **maintenance costs** are related to the cost of repairing or replacing works and of the spare parts. It therefore seemed appropriate to parametrize them to the capital cost required for the Laboratory building with the following rates.

- 1% in the first operation year after the completion of the construction,
- 2% in the 10th operation year after the completion of the construction,
- 3% in the 15th operation year after the completion of the construction.

The **cost of the consumables** is mainly determined by the energy consumption (powering testing facility, lighting of buildings and the areas of the Laboratory, energy for air conditioning of the buildings) that was assessed equal to:

- 8% of the revenues for the testing facilities supplied by the network (all those of the Stage 1 configuration and the HV Power Cables facility),
- 12 % of the revenues coming from the testing facilities supplied by the Short-circuit Generator (the High-Power MV and the Transformer facilities).

Other consumable costs concern: water consumption, fuels for vehicles, protective clothing (gloves, coveralls, etc.) for the personnel involved in testing activities, office supplies.

The overall operating costs of the Testing Laboratory are displayed in the below figure.

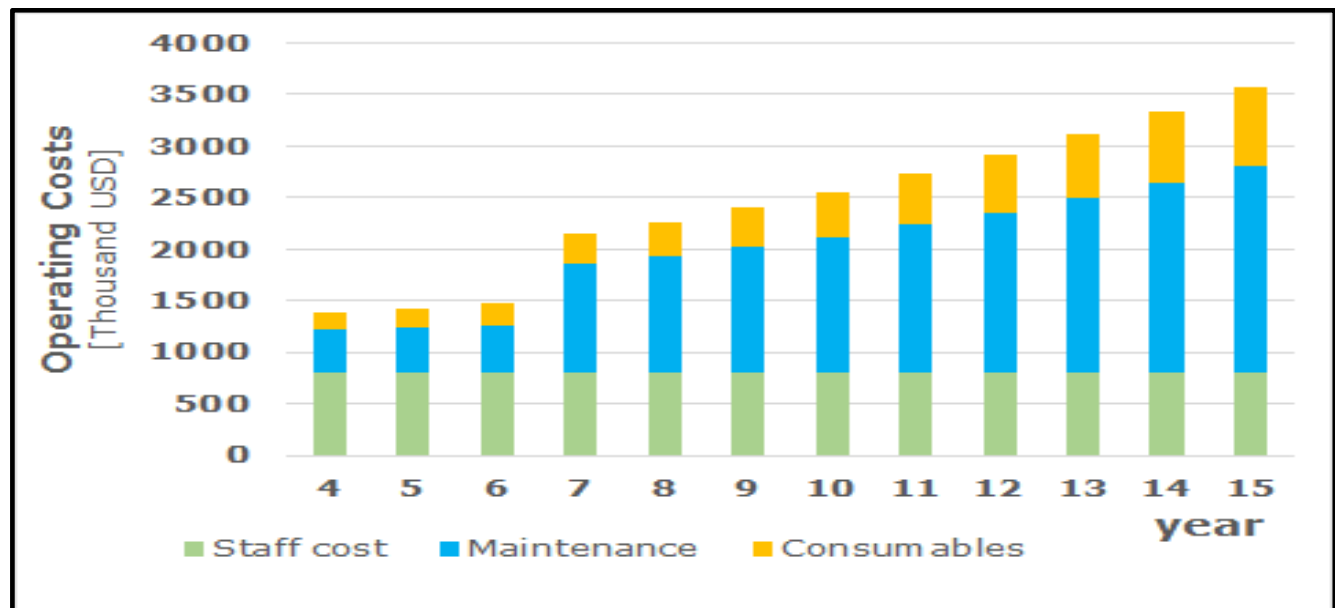


Figure D5–2–3: The operating costs of the Testing Laboratory



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2.3 The required capital expenditure

The needed investment for Testing Laboratory has been evaluated in detail in the Chapter 3 of the Deliverable D4. Table D5.2.1 summarizes for the two development Stages of the Laboratory the cost for testing equipment and civil works (excluding land costs and land development costs related to the Laboratory location which is not yet defined).

Table D5 – 2 – 1: Testing Laboratory CAPEX

Capital Expenditure [Million USD]	Stage 1	Stage 2	
		Option A	Option B
Testing equipment	23.664	42.411	10.518
Civil works	17.433	3.440	0.173
Total	41.097	45.851	10.691

3. The Gross Operating Margin of the National Testing Laboratory

The coverage of operating costs through adequate revenues is the first critical economic (and financial) issues for a testing laboratory in its first years of commercial operation.

In fact, the staff that is necessarily dimensioned for a full operativity of the laboratory as well as the maintenance of the testing equipment, measuring instrumentation and buildings determine costs that are unrelated to the volume of testing services supplied. On the other hand, the pricing policy of the laboratory must be based on market considerations (prices of the competitors) and not to the cost related to test execution.

Moreover, to achieve of a significant volume of testing services, the laboratory must have acquired the trust of the market on the validity of its testing equipment, the competence and skills of its staff and its quality system.

During the first three years from the beginning of its construction, the National Testing Laboratory can carry out all the needed communication activities (at national and international level), accreditation operations and staff training that should ensure market on its technical and organizational performances. This, together with the caution taken in assessing the Achievable revenues, should provide shelter from a shortage of income compared with operating costs.

The following figures show the expected Gross Operating Margin (or EBITDA: Earnings Before Interests, Taxes, Depreciation and Amortization) of the Testing Laboratory at the end of the 3rd, 6th and 12th years of commercial operation, highlighting income and operating costs as they are reported in the previous Chapter 2.

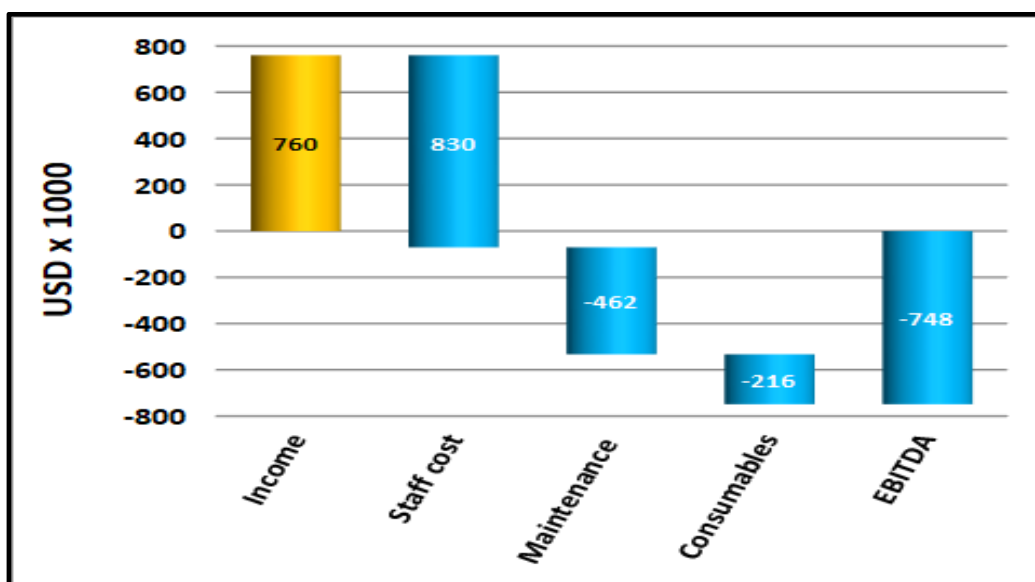


Figure D5–2–4: The Gross Operating Margin at the 3th year of commercial operation of the Testing Laboratory

The Income determined by the Laboratory in Stage 1 configuration are insufficient to cover all the operating costs. But since the 6th year of commercial operation, the Laboratory may have a positive operating margin that becomes approximately 50% of the revenues in the last of the 12 years of Laboratory commercial operation.

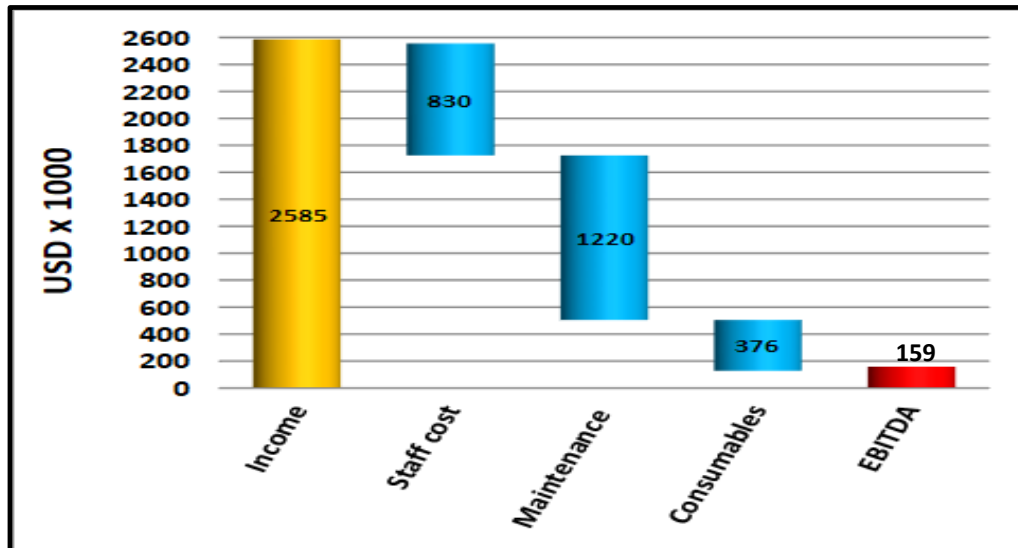


Figure D5–2–5: The Gross Operating Margin at the 6th year of commercial operation of the Testing Laboratory

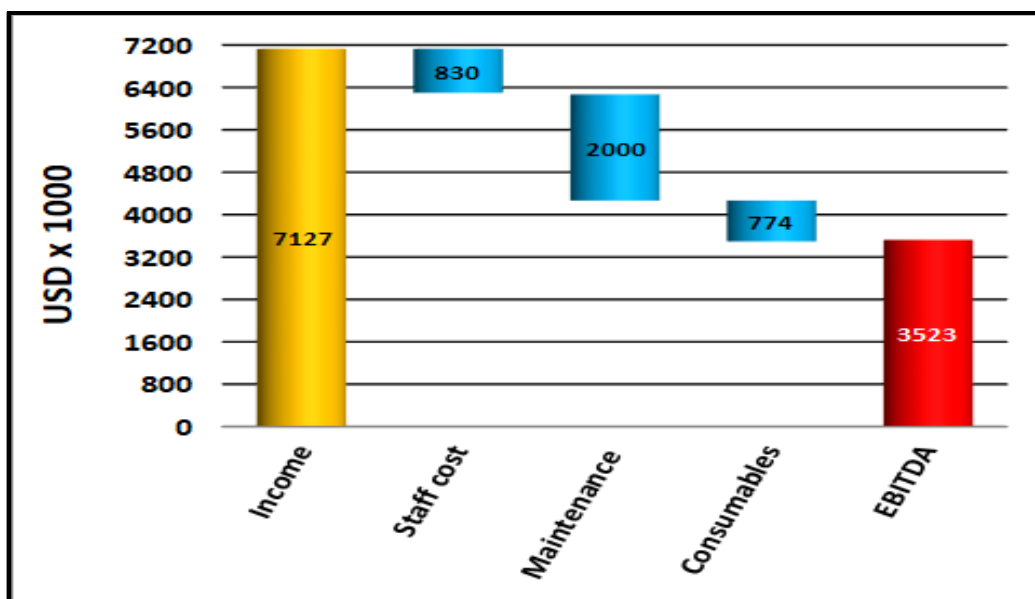


Figure D5–2–6: The Gross Operating Margin at the 12th year of commercial operation of the Testing Laboratory



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4. The National Testing Laboratory's financial viability

The investments listed in Table D5-2-1 are required for the establishment of the Testing Laboratory. But during the commercial operation of the Laboratory further capital expenditures are needed.

The modification of the reference Standard for the type test carried out by the requested better performance of the electrical equipment or the use of new material and/or new manufacturing process, may require an upgrading of the test facilities, and their testing equipment and measuring instrument, to meet the new testing procedure.

In addition, the market may demand to extend the testing capability of the laboratory, (such as short-circuit testing on high-voltage equipment) with consequent additional investments.

The Testing Laboratory has to be able to cope, at least in part, with these new investments without necessarily having to resort to an equity increase by its Shareholders. In other terms the financial sustainability of the Laboratory over time has to be ensured.

This leads to consider the capacity of the Laboratory, as any industrial enterprise, to generate cash flows through its operations. It is not enough that the Laboratory's income is higher than its operating costs: these incomes must also allow to constitute financial resources to be used for all the Laboratory's evolutionary needs.

From the financial point of view this means that the Profit and Loss framework of the Laboratory highlights positive EBIT (Earnings Before Interests and Taxes) values, being:

$$EBIT = EBITDA - \text{Depreciation},$$

and the Depreciation equal to the expensing of a fixed asset (buildings, equipment) as it is used to reflect the deterioration over the time (Amortization, that is related to intangible assets, such as patents and copyrights, is not considered). Using the straight-line method, annual depreciation is assessed by dividing the amount of assets by the number of years of the asset's useful lifespan.

For the Laboratory's financial sustainability, it is necessary that the EBIT values are positive, at least after an initial period of its commercial operation.

Another effective method to evaluate the financial viability of the Laboratory is to consider the profitability of its fixed assets, this is the Return on Assets (ROA), by comparing it with that of other possible financial investments. ROA is evaluated as the following ratio:

$$ROA = \frac{EBIT}{\text{Net Capital Employed}} = \frac{EBIT - \text{Income Tax}}{\text{Net Capital Employed}}$$

being the Net Capital Employed equal to initial value of assets deducted the annual depreciation.

In the following the trend of EBIT and ROA during the first 12 years of commercial operation of the Laboratory are shown under different approaches.

4.1 The financial indices of the Testing Laboratory

Figure D5–2–7 shows the EBIT values for the considered 12 years of commercial operation of the Laboratory having assumed the following favourable depreciation rates of the assets:

- 2% for buildings (meaning 50 years of useful life),
- 4% for equipment (which means 25 average years of useful life for equipment).

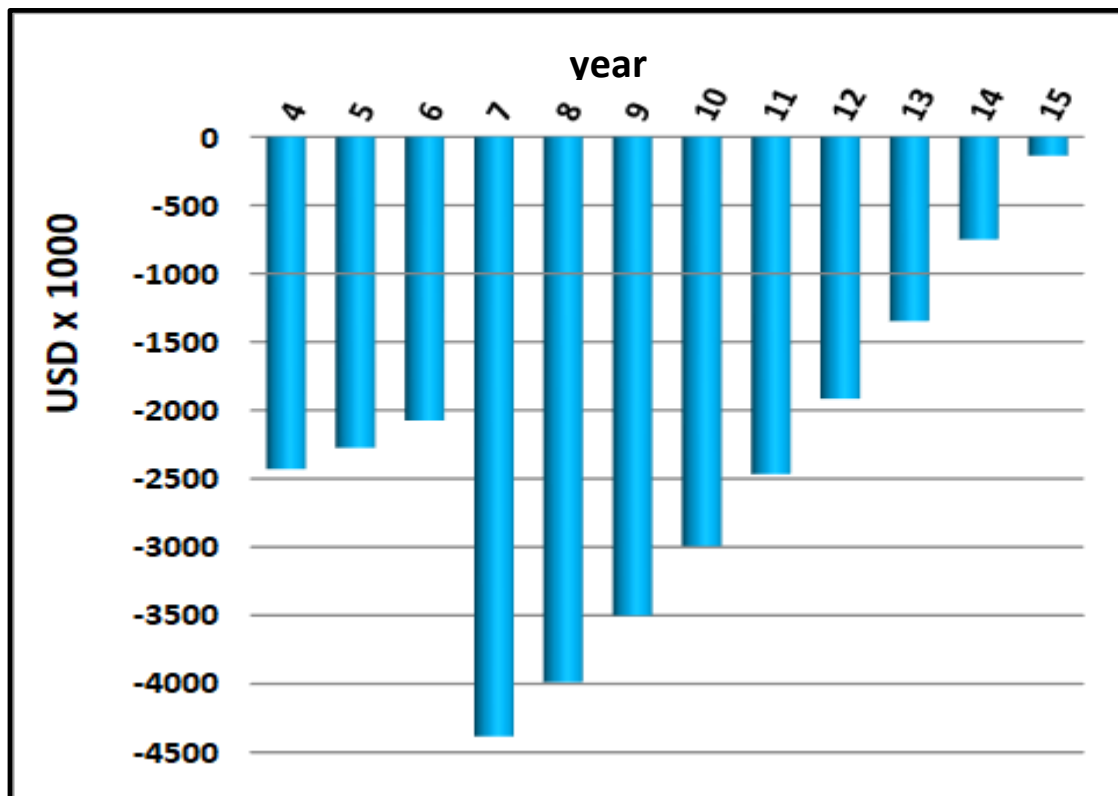


Figure D5–2–7: EBIT trend in the first 12 year of Laboratory operation

The above trend is unsatisfactory for the purposes of a financial viability: even at 15th year there is a negative value of EBIT.

The same unsatisfactory result is reached if the Return on Assets is considered, as displayed by the Fig. D5–2–8: ROA is zero at the fifteenth year only and negative for the previous year.

These results should not surprise. The testing laboratory is a very capital-intensive structure and a satisfactory return on investment is rather difficult to achieve, even considering that it is operating in a very competitive market.

The largest and most known testing laboratories in the world have benefitted from significant government funding. This explains the presence among the shareholders of these laboratories of public institutions and that testing laboratories able to carry out type tests programs are not financially feasible even by great manufacturers of electrical equipment.

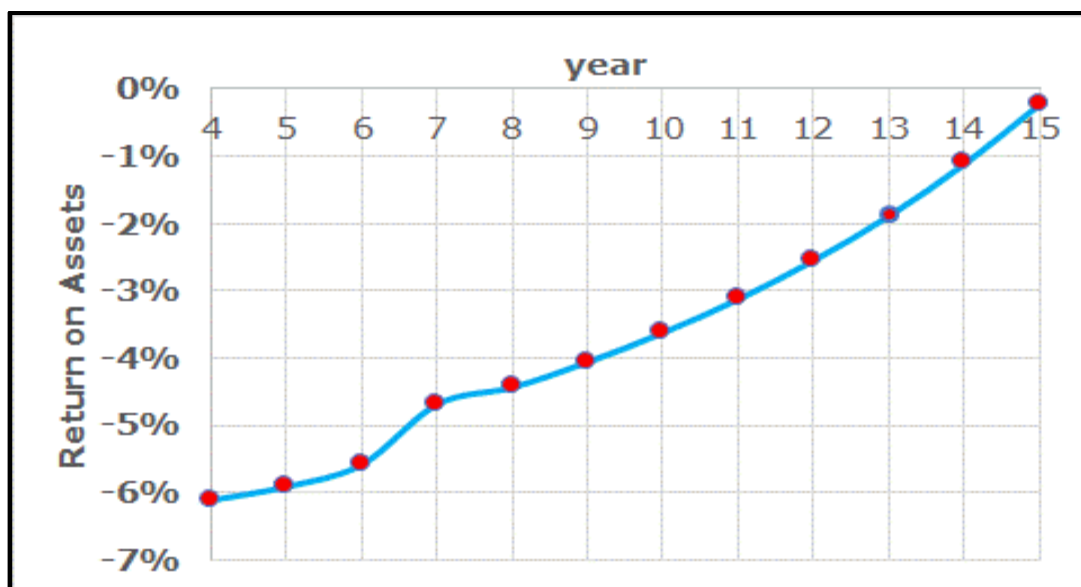


Figure D5–2–8: ROA trend in the first 12 year of Laboratory operation

4.2 The opportunity of grant covering large part of CAPEX

The coverage of the initial capital injection required for the establishment of the Laboratory allows to significantly improve its financial sustainability. In financial terms the part of CAPEX covered by the grant it's like written off since the beginning of the laboratory operation.

The grant may be given by the government or other public institutions or donors (such as the World Bank, the Asian Development Bank, the Japan Development Bank).

A grant equal to 70% of the total investment reported in Table D5-1-1 has been assumed for the National Testing Laboratory. This value should not be surprising: all existing laboratories, including those known internationally, have received grants even 100% of the required capital expenditure.

On this assumption the financial situation of the Testing Laboratory changes significantly.

As resulting from Fig. D5–2–9, EBIT becomes positive from the 8th year of Laboratory operation and at 12th year it's equal to 33% of the annual income.

In a similar way the ROA trend improves (see Fig. D5–2–10): at 12th year it reaches 10% of the Net Capital Employed.

In the event of a 20% downgrade of the estimated Income both EBIT (see Fig. D5–2–11) and ROA (see Fig. D5–2–12) trends exhibit positive values demonstrating a financial sustainability of the Laboratory when a significant share of the capital expenditure is covered by grants.

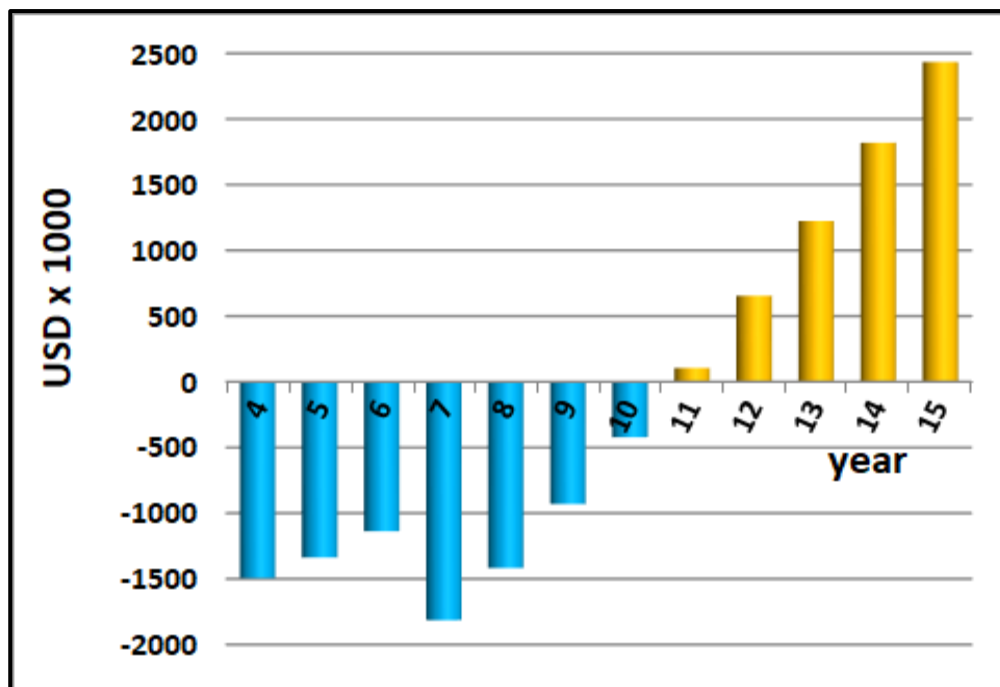


Figure D5–2–9: EBIT trend with grant equal to 70% of capital expenditure

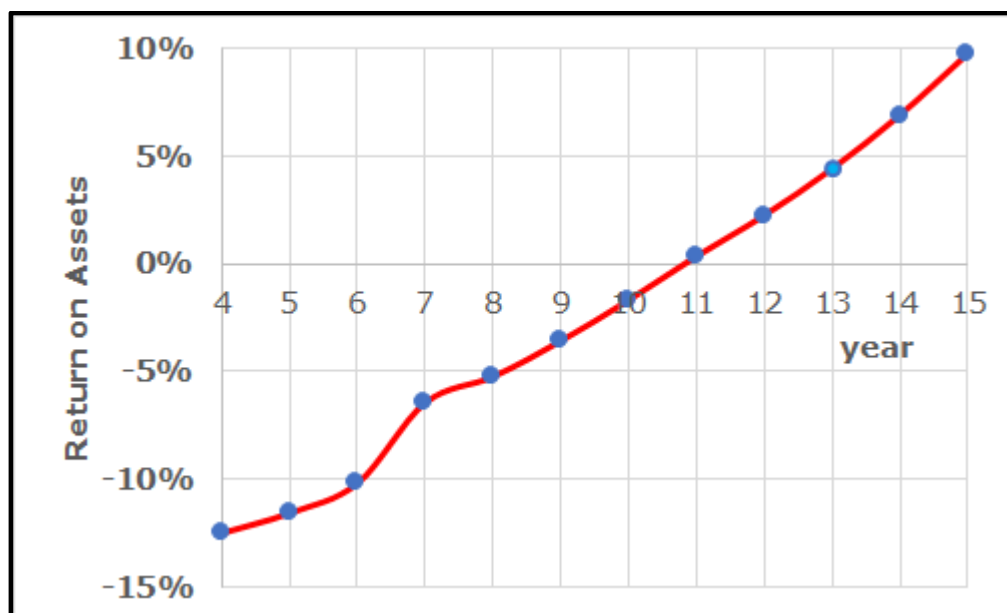


Figure D5–2–10: ROA trend with grant equal to 70% of capital expenditure

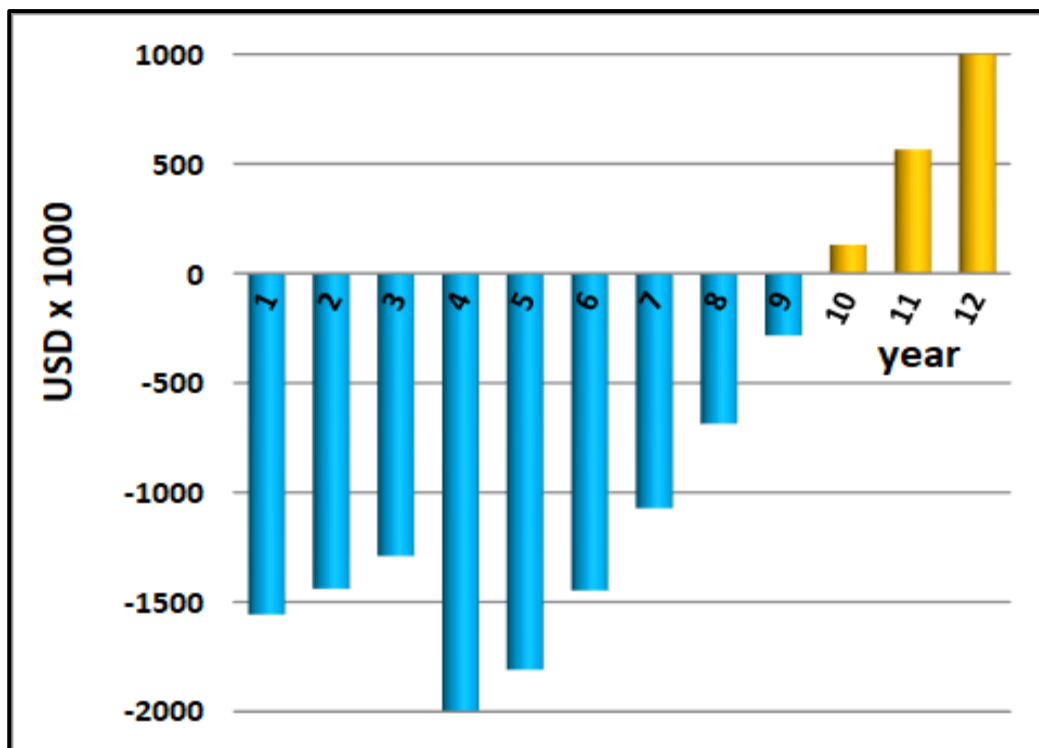


Figure D5–2–11: EBIT trend with grant equal to 70% of capital expenditure and in the event of 20% downgrade of the estimated Income

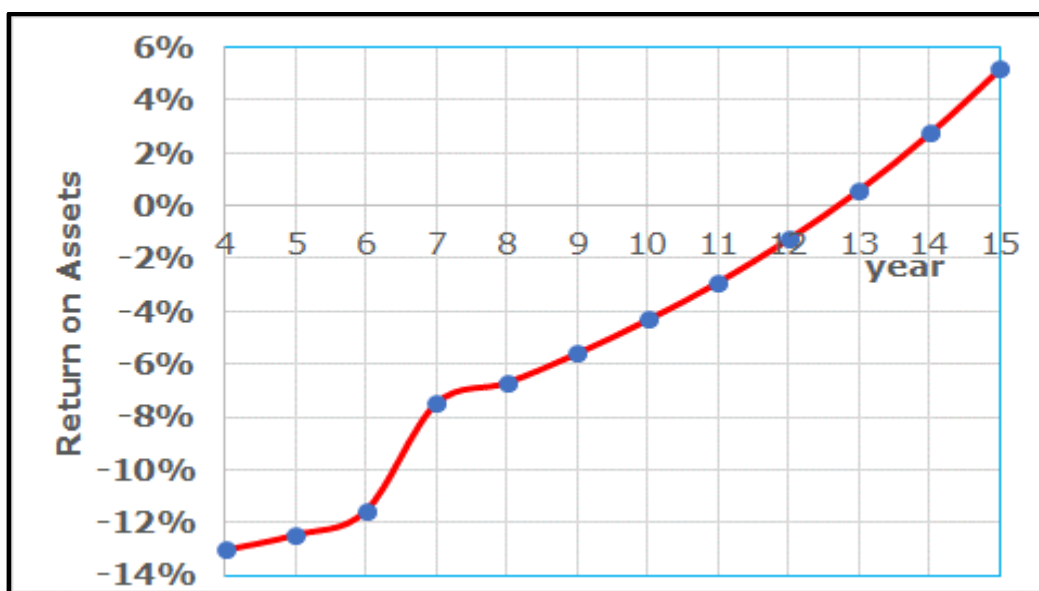


Figure D5–2–12: ROA trend with grant equal to 70% of capital expenditure and in the event of 20% downgrade of the estimated Income



5. The benefits brought about by the National Testing Laboratory

The availability of a Testing Laboratory able to carry out type tests programs in full compliance with Standards involves different and significant benefits for the country.

The local electromechanical sector can qualify the new products or the enhancement of the existing ones (higher operating voltage, higher performances, etc.) at lower costs than those required for testing in a foreign laboratory (even only for the reduced transport costs to and from the foreign laboratory) and avoiding disbursements in foreign currency. Local manufactures can thus improve **their competitiveness in the market of Bangladesh and in perspective in the international one.**

The availability of qualified and competitive (both technically and economically) equipment by the local industry can progressively reduce the import from abroad with significant savings of foreign currency.

Furthermore, the possibility for the electrical utilities to replace by the local industry equipment those previously purchased abroad is a strong incentive for the strengthening of the capacities of the national industry.

This synergic framework, surely generating a positive impact on employment, is placed in a context of strong development of the national power system for which it is estimated 689 Million USD for new equipment to be installed in the distribution and transmission networks in the period 2021-2041³.

Moreover, the Testing Laboratory after some years of operation and related experience and skills of its staff acquired in testing several types of equipment, may supply engineering services addressed to:

- Manufacturers, in supporting the development of equipment, especially in the event of test failure during a qualification program of a new equipment,
- Electrical Utilities, supporting them in the preparation of the purchase specifications of the equipment, in particular to the specifications of the tests (Type Tests and Acceptance Tests) that must be carried out on the purchased equipment.

These benefits largely justify the Government's financial intervention in the development of the National Testing Laboratory as well as International Donors grants.

³ See D2-3-Testing market assessment, Chapter 3



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**Ministry of Power, Energy & Mineral Resources
Govt. of the People's Republic of Bangladesh**

**Consultancy Services for Setting Up Electrical Testing
Laboratory
(Contract Package: S-10)**



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1. Foreword

The Capacity Building activity **must be conducted by the Organization and Management of Human Resources** function¹ with the support of Laboratory Top Management and Training Experts.

The Capacity Building activity is **addressed to the personnel who are mostly new to the testing business** as well as to the related activities (**Inspections and Engineering**) supplied by the National Testing Laboratory.

The Consultant suggests addressing the Capacity Building activity to **Electrical Engineers with a minimum of 8- 10 years' experience** (built in sectors as close as possible to those covered by the Laboratory) and **3 -5 years' experience for junior positions**.

Capacity Building initiatives must also be organized for new graduate employees and workers, as well as non-technical and non-commercial staff, such as Human Resources, Administration, Procurement, etc.

It is recommended that **Stakeholder experts are invited to some of these initiatives**, coming from Electricity Companies, Laboratories, Manufacturers and Inspection Bodies. Therefore, the **Capacity Building aims to increase skills across the entire testing environment**.

It should be underlined that the **Capacity Building plays a fundamental role in the Testing Laboratory startup phase**, but that a **Capacity Strengthening activity will have to be done continuously**.

In fact, **Capacity Building must be considered as a dynamic process** that tends to respond to the growth of the technical, commercial, and managerial complexity of a Laboratory that must compete on a competitive market with international players, in a market in strong evolutions in terms of standards, type of equipment, materials and business model.

The document is built on the following Chapters:

- Setting up the Capacity Building activity,
- Evaluation of existing skills,
- Road Map Proposal for the development of the Capacity Building for NTL technicians and salespeople,
- Summary sheets on the various topics to be explored in detail (see Annex 1 and Annex 2).

¹ See Deliverable 3-2: National Testing Laboratory Organization



2. Main objectives of Capacity Building

The main objectives of the initiative are **Strengthening the skills of:**

- **National Testing Laboratory** (hereinafter NTL) **staff,**
- **Technicians of NTL's main stakeholders,** primarily Electrical Companies, Manufacturers, Inspection Bodies and Universities.

To achieve this objective, it is necessary **to critically study the skills and training needs to create a program adapted to the context** of the electricity sector of Bangladesh. This will help **customize and develop procedures, organizational methods, and technical approaches.**

In conclusion, the Capacity Building initiative must be organized to **become one of the founding moments for NTL and the electricity sector of Bangladesh.**

It is worth underlining that **a pre-established solution is not proposed here,** but rather an **approach based on semi-finished products that can be easily cut out for each context** to help NTL build its best Capacity Building solution based on the objectives and needs identified.

The output of the activity will therefore **not just be a multidisciplinary training program,** but something more ambitious concerning **organization, rules and procedures, investments,** which may also include the training activity.

2.1 The Experts involved in the Capacity Building activity.

It is important to underline that **some Top Managers can be hired already trained and with great experience in the sector,** for example the **Head of the Test Department** from the International market (example CPRI) and the **Sales Manager** from the international market or from the local Manufacturers or EPCs.

In fact, **these two figures will play a key role in the development of NTL** and will most likely be the key people in the organization. They will be able to **actively participate in Capacity Building** and Training activities as Trainers.

Other qualified personnel **may be recruited from private and public companies in Bangladesh,** with experience in sectors adjacent to those of Testing, with minimum experience of 5- 8 years.

In Annex 1 of the document reference is made to **5 professional figures that characterize NTL's activity** that are below listed with the relevant provenience.



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Table D5 – 3 – 1: Professional figures and provenience

Experts	Provenience
Test Engineers	Laboratories of manufacturers.
Inspectors	Measurement and inspection services of: • Electrical utilities, and • Inspection Bodies.
Engineers supporting Manufacturers in developing equipment	• Engineering companies, and • Universities.
Quality systems engineers	Quality system department of: • Manufacturers, and • Utilities.
Commercial Engineers	Commercial Department of: • Manufacturers, and • EPC.

It should be underlined that the **training activity must be carried out during the Stage 0** of NTL (when the Laboratory is under construction) and continuously over the time.

The other professional figures (Organization & Human Resources, Administration, Procurement and Asset Management) **can be hired on the market and do not require specific training**, other than information on the characteristics of the NTL Business Model.



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3. Setting up the Capacity Building activity

3.1 Definition and Methodology proposed by UNDP

Capacity-building is defined as the **process of developing and strengthening the skills, instincts, abilities, processes, and resources** that organizations and communities need to survive, adapt, and thrive in a fast-changing world.

An essential ingredient in **capacity-building is transformation** that is generated and sustained over time from within; transformation of this kind goes beyond performing tasks to changing mindsets and attitudes.

It should be underlined that not only the skills of the experts are strengthened, but also the organization, the attitude to business and the market, etc.

The Consultant proposes that the **methodology on Capacity Building proposed by UNDP² (United Nations Development Program) be adopted.**

Methodology that has already been adopted by various consultants at an international level, even in contexts like today's Bangladesh electricity sector.

First, it should be underlined that:

- there is no single way to develop skills,
- It's not just about training, but much more.

That is, it is a process of continuous learning and change that requires:

- Flexible approach on the part of teachers and learners.
- adequate tools and methods and above all tailored to the needs of the organization that needs to be strengthened,
- Even when it comes to Capacity Building of technical structures, it is a question of operating on not only technical aspects, but also economic/financial, management and human relations aspects.
- Short- and long-term investments.

It can therefore be said that it is a lever for the development of capabilities, in response to the development of the market in which the organization under examination operates.

Capacity building activities often result in proposals to:

- **Multi-annual Operational Plan**, with indication of measurable and verifiable objectives, actions, and results.
- **Roadmap** for achieving the objectives and results described by the Operational Plan. The roadmap must also include moments for verifying the results and updating the Plan itself, when appropriate.

² UNDP: United Nations Development Program



All this will not bring lasting improvements if the project is not part of a broader long-term approach and therefore does not stop, in the case of NTL, after the first 3 years of Startup.

3.2 The 5 Main Phases of Capacity Building

The methodology proposed here can be represented in 5 main phases, such as:

- a) Evaluate the **real needs for the establishment** of Bangladesh's NTL, referring to similar contexts.
- b) Assess **existing capacities and missing capacities** (and gap with target capacities).
- c) Formulate **capacity development strategies**, defining the priority capacities to be strengthened (called **target capacities**), also with reference to similar contexts.
- d) **Implement** capacity development strategies and related **Road Map**.
- e) **Periodically assess capacity** development.

*It should be noted that **point b)** is more delicate to deal with, as the project does not concern the organization of an existing structure, but a new one.*

3.3 Strategic objectives

According to the proposed methodology it suggests the following objectives:

- Lead to significant and measurable improvements,
- Be **adapted to the context** of the organization of Bangladesh's NIA, as well as national priorities, considering in particular the priority issues established by the Government.
- Adopt an **intersectoral and interdisciplinary approach**.
- Be **results-based**, to produce measurable and sustainable capacity development results,
- Appear as **a gradual**, long-term process, made up of short-term, incremental goals to be achieved often in a non-linear way.
- Promote **changes in attitudes and behaviors**.

3.4 Three levels of capacity building

The strengthening of capabilities does not only concern the aspect linked to human resources, in fact according to the proposed methodology it is possible to act on these 3 levers:

- **Development of human resources**, improving their know-how and skills. At this level, improving one's skills involves information seeking, changes in perceptions and behavior, and practical skills.
- **Organizational development**. Organizational development aims to build the capacity of an organization so that it can achieve its goals.



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- **Institutional development.** Organizations have an environment of organizational relationships, partners, legislative and regulatory methods, policies, and cultural context. The development of institutional capacity allows for **better strengthening of relations with the reference environment**. In the case of NTL, it is a question of opening the organization towards the market in:
 - **entry**, through collection of:
 - Commercial information coming from potential customers (Manufacturers who purchase test services), Influencers (e.g., electricity companies who purchase components, but also Technical Bodies, such as Standard ones).
 - Technical information relating to new products, technologies, and standards.
 - **outgoing**, through the implementation of:
 - Relations with Government and other Institutional players
 - Communication and promotional initiatives.

This third point is crucial, as Bangladesh's NTL will have to deal with international market players (competition and customers) and various other bodies such as Technical Bodies, External Certification and Inspection Bodies, R&D Centre.

Above all, the NTL will deal with the Government which, through laws and regulations, will be able to strongly influence its business.

3.5 Organizational development

The development of the organization concerns the following levels on which it is advisable to intervene:

- **Strategy and policy development** (long term planning, translating the mission into concrete objectives and methods).
- **Organizational learning capacity** (the ability to learn from different experiences and use feedback in policy formulation and execution).
- **Organizational structure** (formal and informal division and coordination of roles, functions and responsibilities).
- **Internal processes** that govern the daily procedures of an organization
- All activities and policies aimed at **motivating staff**.

*In the case of Bangladesh's NTL, strong attention must also be given to **technical monitoring** activities of the international market (standards, products) and **commercial** (customers and competitors).*



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3.6 Functional and technical skills

It should be underlined that Capacity Strengthening **does not only concern the technical aspects** (or commercial ones for Sales Engineers), but **also above all the Functional ones**, all of which is extremely true for Management positions.

3.6.1 Functional capacities

They are needed to create, manage, and review policies, strategies, organization, commercial, human resources, purchase and programs. The main functional abilities are:

- Ability to engage stakeholders, for the Top Management,
- Ability to analyze a situation and define a vision and a mandate,
- Ability to formulate policies and strategies,
- Ability to sales,
- Ability to budget, manage and implement,
- Ability to evaluate the context.

3.6.2 Technical capacities

These vary according to the situation, the needs expressed, and the parties involved. Technical abilities are associated with particular areas of expertise and practice in specific industries or themes, as they are very application dependent, unlike functional skills which are more general in type.

*In the case of Bangladesh's NTL establishment, this point is crucial, as **most of the skills are not found on the market and they must be created internally** and need continuous strengthening.*

*The **recruitment activity** must therefore be directed towards personnel who already have a background as close as possible to its business.*

3.7 The main phases of Capacity Building activity

These are the phases suggested by the Methodology of UNDP:

- **Phase 1:** Diagnosis of capacities,
- **Phase 2:** Development of the Capacity Building Plan,
- **Phase 3:** Implementation of the Plan.

3.7.1 Phase 1: Diagnosis of capacities

The activity generally consists of these steps:

- **Identification of the needs and relevant skills** to carry out the different activities and independently of the existing resources in Bangladesh,
- **Diagnosis of existing capacities.**

This point is very challenging, as it will be necessary to make an indirect diagnostic as most of the staff has not yet been recruited and the organization is known only on paper.

- **Assessment of capacity gaps** (strategies, organization, procedures, technical and functional skills, tools, communication, etc.) and of the existing gap.
- **Prioritize missing skills or weak retention** and not adequate to the challenges of implementing the Bangladesh's NTL.

From an operational point of view, the activity can be conducted in a qualitative manner or by going deeper using maturity grids (also called evaluation grids).

The **Consultant suggests using this second approach** (maturity grids). In fact, using these grids, a **score can be assigned for each area of ability or performance**.

A team made up of experts will validate these scores recorded by the Human Resources Management, **proposing target values that must be achieved once the Capacity Building activity is completed**.

This matrix can therefore constitute a valid evaluation support for improving existing capabilities, guiding the choice of actions to prioritize.

Some examples of using these matrices are presented below.

3.7.1.1 Capabilities Matrix

It is used to **organize the required capabilities** in a logical way. It represents a useful basis for **identifying missing capacities**.

The goal is to generate a list of required abilities for each box.

Table D5 – 3 – 2: Structure of Maturity Grid

Level	Capacity	Formulation of questions	Analysis of data	Results
Individual	Technical			
	Functional			
Organisation	Technical			
	Functional			
Looking at the outside (market, stakeholder, institution)	Technical			
	Functional			

At the end of this process a complete **list of all the capacity needs** for the successful of the project (and achievement of long- and short-term objectives)

Functional skills are as important as technical skills, so they should be listed separately.

On the following page, a sample table for conducting gap assessments at 3 levels (individual, organizational and system level) is presented.

Evidently the table will be personalized on the context of the Project.

Table D5 – 3 – 3: Example of a Maturity Grid applied to NTL

Level	Abilities	Formulation of questions
Individual	Technical	- Do key individuals have the appropriate technical skills to implement the project objectives? - Is this attention also paid to commercial aspects, quality and safety system management, procurement, etc.? ...
	Functional	- Do key individuals have effective functional skills to achieve project objectives? (Ability to negotiate or manage conflict, interpersonal communication skills, teamwork, ability to identify solutions to overcome challenges, etc.) - Is there a Capacity Building and continuous training process underway? ...
Organisation	Role/function	- Does the organization allow individuals to carry out their respective roles? - Are the roles and responsibilities clear, is the composition of the teams adequate, is communication with the managerial level encouraged, etc.) ...
	Management and supervision	- Are management, monitoring and appropriate information systems in place to meet the organization's commitments? - Is the organization's mandate, reputation and credibility conducive to meeting the organization's commitments? - Is attention to quality and safety shared within the organization? ...
Looking at the outside (market, stakeholder, institution)	Systems and structures	- Is the market monitoring system in place functional and effective? - Are there the skills to prepare competitive technical and commercial proposals? - Is there a legislative, regulatory and incentive framework capable of encouraging the use of the Laboratory by Manufacturers? ...
	Role/function	- Is the added value of the organization told to the market known within the organization and above all shared? - Is the budget allocation for the various functions adequate and known/shared? - Is the annual and multi-annual revenue budget feasible and shared at company level? ...

3.7.1.2 Prioritization of capacity development areas

The final step in the capacity gap analysis is to prioritize areas for capacity development.



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To achieve this objective, it is essential to involve the Top Management of NTL.

For this, it is preferable to organize a workshop, also open to the main stakeholders.

Table D5 – 3 – 4: Structure of Priority Grid

Individual	Organizational	Looking at the outside
• Priority 1: • Priority 2: • Priority 3:	• Priority 1: • Priority 2: • Priority 3:	• Priority 1: • Priority 2: • Priority 3:

3.7.1.3 Tools that can be used for Capacity Building

Table D5 – 3 – 5: Example of Tools to be used for Capacity Building

Individual	Organizational	Looking at the outside
• Training (short term and long term) • Workshops • Seminars • Peer learning events (regional, international) • Tools, technical notes, guides • Twinning and exchange program • Online learning	• Technical assistance • Training in organizational management • Documentation and sharing of best practices • Inter-departmental exchanges • Study trips	• Awareness campaign • Media training • Learning events • National and international events • Membership of international organizations

3.7.1.4 Indicators

Indicators are objectives that show progress in Capacity Building activities.

The **indicators must be chosen carefully**, considering the organizational context and current skills at the time of startup. The indicators **must be clearly described and shared, and above all measurable. The target** to be achieved in the expected time and the measures (actions, investments, organizational changes) to be adopted to achieve these objectives **must therefore be defined**.

Generally, these two types of indicators are developed for capacity development:

- **process indicators:** process measures that have been facilitated so that dynamic changes are encouraged to put the work of participatory approaches.
- **output indicators (or product indicator):** measurement of the concrete results that have been achieved.



3.7.2 Phase 2: Development of the Capacity Building Plan

The Capacity Building plan summarizes all the capacity needs in the medium and long term, indicating their priorities and proposing a Road Map.

In the case of NTL, the Plan should pay attention- by the way- to:

- Organizational point of the 3 business legs (Testing, Inspection and Engineering)
- Organization of the managerial functions (Human Resources, Procurement, Administration and Finance, Asset Management)
- Recruitment of the technical and non-technical personnel

Implement the Capacity Building Plan and the Training Plan which is normally proposed by a consultant. This activity will obviously have to continue over the years even after the conclusion of the NTL start-up.

3.7.2.1 Training of Trainers (ToT)

The Training Plan indicates **which activities can be carried out by local personnel** (for example: Ministry of Energy, Electrical Utilities, Manufacturers, Universities) and which ones can be carried **out by international personnel** from laboratories, certification bodies and universities.

Particular attention will also be paid to **Training of Trainers (ToT) activities** which involve Senior Trainers (international and local) in coaching new, less experienced trainers.

This way the ToT business can **build a pool of competent instructors** who can then teach other people. It should also be considered that the trainer then trains the other employees and at the same time trains himself.

For this reason, NTL shall equip itself to carry out this service.

3.7.2.2 Approach for Capacity Building implementation.

It is advisable that the Capacity Strengthening Plan (and the Training Plan) are based on a **motivating pedagogical approach** that combines group work (exchanges of experiences with sector experts and between learners) and theoretical and practical insights (in the laboratory setting or factory).

This approach normally involves 3 phases:

- **Academic phase**, describing the theoretical and experimental aspects and the international best practices.
- **Phase of reflection**, during which the trainers abandon the methodological aspects in order to be able to deepen the ideas and proposals of the participants.
- **Phase of solution**, arriving together (trainers and trainees) at functional and/or technical solutions adapted to the environment.



3.7.3 Phase 3: Implementation of the Plan through the Road Map.

The activity can be divided into four phases:

- **Introductory Phase**, in which the Consultant proposes the Plan and the Road Map Proposal, indicating the horizon year (e.g., 18 -24 months),
- **Plan Acceptance Phase**, in which the proposed Plan is discussed with NTL Stakeholders and accepted,
- **Implementation Phase** of the capacity building plan. This phase will therefore be managed directly by Power Cell or by the new NTL Managers,
- **Continuous Training**, which will last the entire life of NTL even if with less effort.

3.7.3.1 Operational suggestions

The Consultant suggests that the **main phases of training** (in particular the more theoretical and functional ones) **be recorded** for other internal training courses, accompanied by the documentation presented.

At the beginning of the training activity, it is advisable that participants also **carry out a placement test** (via a specific questionnaire) to validate the skills acquired.

Throughout the training activity, the Consultant suggests that the trainers evaluate the training progress of the participants at the level of the Group and the individual participant. This assessment can be carried out using simple questionnaires (e.g. MCQ: Multiple Choice Questionnaire) or interviews.

This evaluation **is important to highlight that they need to be further explored or expanded to other topics.**



4. Evaluation of starting skills

As already indicated, this involves evaluating skills before the start of the Capacity Building Phase.

As already previously indicated, the Program here described concerns 2 types of staff:

- **5 – 10 Electrical Engineers with approximately 10 years of experience in sectors close to those in which NTL operates** (see paragraph 1.2)
- **10 – 15 Electrical Engineers with approximately with 3-5 years of experience** with knowledge of the main topics of the electricity sector.

The Stakeholder Experts who will also participate in these initiatives must also have similar skills and work experience as presented above.

In total, **the Capacity Building for the technical and commercial aspects could involve at least 25- 30 Engineers**, including Stakeholder experts.

The Capacity Building activity must be organized by a Team **coordinated by the Human Resources Management Department** with the participation of:

- **1 Training Expert**, coming for example from the University.
- **1 Senior Test Engineer** with at least 15 years of experience gained in Testing Laboratories, better if coming from the International (e.g., CPRI).
- **1 Senior Sales Engineer** with at least 15 years gained in Commercial Department of local Manufacturers or EPC, better if they operate on the international market.

The last two experts shall also play a role of **Top Managers in Testing and Sales Departments**.

4.1 Program Structure

Training initiatives must be organized in the **classroom**, on the **plant** (test facilities) and in **premise of the stakeholders**.

The initiatives on the plant **will depend greatly on the types of systems installed in the various Test Facilities** and can be better defined in collaboration with equipment suppliers (e.g., Short Circuit Generator, Short Circuit Transformer, Measuring Instruments, etc.) and with the Senior Test Engineer by NTL.

Stakeholder visits may include the following aspects:

- **Manufacturers' laboratories** to discuss, for example, preparation of test programs, and assist the execution of tests.
- **Sales Department of Manufacturers or EPC** to discuss ways of monitoring the market, preparing offers and above all to provide an overview of the market's needs and the strengths of competitors.



- **Electrical Companies** to discuss with the Department in charge of the Preparation of the Specifications regarding the Specification of the tests to be carried out.
- **Electrical Companies**, to understand their main needs in terms of component quality and performance.
- **Inspection Bodies**, to get information on their business model and market demands.

Classroom training initiatives can be of different types:

- **Theoretical of a technical nature**, such as evolution of standards, program and execution of tests, etc.
- **Organizational**, for example the test program preparation,
- **Commercial**, for example the technical economic proposal preparation
- **Management of the quality** (and safety) system, for example the internal audit organization.

At the end of the presentations, all these initiatives must include:

- **Debate** with a series of proposed questions,
- **Workshop** in which participants (under the Consultant supervision) delve deeper into the themes of the presentation and participate, for example, in preparing operational procedures tailored to their needs.

It would be very useful, budget permitting, to organize **technical visits to independent international laboratories** (such as CPRI, but also CESI/Kema or Keri) or **conferences in Dhaka** inviting international experts.

4.2 The Target Technical and Commercial Skills

As seen in Chapter 2, to adequately set up Capacity Building **it is necessary to define the Target skills that must be acquired** and those existing in their initial state before the start of the Training phase.

As regards skills, it is considered useful **for the entire Team to participate in most of the initiatives**, except for the more specialized and typical ones, for example the testing method (e.g., of a Power Cable or a MV GIS) or management of Short Circuit Generator.

The two tables below summarize the **technical-commercial skills** (see table 6) **that must be known by everyone**, albeit at a general level and **those typical of the various functions** (see table 7).

This widespread knowledge is important, because especially in the first years of NTL's life there will have to be an **important flexibility between the various technical roles**, not only at the level of carrying out tests on the various components, but also between the various functions. In some cases of emergency, it will also be **possible to resort to the support of the Inspectors in carrying out the tests** and vice versa.

With this approach, **quality will be ensured by reference figures**, such as: Power Test Manager, Power Cable Test Manager, Inspection Activities Manager, etc.

Table D5 – 3 – 6: Example of Tools to be used for Capacity Building

Basic skills for all 5 figures
<u>General Information</u> Business Model of an Independent Laboratory Various types of tests (Development Tests, Routine Tests, Type Tests, Acceptance Tests) Laboratory Accreditation. Type of Test Documents. Structure of an offer, for the testing part. <u>Information characterizing the Bangladesh market</u> Structure of the electricity market (Electricity Companies and Manufacturers) Development of the Electricity System of Bangladesh Typical structure of equipment orders from electricity companies NTL and Competition Prices

Table D5 – 3 – 7: Target Duties and Skills for each function

Experts	Duties and Responsibilities	Needed skills
Test Engineers	• Management of test dispatching between the various Test Facilities, • Preparation of test programs • Carrying out tests, • Evaluation of Results.	• Knowledge of the Standards • Knowledge of the instrumentation and components of the Laboratory, • Knowledge of the equipment to test.
Inspectors	• Preparation of test programs • Witnessing the tests performed by the Laboratories. • Evaluation of Results.	• Knowledge of the Standards • Knowledge of the equipment to test.
Engineers supporting Manufacturers in developing equipment	• Preparation of the Test specifications of the various Components • Support to Manufacturers in the development of equipment with particular attention to the event of test faults* • General knowledge of the solutions adopted on the market.	• Knowledge of the Standards • Knowledge of the equipment to test. • Knowledge of the impact of components on the electrical system • Use of mathematical models and related software tools



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Experts	Duties and Responsibilities	Needed skills
	In the later stages of NTL development: • Design Review studies. • Fault Analysis studies,	
Quality systems engineers	• Preparation for review of procedures, • Knowledge of the company quality system, • Audit organisation, • Management of non-conformities.	• Knowledge of the Standards concerning equipment and quality system.
Commercial Engineers	• Market monitoring, • Preparation of Communication and Promotional Plan, • Preparation of offers from a technical and commercial point of view. • Definition of the Price, • Negotiation, • Sales trend analysis and forecast.	• Important technical background both at the power system and equipment level, • Business Plan preparation, • Economic evaluations.

The Table above describes the overall activities managed by the different functions. Different roles and specializations can be established within each function once the company has grown enough to justify a more complex structure.

4.3 The Skills existing at the Start-up of Capacity Building

Referring to the figures described above, the **audience of the training activity will be constituted by some engineers with a general knowledge of NTL's business issues**, coordinated by 2 Senior Experts who already know the Business Model of organizations similar to those of NTL.

However, **none of these yet knows the actual Environment and Business Model of NTL because it must be created by them**, even during the various Capacity Building sessions.



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5. Road Map Proposal for the development of the Capacity Building for NTL Technicians and Sales people

The below Table D5-3-8 lists the main topics that are usually explored in depth, essentially based on the technical-commercial activities of managing a laboratory (including the related activities of Certification and Engineering). The preparation of this documentation will involve a strong involvement of the 2 previously hired NTL Senior Experts.

For these general topics indicated, **PPT presentations will need to be prepared and submitted**. Sheets summarizing the contents of these training courses are in Annex 1.

Table D5 – 3 – 8: Main general topics to be explored during Capacity Building

Main general topics
1. The equipment to be tested. 2. Considerations of Testing and Inspections Bodies 3. Certification, Testing, and the Risk Management 4. Laboratory basic Infrastructure 5. Laboratory Quality System 6. Calibration 7. National and International accreditation 8. The Large Electrical Laboratory 9. The Criteria to design a Large Electrical Laboratory 10. General on HP Labs 11. General on Direct testing Labs 12. General on Synthetic Testing Labs 13. General on HV Dielectric Labs 14. General on other Laboratories 15. Measurement and control systems 16. Business Model of the Independent Laboratories 17. The Documents delivered by Independent Laboratories 18. Key Role of Organization and Human Resources Management 19. How create the test market. 20. Communication and Commercial process 21. The typical structure of a Specification, concerning the required tests. 22. Worldwide investments in Target Period (2021-2041)

The following Table D5 – 3 – 9 lists the topics most related to the context of the Bangladesh market: they could also be useful to involve the main NTL Stakeholders.



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Table D5–3– 9: Main topics related to the context of the Bangladesh market

Main Topics related to the context of the Bangladesh market
1. Structure of the Bangladesh electricity market (Electricity Companies and Manufacturers) 2. Investment Plans in Electricity Distribution and Transmission in Bangladesh 3. Needs for Testing by Manufacturers 4. Structure of typical Specification used in Bangladesh, especially for what regards Tests 5. Collection of information on Development, Routine and Type Tests carried out by Manufacturers

In addition to these in-depth training courses, it will be necessary to organize **training courses on the main equipment and instrumentation installed in the Testing Laboratory**, as reported in the below table.

Table D5 – 3 – 10: *Main Topics related to equipment and instrumentation of the Testing Laboratory*

Main Topics related to equipment and instrumentation
1. Short Circuit Generator 2. Short Circuit Transformer 3. Other electromechanical machineries 4. Instrumentation tools 5. Control system 6. Safety control



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ANNEX 1

Summary sheets on the technical-commercial topics



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1. The equipment to be tested.

Numbers of sessions: 2 – 3

- Components to consider (Power Transformers, Current Transformers, Voltage Transformers, Reactors, Circuit Breakers, Switchgears and Controlgears, Switches, Gas Insulated Switchgears, MV fuses, Power Cable Systems, Joints and Terminations, Disconnectors, Surge Arresters, Bushings, Insulators, Condensers, Bus, and Busbars).
- Aspects to consider for each component (Definitions following Standards, marketing and application point of view, Application description, Classification by standards, Typologies, Advantages/Disadvantages of the different technologies, Tests to be carried out and foreseen by the International Standards, Typical size).
- Main Manufacturers in the various in the international markets.

2. Considerations of Testing and Inspections Business

Number of sessions: 1

- General (What is a test? Why is the test performed? Which is the equipment tested? Where is the electrical test performed?)
- The equipment classified [Low Voltage (LV): ≤ 1000 V, Medium Voltage (MV): $1000 < V \leq 38\,000$ V, High Voltage (HV): $> 38\,000$ V],
- The types of equipment,
- The main tests,
- Applied Standards.
- Commercial and Technical Reasons to perform Tests,
- When there is a market for tests (domestic and international).

3. Certification, Testing, and the Risk Management

Number of sessions: 1

- Risk Management Definition,
- Testing and Certification a way to address and manage risks.
- Changing relationships [the major players (Equipment Suppliers, Component Purchaser & users, Testing & Certification Bodies), Division of Responsibility among the Players, Responsibility more formalized in the different phases (Specification, Design, Testing)].
- What do the utilities want?
- What are the utilities doing?
- How the Manufacturers are organizing themselves.
- How Testing and Certification Bodies are reacting.



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- International Standards.
- User specifications.
- Testing as Risk Management.
- Verification of performances.
- Limitations of testing and certification.
- Current situation in the International Utilities (Western Countries, Asian Pacific, Russia, and Brazil).

4. Laboratory basic Infrastructure

Numbers of sessions: 2

- Main facilities [Electrical supply (via electrical network, and/or generators), Testing facilities (Various tests plants, control room, measurement system), Good reception and storage, Assembling and disassembling halls, Workshop, Testing bay, Hall for clients witnessing to the tests],
- Typical configuration [High Power Laboratory (LV, MV and HV), High Voltage Laboratory, Temperature rise Laboratory, Power Cable test Laboratory, Prequalification test Laboratory on MV/HV]
- Main Components to be tested.

5. Laboratory quality system

Numbers of sessions: 1

- General - Management requirements from ISO/IEC 17025 (General requirements for the competence of testing and calibration laboratories)
- Quality Control (technical competence, Commercial, Organization and management of the activities)
- ISO 17025 guidebook for the quality management system of Labs.
- Company quality system
- Differences between accreditation and certification
- Certification [compliance with a standard or specification (e.g. systems or product standards)].
- Accreditation, attesting laboratory is competent to carry out specific tests or specific types of tests.



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6. Calibration

Numbers of sessions: 1

- Calibration (ISO/IEC 17025:2005)
- Estimation of uncertainty of measurement
- Reporting the results
- Measurement traceability
- Calibration, organizational aspects

7. National and International accreditation

Numbers of sessions: 1

- Need for accreditation.
- Technical (quality system) and commercial accreditation.
- Laboratory accreditation practice (Accreditation to ISO/IEC 17025, Scope, Accreditation Phases).
- ILAC “International Laboratory Accreditation Cooperation” (Member Accreditation of laboratories and inspection bodies supports activities)
- Lovag [The Low Voltage Directive (LVD), Electromagnetic Compatibility Directive (EMC), Machinery Safety Directive (MSD)]
- STL “the Short-Circuit Testing Liaison” (Members, Applicants, Main Objectives, Organization Why become member of STL)

8. The Large Electrical Laboratories

Numbers of sessions: 1

- Commercial definition of Large Electrical Laboratory,
- The segmentation from the marketing point of view (Manufacturer labs, Commercial and third part labs, Institutional and National R&D labs,
- The segmentation from the technical point of view (High Power Laboratory, High Power Laboratory for testing Power Transformers, High Voltage Dielectric Laboratory Temperature Rise Test Laboratory, Cable Ageing and Cable Pre-Qualification test Laboratory, Climatic Laboratory, Mechanical Laboratory)
- The more known Laboratories [High Power Laboratories (STL Full Members, STL Applicant, Others, Laboratories owned by manufacturers), HV Dielectric Laboratories, Power Cable laboratories, High Power Laboratories for Testing Transformers]
- The more known Laboratories of Asia Pacific



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9. The criteria to design a Large Electrical Laboratory

Numbers of sessions: 1

- The main phases,
- Phase 1: Strategic, Technical and Financial Feasibility Study,
- Phase 2: Detailed Design, Construction and Commissioning Supervision,
- Phase 3: Activities after Commissioning,
- The main Criteria,
- Testing Services Market Assessment ([Analysis of the demand market (electricity companies, railways, energy-intensive industries), analysis of local and international supply (competitors), evaluation of the accessible market (and its trend)],
- Evaluation of the direct and indirect benefits (improved competitiveness of the domestic electromechanical sectors, employment reinforcement Improved efficiency, power quality, reliability and security of the local Distribution and Transmission Power System).
- Evaluation of Investment Return.

10. General on HP Laboratories

Numbers of sessions: 2

- General on HP Labs (The components to be tested, Typical configuration of an High Power Laboratory, Main testing facilities and schemes, Development of special equipment and systems for HPL, Power Supply and Generator Circuit Breakers, Measurements and Control System),
- Main testing facilities and schemes [LV – HP lab, MV – HP lab, MV/HV – HP lab (up to 150 kV), Generator circuit breaker - HP lab, HV/EHV – HP lab (up to 1200 kV), HP Lab. for testing High Power Transformer, MV/HV – HP lab to test AC CBs to be installed in a network with strong Harmonic content, MV DC – HP lab, HP Lab for Power Electronics valve testing],
- Power supply and Generator Circuit Breakers (Complete test circuit, Network and short circuit generator, Typical Characteristics of Generator Circuit Breaker, Generators running in parallel).

11. General on Direct testing Labs

Numbers of sessions: 1

- Laboratory main components (Power transformers, Current limiting reactors, LV and MV Making switch, TRV control circuit, Auxiliary Circuit Breakers, Loads, Test bay)
- Tests to be performed on the main components (MV/HV Circuit Breakers and GIS, Metal enclosed switchgear, Disconnectors, Load break switch, Fuses, Power transformers).



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12. General on Synthetic testing Lab

Numbers of sessions: 1

- Why Synthetic tests?
- Synthetic testing Lab – The Breaking Test Methods,
- Synthetic testing Lab – The Making Test Methods,
- Three – phase Synthetic tests,
- Synthetic capacitive switching tests,
- Synthetic Laboratory main components,
- Evolution of the HV synthetic testing.

13. General on HV Dielectric Labs

Numbers of sessions: 1

- General on HV Dielectric Labs (not only AC tests),
- Test facilities integrated with Dielectric Lab [Climatic and Environmental labs, DC Dielectric facilities (especially dedicated to performing tests on DC power cables), Laboratories to perform ageing tests on MV power cables],
- Typical configuration of a High Voltage Laboratory [AC & DC Dielectric facilities (power frequency voltage, lightning impulse voltage, switching impulse voltage, combined voltage, DC voltage, partial discharge measurements, $\tan\delta$ and loss measurements)].
- Brief description of Faraday Cage, Power frequency voltage transformer, Rain supply system, Impulse voltage generator, DC generator, Voltage divider, Measuring shunts,
- The components to be tested on HV Labs [Electromechanical components (Power cables, Insulators, Bushings, Transformers, circuit-breakers and switching equipment, GIS, Metal enclosed switchgear & controlgear, panels) Components other than electromechanical (Power Electronic components, Telecommunication Systems, Aircrafts components, Defense systems, Autobus and lorries, Mechanical structures)

14. General on other Laboratories

Numbers of sessions: 1

- Testing plants (Temperature rise Lab, Mechanical Lab, Environmental Testing Laboratory, Cable Ageing, Cable Pre-Qualification, Seismic Lab, Chemical Lab)
- Typical test objects for each Testing plants
- Other facilities (Workshops, Warehouse, Assembling/disassembling halls).



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15. Measurement and control systems

Numbers of sessions: 1

- Current measurements (Shunts, Rogowski coil, Current Transformer),
- Voltage measurement (Capacitor compensated Dividers, Voltage Transformer),
- Transient recorders
- Control and acquisition system

16. Business Model of the Independent Laboratories

Number of sessions: 3 - 4

- Laboratory Typology [International Laboratories, Public), Laboratories of Manufacturers and R&D laboratories],
- Need of accreditation,
- The main players of the market [Buyers (Electrical Utilities, Railways, Energy-intensive industries), Salers (Manufacturers and System Integrators), Test and Certification Bodies],
- Related activities (Certification, Inspection and engineering activities to support equipment development),
- The reference market,
- Characteristics of the business (The most profitable businesses, Development and routine testing market, Role of Independent Labs in Development and routine tests),
- Factors characterizing a successful Independent Laboratory [Brand, Independence, Accreditations, Membership of Technical Bodies, Integration of Laboratory services, Qualification of Human Resources, Commercial conditions (price and technical support)],
- Market consideration (High investment barriers against the market entry of other players, need of financial support from the state and/or shareholders, limited number of players),
- The main International Independent Laboratories,
- The main Regional Laboratories,
- Test market amount and Tariffs,
- Business drivers [State-of-the-art test facilities, Membership (such as STL), High brand].
- Type of tests (Calibration Tests, Research and Development Tests, Routine Tests, Type Tests, Factory Tests, Acceptance Tests, Measurements and field tests once the equipment is installed),
- Profitability of the Tests.
- Conceptual organizational structure of the Laboratory [Centralized models (CESI, Kema, CPRI, and Keri), Distributed models (PEHLA, ESEF ASEFA, STLNA, SATS),



- Return on Investment of a Test Facility [Direct benefits (Sales) and Indirect benefits (strengthening of the electricity system, Return to the business of the manufacturing industries, creation/reinforcement of employment).

17. The Documents delivered by Independent Laboratories

- Document issued by the Laboratory (Test Report, Type Test Certificate, Inspection Report),
- Documents issued by the Certification Body (ex. Certificate of Conformity),
- Documents issued by the Inspection Body (Inspection Report, On-field Measurement Report),
- Documents issued by the Engineering & Consulting structure (Study report, Specifications of equipment and systems, Design Review documents, Failure Technical Analysis),
- Duration of Test documents validity,
- Type Test Report - The Format and structure (Mandatory information in the cover page, Further information in second page).

18. Key Role of Organization and Human Resources Management

Number of sessions: 2

- Not just Test Facilities (also Organization, Administration Human resources, Commercial and Communication Policy, Attention to institutional aspects),
- Conceptual Organisation,
- Technical Functions [Main functions (testing, certification, inspections, and engineering services), Others (Calibration and Measuring Centre, Technological window)],
- Non-Technical Functions [Market monitoring and commercial activity, Human Resources Management and Organization, General Services (Procurement of equipment, Consulting services and energy for the power supply of the Laboratories, Asset Management, Security Management), Administrative and financial management],
- Aspects characterizing the organization [qualified personnel, need of continuous training, Skills difficult to find on the market (Testing, Consulting, Engineering, Commercial), Different types of skills for each business legs, need for strict relations with universities and national and international technical bodies],
- Key aspects (organization not as a Research Centre, operation in a competitive market, tight deadlines),
- Communication and Commercial Organization (Market Monitoring, Proposal preparation, Commercial Follow up, Negotiation, etc.),



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- Organization of Test activities (Dispatching of tests among the various facilities, Organization and sizing of the test teams, Safety of laboratory staff and customers, Execution of the tests, Preparation of test documents),
- Attention to the procedures and the quality system which does not only concern the technical aspects.
- Complaint Management.
- Quality System and evaluation of the nonconforming.

19. How create the test market.

Number of sessions: 1 - 2

- How to convince equipment buyers (electricity companies and energy-intensive industries) to spend more?
- How to convince equipment sellers (Manufacturers and System Integrators) to involve the NTL in the development of their prototypes? Considering the related costs, logistical problems (transport of equipment) and possible unsatisfactory test results,
- Active involvement of the Government obliging or suggesting test activities to be carry out in the Independent Laboratories, favoring the local ones (NTL) Bangladesh.
- A gradual approach, choosing the most critical types of components (to be tested) for the electrical system.
- Experience returns from China, Taiwan and Brazil, India and Malaysia.

20. The Commercial and Communication Policy

Number of sessions: 2

- Reference market of the business legs (Testing, Certification, Inspection, Consulting): National Market, Regional Market, International marketFunction description,
- Promotional activity of testing services (main interlocutors, stakeholders),
- Actions versus Manufacturers and Utilities (when are already clients, when not a client),
- Actions versus Utilities (when are already clients, when not a client),
- Actions versus Ministry of Energy of the Country,
- Actions versus International Banks (e.g., Word Bank) and Investors,
- Actions versus Market Influencers (Technical Bodies, Universities, Research Centers),
- Approach and Tools for communication,
- The Commercial and Communication Organisation.

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21. The Typical Structure of specification, concerning the required tests.

Numbers of sessions: 1

- Structure of the specifications
- Requirements (including environmental),
- Reference Standards (IEC or also others?),
- Requests addressed to the Manufacturers (e.g., Quality System in compliance with ISO 9000, execution of routine tests on all equipment), Request for Type Tests and Acceptance Tests,

22. Worldwide investments in target period (2021 – 2041)

Numbers of sessions: 1

- The business framework of testing activities
- Worldwide Investments in target period in the power system sector [Generation (conventional and renewable), Transmission, Distribution (micro grid and rural applications included), other applications (Railways, Energy-intensive industries), applications beyond the meter (Industrial, Commercial, and Residential)]:
- Segmentation of investments (business as usual, re-engineering, new applications),
- Segmentation for components for T&D application (electro-mechanical components, lines, automation, and instrumentation),
- Trend Evaluation of the Electromechanical Components (especially switching equipment and Distribution and power Transformer),
- Trend evaluation of the testing market,
- The trend evaluation of the performances of the Large Electrical Laboratories.



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ANNEX 2

Summary sheets on the contextual topics



This documentation has to be prepared with the strong involvement of the main Stakeholders who - in some cases - also play the role of teacher.

1. Structure of the Bangladesh electricity market (Electricity Companies and Manufacturers)

Numbers of sessions: 1 - 2

- Structure of the electricity sector, in particular electricity companies (including TSOs, GenCOs, IPP, distribution companies),
- Structure of the offer of equipment sellers and manufacturers (including international manufacturers who sell in Bangladesh or have a production structure on site)
- Third parties (Certification and Inspection Bodies),
- Existing Testing bodies (owned by State or by Manufacturers),
- Standard Bodies,
- Metrological organisation,
- Accreditation Bodies.

2. Investment Plans in Electricity Distribution and Transmission in Bangladesh

Numbers of sessions: 1- 2

- Investments in the Generation, Transmission and Distribution (MV and LV) electrical sector (and their trends in the next 10 - 15 years),
- New developments at the electrical system and component level [e.g., voltage and short circuit current levels, materials, equipment based on IBRs (Inverter Based Resources), FACTS (Flexible AC Transmission System) and HVDC],
- Segmentation by voltage level (EHVAC, HVAC, MV, LV),
- Segmentation by type of equipment.

3. Need for Testing by Manufacturers

Numbers of sessions: 1

- Needs to carry out development tests on new equipment and need for technical support in development activities.
- Need for technical support for the development of equipment for the international market.



4. Structure of typical Specification used in Bangladesh, especially for what regards Tests.

Numbers of sessions: 1

- Structure of the specifications of the System Operator of Bangladesh with particular regard to the requirements (including environmental), Reference Standards (IEC or also others?), requests addressed to the Manufacturers (e.g., Quality System in compliance with ISO 9000, execution of routine tests on all equipment), Request for Type Tests and Acceptance Tests,
- Structure of the specifications of 2 – 3 Distribution companies of Bangladesh.
- Request to carry out tests in specific laboratories.
- Participation of electricity company inspectors during the Type Tests.

5. Collection of information on tests (Development Tests, Routine Tests and Type Tests) carried out by Manufacturers of Bangladesh.

Numbers of sessions: 1

- The equipment buyers need for testing, inspection, and engineering services. For testing services, reference standards, equipment ratings, special tests.
- Segmentation by type of Tests (Development Tests, Type Tests, Routine Tests and Acceptance Tests),
- List of tests carried out internally at the Manufacturers' laboratories.
- List of tests carried out at international laboratories (e.g., CPRI, CESI, KERI).
- Description of the features of existing local test facilities.
- Accreditations of existing laboratories in Bangladesh.



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Ministry of Power, Energy & Mineral Resources
Govt. of the People's Republic of Bangladesh

**Consultancy Services for Setting Up Electrical Testing
Laboratory**
(Contract Package: S-10)



Deliverable	D4
Document	Electric, civil, architectural engineering of Testing Laboratory
Revision	1
Date	07/11/2023
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1. Summary

This document constitutes the engineering development of the Feasibility Study object of Deliverable D3 in the framework of the Project for the setting up of a National Testing Laboratory for electrical equipment.

All the Testing facilities for the two considered configurations of the Laboratory, named Stage 1 and Stage 2, are completely defined in terms of:

- Block diagram and Single line diagram starting from the power source until the testing cell housing the equipment under test,
- the equipment that can be tested and their maximum operating rates,
- main ratings of all the involved testing equipment.

On the basis of the above specifications, the required capital costs for the establishment of the testing laboratory are evaluated taking into consideration procurement, installation and commissioning of the testing facilities as well as of all the Laboratory buildings.

The achievable turnover for the three services provided by the Laboratory (testing, inspection and engineering services) is assessed under the condition of a regulatory framework pushing the electrical utilities to install on the equipment that has been previously type tested.

The staff of the Testing Laboratory is defined taking into consideration its Operative Functions and the workload related to the supplied services corresponding to the estimated yearly turnover.

The operating costs of the Laboratory are defined and compared with the revenues to determine the Gross Operating Margin in the first fifteen years of operation.

Finally, the document considers:

- the legal aspects to be taken into account in the establishment of the Testing Laboratory in the light of the existing legislative and regulatory framework,
- the aspects to be taken into consideration in the Laboratory's executive design in order to obtain a resilient realization avoiding or mitigate any possible environmental impact.

This rev.1 of the document takes into account the comments and remarks raised by the Client and Stakeholders during the 2nd Informative Meeting held on 6th November 2023.



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2. Testing facilities Specification

In the Feasibility Study of the National Testing Laboratory¹ the capabilities of all the testing facilities of the Laboratory have been defined. In the following for each testing facility of both the two planned Stages (Stage 1 and Stage 2) of Laboratory a short description and the complete list of its testing equipment, with the relevant main ratings, are reported.

2.1 Stage 1

2.1.1 High Power MV-LV testing facility

The facility is addressed to perform:

- all the type tests on LV equipment with rated voltage up to 690 V,
- the type tests on MV equipment with rated voltage from 3.6 kV up to 36 kV and rated current up 6300 A, with the only exclusion of making and breaking tests²,
- the ability to withstand short-circuit of:
 - Distribution Transformers with rated power up to 4 MVA and having primary voltage up to 13.8 kV and 0.4 kV secondary voltage,
 - Power Transformers with rated power up to 20 MVA, ratio voltage 33/11 kV and short circuit impedance in the range 4% ÷ 8%.

This facility is supplied by an external power line at 230 kV coming from a 230 kV Station having not less than 5000 MVA short-circuit power. The short-circuit power drawn by the Testing Laboratory is not higher than 250 MVA for a maximum duration time of 0.3 s.

A bank of 3 single-phase 1200 MVA Short Circuit Transformers with 230 kV primary voltage and four 10 kV secondary windings allows to obtain secondary voltages of the bank in the range 3,6 ÷ 40 kV by means of the MV Ratio changer (see the block diagram of Fig. D 4-1). This equipment consists of a number of motor operated disconnectors connecting in series or in parallel the secondary windings of each Transformers.

The secondary voltage of this HV/MV Short Circuit Transformers bank feeds the power circuits for:

- the tests bay addressed to MV equipment testing,
- the test bay for the short circuits test on Distribution and Power Transformers,
- a MV/LV 3-phase 250 MVA Short Circuit Transformers, having 36 kV primary voltage and two 0.26 kV secondary windings, which supply the power circuits for all the tests on LV equipment and all the low voltage tests on MV equipment.

¹ See D3-1: National Testing Laboratory Feasibility Study, rev. 1.

² For a detailed list of the tests performed on MV equipment see D3- 1: National Testing Laboratory Feasibility Study, rev.1, Annex 1, pag.36.

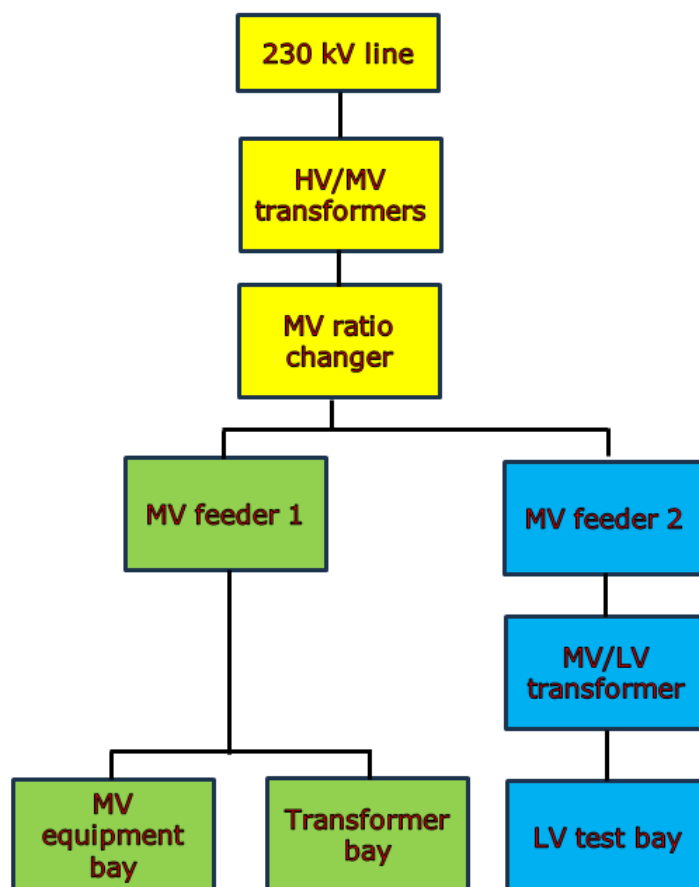


Figure D4 – 1 – Block diagram of the Stage 1 configuration

From the above it is evident that in the High-Power LV-MV testing facility only one test can be performed at a time, be it on LV equipment or MV equipment or on Transformer. This does not constitute a serious impediment to the productivity of the Laboratory as adopting appropriate separations (through fences) in the testing facility it is possible to prepare the test circuits (not energized) in one of the segregated areas while in another area is running a test.

Appropriate disconnectors, remotely controlled by the Control room, allow to select the test circuits to be powered as well as the regulation of the test voltage and current to be applied to the equipment under test.

Current and voltage transformers provide the measurement of the tests parameters that are displayed and recorded by the workstation located in the control room of the testing facility.

All the testing equipment, with the relative main ratings, of the High-Power LV-MV testing facility are listed in Annex 1 at page 53.

The below Fig. D4 -2 shows the single line diagram of Stage 1 configuration of the Testing Laboratory, starting from the external 220 kV power line until the three test bays addressed to MV equipment, Distribution and Power transformers and LV equipment testing.

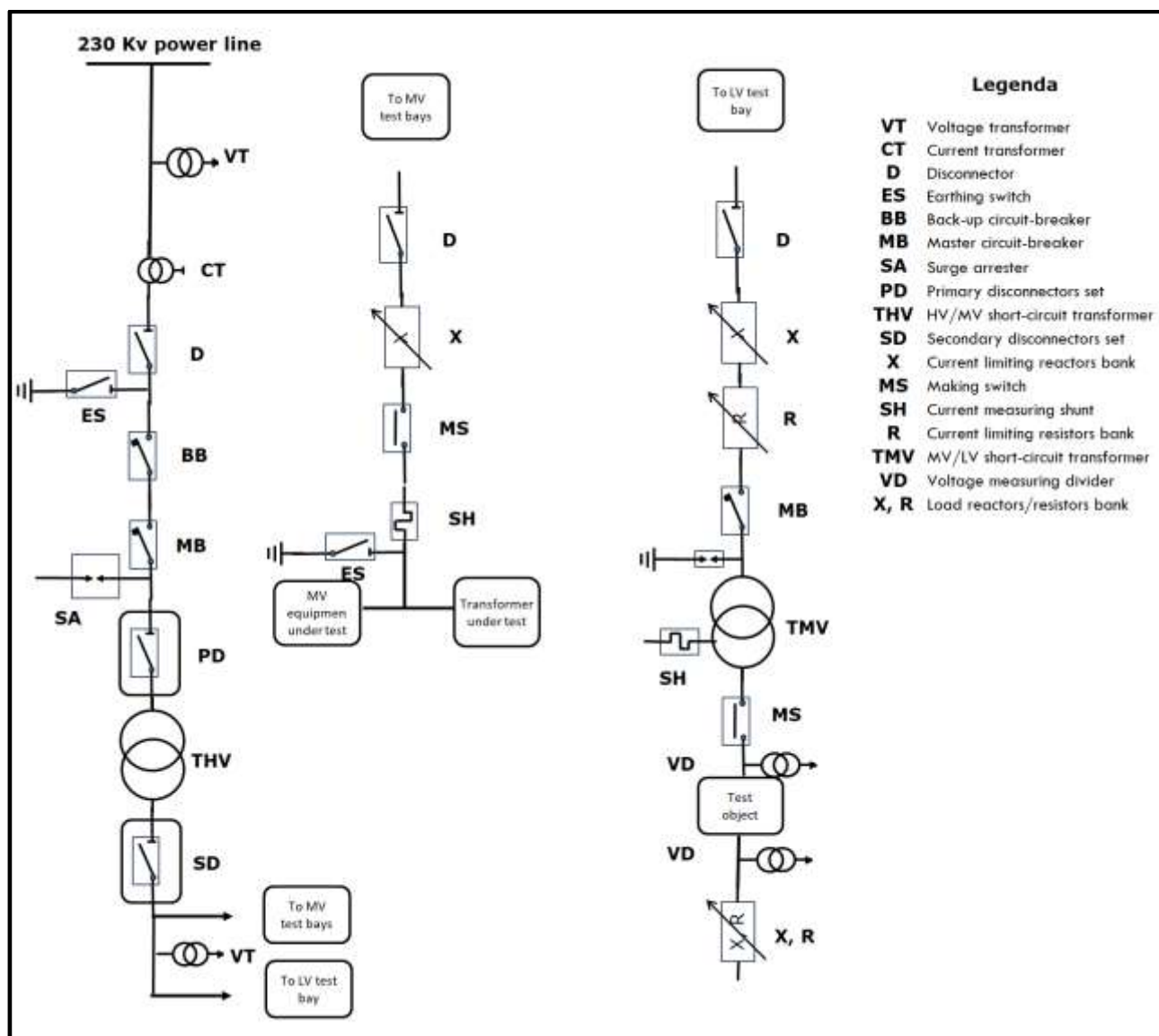


Figure D4 – 2 – Single Line diagram of the Stage 1 configuration

2.1.2 High Voltage testing facility

This testing facility is supplied by a 33 kV external power line and appropriate LV switchboard feeds the different located testing equipment.

This facility is addressed to perform:

- the dielectric test (lightning impulse, power frequency, partial discharge and radio interference voltage) on all the equipment listed in the previous paragraph 2.1.1;
- the dielectric test (impulse voltage, lightning impulse, power frequency, $\tan \delta$) and the Heating tests on Power Cables with rated voltage from 1.2 kV up to 36 kV;
- the dielectric tests on ceramic, glass and polymeric Insulators with rated voltage up to 36 kV;
- all the tests on Distribution and Power Transformers (temperature rise, induced voltage, applied voltage and the measurement of voltage ratio, check phase displacement, short-

circuit impedance, load losses, no load losses and current, capacitance and $\tan \delta$) on the Distribution and power Transformers listed in the previous paragraph 2.1.1.

All tests, except for the ability to withstand short circuit, on power and distribution transformers are performed in this testing facility in order to limit the movements of the transformers between the various facilities for the benefit of greater efficiency of the Laboratory.

The temperature rise test on Transformers is performed by injecting the rated current in one of the windings (primary or secondary), while the other winding is short-circuited, for a time span necessary to achieve a steady-state of the equipment temperature. The power supply at the higher voltage winding allow to lower the injected rated current in so reducing the requested current ratings of the upstream testing equipment. In order to allow the performing the temperature rise tests at both 50 Hz and 60 Hz, the test circuit is powered through a Static Frequency Converter able to generate a range of output voltages.

The power transformers under temperature rise test has a predominant inductive load determining the supply for the whole duration of the test of reactive power much higher than the active power. The use of a proper Capacitors bank located upstream of the transformer under test and able to supply a large share of the requested reactive power is the preferred solution allowing to reduce the rated power of the Static Frequency Converter and of the related Step-up Transformer.

The proposed test circuit for Temperature rise test is shown in the below Fig. D4-3.

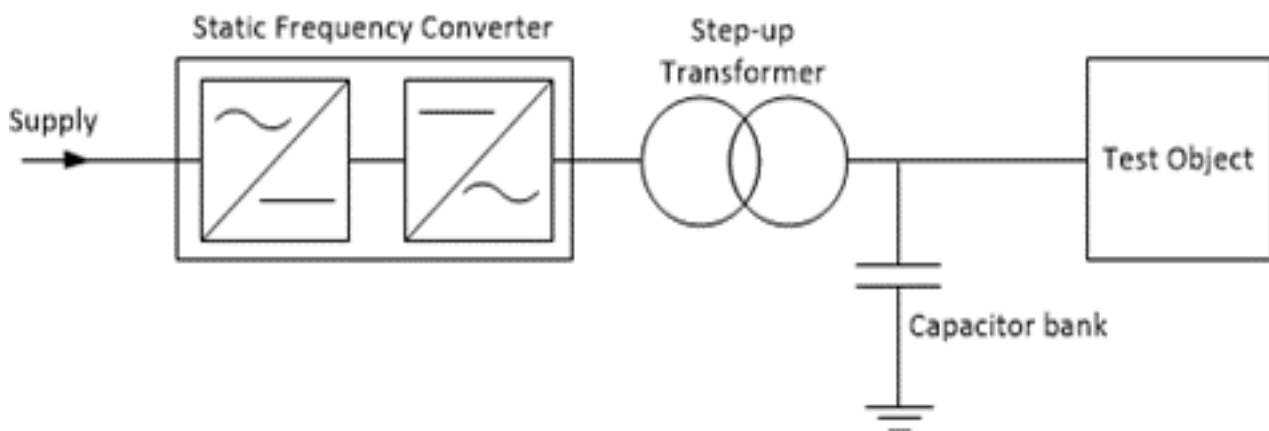


Figure D4 – 3 - Test circuit for temperature rise test and Induced Voltage test on transformers

The Step-up Transformer allow to increase the output voltage of the Static Frequency Converter up to the required test voltage of the transformer under test.

The same circuit is also used to carry out the Induced voltage test on transformers. This test is performed by applying an alternating voltage, equal two times the rated voltage, to the terminals of one winding, while the terminals of the other winding are not connected. As this set up may cause the saturation of the transformer ferromagnetic core, the test frequency has to be increased above the rated frequency (usually at double value or more) in order to avoid excessive magnetizing current during the test. So, test frequency up to 200 Hz is to be considered. For this reason, the electronic converter is required to be able to adjust in addition to the output voltage also the frequency in the range of 50 ÷ 200 Hz.

The test circuit shown in Fig. D4-3 is also used to carry out the measurement of the short-circuit impedance of the transformer as well as the measurement of load losses, no load losses and the no load current.

The Applied Voltage test on transformers is performed in turn on each separate winding. The voltage test is applied between the terminals, connected together, of the winding under test and all the terminals of the remaining windings, core, frame and tank of the Transformer, connected to earth. The applied sinusoidal test voltage shall have a frequency not less than 80% of the rated frequency of the transformer under test and an amplitude defined in Table 2 of the IEC 60076-2 for the different voltage level. The proposed test circuit mainly consists of (see Figure D4-4):

- a Regulator Transformer able to provide an adjustable output voltage,
- a Power Frequency Source rising the Regulator Transformer output voltage in the requested voltage to be applied to the Transformer under test,
- an AC Voltage divider performing the applied voltage measurements.

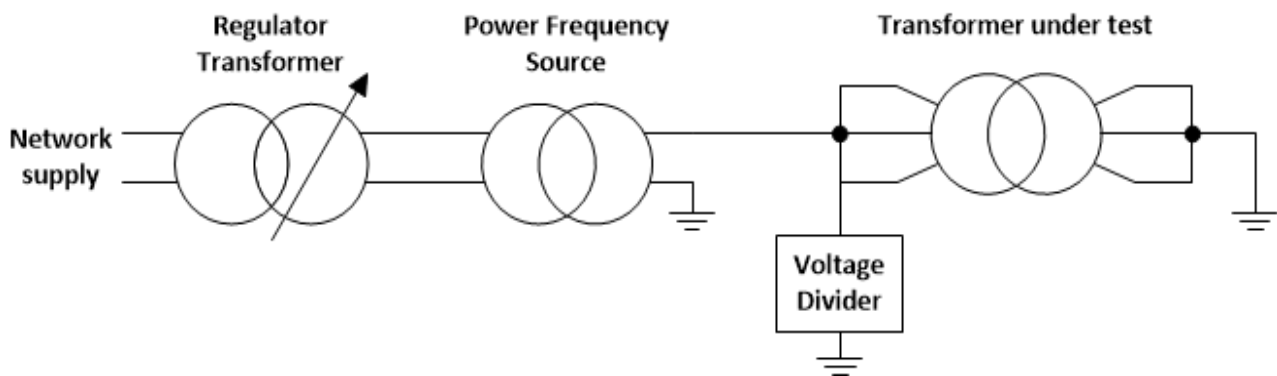


Figure D4 – 4 – Test circuit for Applied Voltage tests on transformers

In the High Voltage Testing facility are to be carried out all the test concerning Power Cables with rated voltage up to 36 kV. On samples (10 or 15 meters long) of Power Cable with rated voltage from 3,6 kV up to 36 kV are performed the dielectric tests and the Heating test.

In the Heating test the conductor shall be heated, by means a current flowing, at a temperature higher than $5 \div 10$ K its maximum allowed temperature in operating condition. The most effective solution for the injection of current into the conductor consists in using Heating Transformers. This equipment is a toroidal transform, usually square shaped, with only one winding; the second winding is the conductor of the cable under test crossing the hole of the core. The induced voltage into the conductor determines a current flow. To obtain the required test current several Heating Transformers may be used as shown in the below Fig. D4 – 5.



Figure D4 – 5 – Heating test on Power Cables

In the High Voltage testing facility is installed a Shielded Room allowing to perform Partial Discharge test in compliance with Standards.

In a corner of the High Voltage testing facility a dedicated area is addressed to perform the special dielectric tests on surge arresters by means of dedicated testing circuits.

All the testing equipment, with the relative main ratings, of the High Voltage testing facility are listed in Annex 1 at page 55.

2.1.3 Temperature rise testing facility

This testing facility is supplied by the 33 kV external power line and it is addressed to perform temperature rise on the LV and MV equipment listed at paragraph 2.1.1.

Differently from the distribution and power transformers, the impedance of LV and MV equipment are low and comparable with the impedance of the connections (copper braids, cables) between the power source and the test object. The maximum voltage drop in the power circuits and thus the maximum requested test power are determined by the LV Bus Bar trunking and the MV busducts. The level of inductive reactive power of the equipment and the connection leads to making use of a suitable capacitors, in so reducing the supplied apparent power.

The involved testing equipment:

- a Static Frequency Converter with output voltages in the range $40 \div 400$ V, with possibility of adjustment with steps of 50 mV each,
- a number of Heating Transformers with 400 V primary winding and 40 V secondary winding,
- a Capacitor Bank upstream the Regulator Transformer that allows to reduce the reactive power absorbed by the inductive reactance of the test circuit.
- a Resistor Bank for adjusting the voltage drop of the power circuit.
- Current transformers for the measuring of current flow into the equipment under test.

The above testing equipment, with the relative main ratings, are listed in Annex 1 at page 57.



2.1.4 Mechanical testing facility

The testing facility is supplied by the 33 kV external power line and it is addressed to perform mechanical and endurance tests on the LV and MV equipment listed at paragraph 2.1.1.

The testing equipment for this facility mainly consist of:

- No. 2 Automatic test system performing thousands of opening and closing cycles on LV and MV switching equipment (two systems have been envisaged due to the long duration of these tests),
- Resistance meter and portable Micro-Ohmmeter,
- A set of AC and DC power sources to feed the auxiliary circuits of the switching equipment during the performing of thousands of opening and closing cycles.

All the testing equipment, with the relative main ratings, of the Mechanical testing facility are listed in Annex 1 at page 58.

2.2 Stage 2 Option A

2.2.1 High-Power MV testing facility and Transformer testing facility

Both these facilities shall be powered by a 2500 MVA 3-phase Short-circuit Generator with 17.5 kV output voltage. This Generator feeds a MV/MV Transformer bank consisting of 3 single phase 900 MVA Short-circuit Transformer with 17.5 kV primary voltage and four secondary voltage at 10 kV (see the block diagram of Fig. D4-6). A Ratio Changer, consisting of a number of motor operated disconnectors connecting in series or in parallel the secondary windings of the three Transformers, makes available the secondary voltages of the bank in the range $3,6 \div 40$ kV that through switched on/off disconnectors can alternatively supply two High-Power MV testing facilities or the Transformers testing facility. The choice of two High-Power MV testing facilities is related to the expected high demand of tests for this facility.

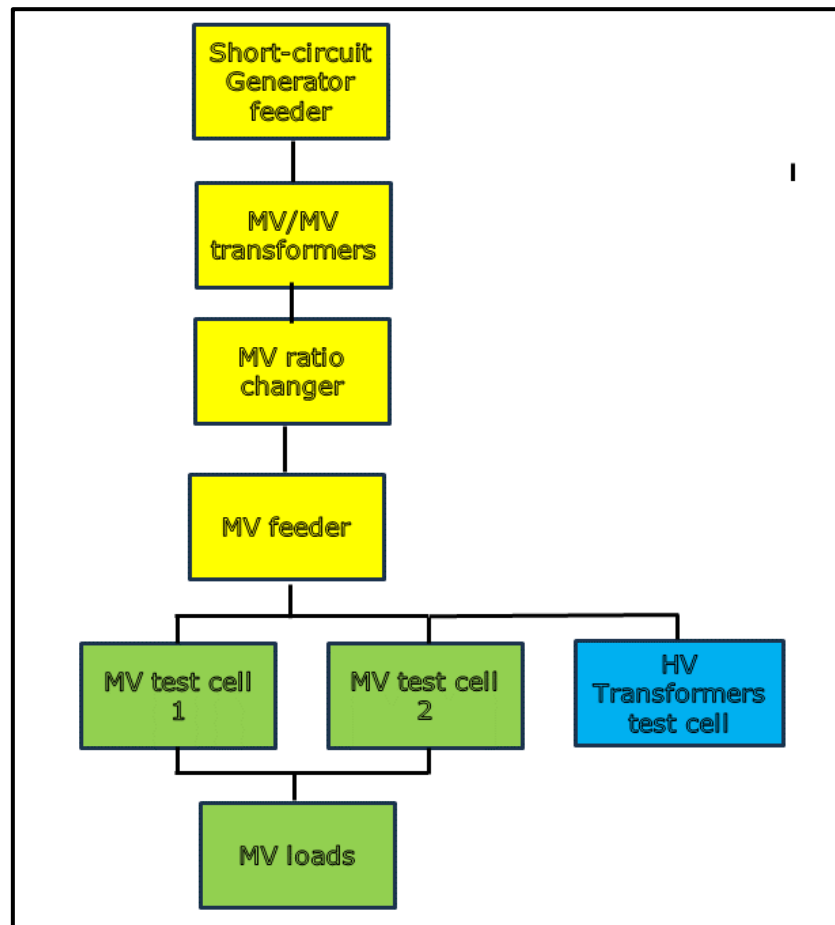


Figure D4 – 6 – Block diagram of the Stage 2 configuration

The Transformers testing facility is an outdoor area addressed to perform the ability to withstand short-circuit on:

- Distribution Transformers having:
 - primary voltage up to 13.8 kV and 0.4 kV secondary voltage, short-circuit impedance from 2,5% up to 4% and rated power up to 2,5 MVA,
 - primary voltage 33 kV and 0.4 kV secondary voltage, short-circuit impedance from 4% up to 7% and rated power up to 5 MVA;
- Power Transformers with:
 - primary voltage 33 kV and 11 kV secondary voltage, short-circuit impedance from 4% up to 8% and rated power up to 28 MVA,
 - primary voltage 66 kV and 11 kV secondary voltage, short-circuit impedance from 7% up to 10% and rated power up to 28 MVA,
 - primary voltage 132 kV and 11 kV secondary voltage, short-circuit impedance from 15% up to 22% and rated power up to 50 MVA,
 - primary voltage 132 kV and 33 kV secondary voltage, short-circuit impedance from 15% up to 22% and rated power up to 50 MVA.



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The two High Power MV testing facilities is addressed to perform:

- all the type tests on MV equipment with rated voltage from 3.6 kV up to 36 kV and rated current up 6300 A³,
- the short-time current tests (up to 6.3 kA), the short-circuit current test (up to 1500 MVA of required short-circuit power), the test for accuracy and the internal arc fault test on Current, Voltage and Combined Transformers with rated voltage up to 36 kV.

The below Fig. D4 - 7 shows the single line diagram of the Stage 2 configuration, starting from the Short-circuit Generator system until the three testing facilities.

The Internal Arc Tests to be carried out on MV Switchgears and Controlgears and on Instrument Transformers have to be executed in an appropriate containment structure located outside and in the vicinity of the High-Power MV testing facility.

All the testing equipment, with the relative main ratings, of the High-Power MV testing facility are listed in Annex 2 at page 60.

2.2.2 High Voltage testing facility

Additional test equipment shall be installed in this facility to allow:

- all the tests⁴ (excluding the short-circuit tests performed in Transformer testing facility) on Transformers with rated power up to 160 MVA,
- the dielectric test on:
 - Current, Voltage and Combined Transformers with rated voltage up to 400 kV⁵
 - Ceramic, glass and polymeric insulator with rated voltage up to 400 kV⁶
- the dielectric test on Power Cables with rated voltage up to 400 kV⁷ while the Heating cycle voltage in prequalification tests of Power cables with rated voltage higher than 36 kV are to be carried out in the HV Power Cables testing facility.

All the additional testing equipment, with the relative main ratings, of the High Voltage testing facility are listed in Annex 2 at page 61.

³ For a detailed list of the tests performed on MV equipment see D3-1: National Testing Laboratory Feasibility Study, rev.1, Annex 1, pag.37.

⁴ See D3- 1: National Testing Laboratory Feasibility Study, rev. 1, Annex 1, pag.39 for Stage 2 Option A and Stage 2 Option B.

⁵ See D3-1: National Testing Laboratory Feasibility Study, rev.1, Annex 1, pag.40.

⁶ See D3-1: National Testing Laboratory Feasibility Study, rev.1, Annex 1, pag.41.

⁷ See D3-1: National Testing Laboratory Feasibility Study, rev.1, Annex 1, pag.42.

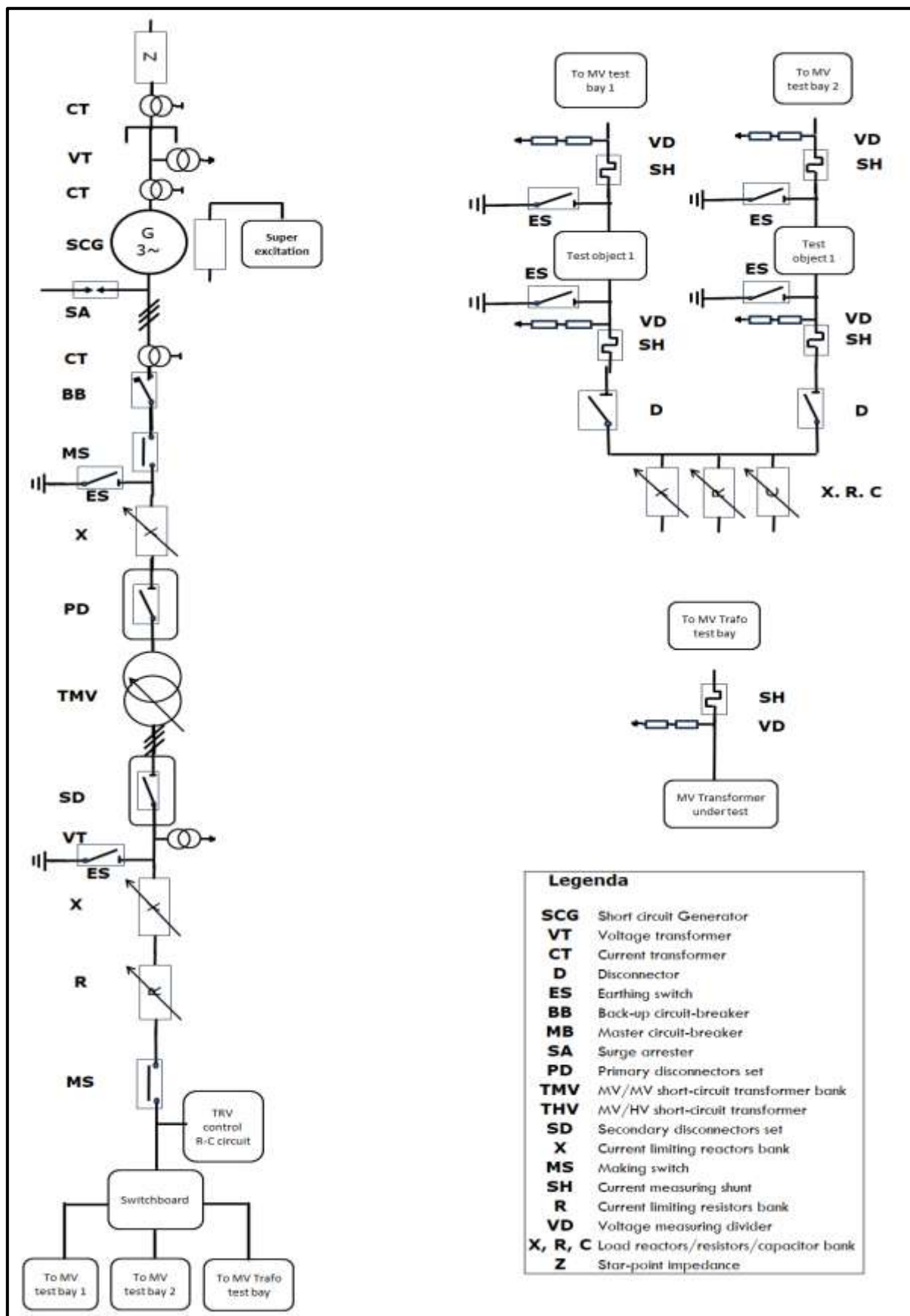


Figure D4 – 7 – Single Line diagram of the Stage 2 configuration-Option A

2.2.3 High Voltage Power Cables testing facility

For Power Cables with voltage ratings above 36 kV and up to 400 kV the Standards requires prequalification tests aimed to check their long-term reliability. The cable, approximately 100 m in length with relevant accessories (terminals and joints), is to be installed under various laying conditions (such as direct buried, rigidly installed in a tunnel, installed in a duct, etc.) similar to the foreseen operating ones.



Figure D4 – 8 – Construction of the test side for the prequalification tests of Power Cables with rated voltage above 170 kV

During one year a testing voltage equal to 1,7 times the rated voltage is to be applied to the cable while the test loop is to be subjected to thermal cycles. During the heating cycle voltage test the cable is to be heated to a temperature slightly above the maximum operating conductor temperature. The minimum duration of a heating cycle is 24 hours: a minimum of 8 hours for heating and a minimum of 16 hours for natural cooling. The total number of heating cycles are to be not less than 180 that are to be carried out during the one year. A lightning impulse voltage test on one or more cable samples taken from the test set-up an examination of the cable system must be performed.

All the testing equipment, with the relative main ratings, of the High Voltage Power Cables_testing facility are listed in Annex 2 at page 62.

2.3 Stage 2 Option B

This option of the Stage 2 configuration extends the capability of the Laboratory to be able to perform the following type tests:

- the ability to withstand short-circuit on Power Transformers with rated power up to 160 MVA, primary voltage up to 260 kV and secondary voltage in the range 65-260 kV;
- the short-time current test, the short-circuit test, the test for accuracy and the internal arc fault test on Current, Voltage and Combined Transformers with rated voltage up to 260 kV, short-time current up to 6300 A and requiring a maximum short-circuit power of 1500 MVA.

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For these purposes the Transformer testing facility is to be equipped with a 1500 MVA Short-circuit Transformer having 17,5 kV primary voltage and four secondary windings at 65 kV. This Transformer is fed by the 2500 MVA 3-phase Short-circuit Generator through switched on/off disconnectors. At the secondary side of the Transformer a Ratio Changer system allows to obtain the required testing voltage by series or parallel connecting of the four secondary windings.

The single line diagram of the Stage 2 configuration with Option 2 is shown in Fig. D4 – 8 while the additional testing equipment for this Option B are listed, together with their main ratings, at page 63 of Annex 2.

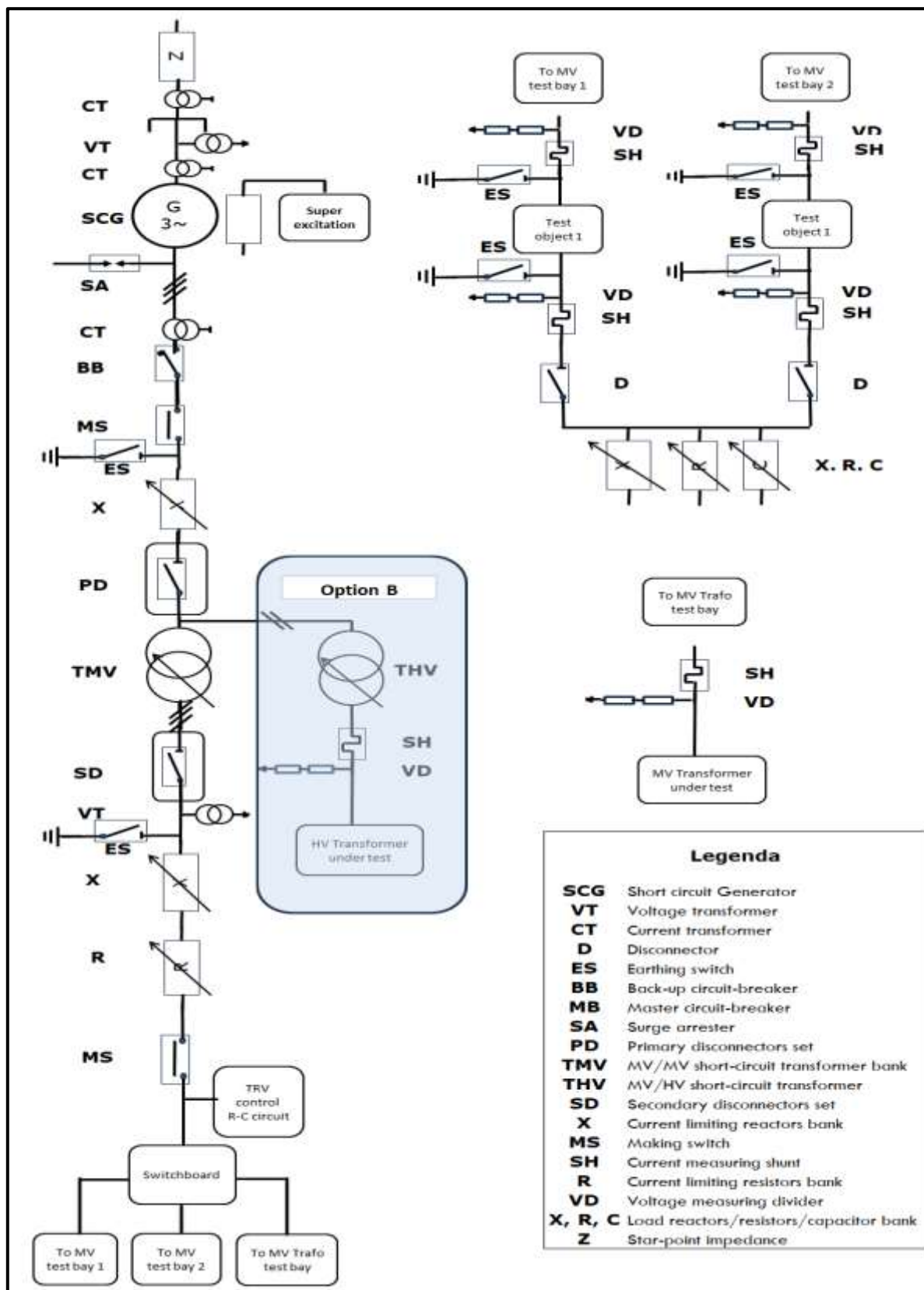


Figure D4-9– Single Line diagram of the Stage 2 configuration with Option B



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3. Evaluation of Capital Expenditure for Testing Laboratory building

The assessment of the capital cost related to the establishment of the National Testing Laboratory is divided into two sections:

- the capital costs envisaged related to the engineering activities, purchasing, installation and commissioning of all the equipment specified in Annex 1 (for the Laboratory in the configuration of Stage 1) and Annex 2 (for the Laboratory in the configuration of Stage 2);
- the cost of civil works for the construction of all buildings and areas of the Laboratory for the two considered configurations (Stage 1 and Stage 2).

The costs reported in this Chapter are in current currency 2023 and are expressed in USD.

3.1 Engineering, procurement, installation and commissioning of the electromechanical equipment

It has been assumed that the building of the Laboratory is assigned to an EPC Contractor which is fully responsible for the design, procurement, installation and commissioning of the electromechanical equipment of the Laboratory on the basis of a detailed scope of work. This solution is often applied in the power industries and almost always in the case of large testing laboratory.

The Consultant has estimated the costs of the equipment specified in the previous Chapter on the basis of supply prices by international manufacturers. On these prices the EPC Contractor usually applies a mark-up for its assessment of the cost of the work. Considering that some equipment (such as the Short-circuit Generator and the Short-circuit Transformers) have a preponderant role on the total cost of the Laboratory's equipment, it has been assumed that these components are purchased directly by the public body in charge of the Laboratory establishment. This has no impact on the final quality of the work because the know-how for the design and construction of such equipment is owned by some international manufacturers perfectly able to best meet the technical specification provided by the EPC Contractor. On the other hand, this solution allows a significant cost reduction.

3.1.1 The expenditure evaluation for the electromechanical equipment in the Stage 1 configuration

The estimated costs for the equipment of the Laboratory in Stage 1 configuration are listed in Annex 3. The below Table D4 – 1 summarizes the overall cost the equipment for each of the testing facilities specified in the previous paragraph (High Power LV-MV, High Voltage, Temperature rise and Mechanical) and the Auxiliary Facilities⁸:

- Assembly and Disassembly Hall for Distribution and Power transformers,
- Calibration room,
- Workshop and Warehouse facilities,
- the Utilities facility and the related General Services for the Laboratory.

The listed costs include:

- the procurement costs based on the supplied prices of international manufacturers,
- the transport costs to the Laboratory site,
- the EPC Contractor charge for engineering, installation, commissioning and mark-up,

and doesn't include any importation or local tax.

⁸ See D3-1: National Testing Laboratory Feasibility Study, rev. 1, paragraphs 6.1 and 6.2.

Tab. D4 - 1 Expenditure [Million USD] for equipment in Stage 1 configuration	High Power LV/MV	High Voltage	Temperat. rise	Mechanical	Auxiliary Facilities and General services
Equipment procurement	14.468	1.787	0.849	0.415	0.703
Transport	0.579	0.071	0.034	0.017	0.028
On site installation and commissioning	1.013	0.125	0.059	0.029	0.049
EPC charge on procured equipment	1.461	0.364	0.171	0.084	0.142
EPC charge for engineering and project management	0.803	0.198	0.094	0.046	0.078
TOTAL	18.324	2.542	1.207	0.591	1.000

3.1.2 The expenditure evaluation for the electromechanical equipment in the Stage 2 configuration

Three further testing facilities are to be considered in the Stage 2 configuration of the Laboratory:

- High Power MV testing facility
- Transformer testing facility
- High Voltage Power Cable testing facility

and additional testing equipment in the High Voltage testing facility to cope with higher test ratings. Moreover, the Option B for this Laboratory configuration requires a dedicated MV/HV Short- circuit transformer (see paragraph 2.3).

The estimated costs for the additional equipment of the Laboratory in Stage 2 configuration are listed in Annex 4 and the below Table D4 – 2 summarizes the overall cost the equipment for each additional testing facility.

Tab. D4 - 2 Expenditure [Million USD] for equipment in Stage 2 configuration	High Power MV facility and Transformer facility	Improving of High Voltage facility	HV Power Cables facility	Transformer facility (Option B)
Equipment procurement	31.386	2.888	0.710	9.216
Transport	1.255	0.115	0.028	0.369
On site installation and commissioning	2.197	0.202	0.050	0.645
EPC charge on procured equipment	1.584	0.583	0.143	0.186
EPC charge for engineering and project management	0.871	0.320	0.079	0.102
TOTAL	37.293	4.108	1.010	10.518

3.2 Estimated costs for the Civil works

For the Civil works it has also been considered the assignment to an EPC Contractor which is fully responsible for the design and construction of all the buildings and relevant services (lighting, air conditioning, shower and dressing rooms, etc). In case of offices, canteen, Auditorium and Residential facility the EPC Contractor has to provide and set up all interior fittings and furnishings.

Considering the two stages of Laboratory Development, for the Stage 1 it has been evaluated the costs for the involved testing facilities but also those related to all the auxiliary civil infrastructures (such as canteen, Auditorium, etc.) in order to assure from the beginning a complete operativity of the Laboratory.

For the estimation of the civil works cost reference was made to the price catalogues of GT Engineering company (Dhaka).

Table D4 – 3 shows the plan dimensions and heights of the different buildings of the Laboratory resulting from the defined layout⁹ with the corresponding unitary and overall cost.

Similarly, Table D4 – 4 lists the evaluated costs for Stage 2.

⁹ See D3-1: National Testing Laboratory Feasibility Study, rev.1, Fig. D3-1-2 in Chapter 7.

Table D4 – 3 - Cost of Civil Works for Stage 1 configuration of the Laboratory

Buildings and Areas	Sizes [m]	Surface [m ²]	Heigh [m]	Unitary price [USD/m ²]	Total price [USD]
230 kV Substation	95x15	1425	- ⁽¹⁾	200	285,000
HV/MV Transformer Bank and Ratio Changer	20x15	300	- ⁽¹⁾	200	60,000
MV Switchgears and MV Reactors	20x15	300	10	540	162,000
MV and LV test cells and Control rooms	40x15	600	10	540	324,000
High Voltage testing facility	40x30	1200	10	540	648,000
Temperature rise testing facility	65x30	1950	25	540	1,053,000
Mechanical testing facility	30x15	450	8	540	243,000
	30x15	450	8	540	243,000
A/D Hall dor Distribution and Power Transformers	40x30	1200	15	540	648,000
Calibration	20x15	300	4	540	162,000
Workshop	25x8	200	5	540	108,000
Warehouse	65x15	975	15	540	526,500
Utilities building	50x30	1500	6	540	810,000
Direction (including furniture, PC,printers,etc)	20x15	300	4	870	261,000
Offices (including furniture, PC,printers,etc)	[40x15]x2	1200	10	870	1,044,000
Canteen	d=20	314	6	870	273,180
Residential Facility (including furniture)	[20x20]x2	800	10	870	696,000
Auditorium	30x30	900	10	870	783,000
Roads		19375	- ⁽¹⁾	250	4,843,750
Green areas		9000	- ⁽¹⁾	200	1,800,000
Car parking and porters		3500	- ⁽¹⁾	250	875,000
Subtotal for all the listed buildings and areas					15,848,430
Engineering & civil works management (10%)					1,584,843
Total Civil Works					17,433,273

(1) Outdoor area

Table D4 – 4 - Cost of Civil Works for Stage 2 configuration of the Laboratory

Buildings and Areas	Sizes [m]	Surface [m ²]	Heigh [m]	Unitary price [USD/m ²]	Total price [USD]
Short-circuit Generator Auxiliaries	30x20	600	10	540	324,000
Short-circuit Generator House	40x20	800	20	540	432,000
MV/MV Transformer	45x20	900	-(1)	200	180,000
Ratio Changer and MV Reactors	45x13	585	20	540	315,900
MV Busbar system, MV load and TRV circuit	45x20	900	15	540	486,000
High Power MV test cells	[15x10]x2	300	10	540	162,000
A/D Hall for MV equipment	[15x10]x2	300	10	540	162,000
High Power MV Control Room	40x15	600	5	540	324,000
Transformer testing facility	50x30	1500	-(1)	350	525,000
HV Power Cable testing facility	140x50	7000	-(1)	-	0
	20x20	400	8	540	216,000
MV/HV Transformer for Option B	30x15	450	-(1)	350	157,500
Subtotal for all the listed buildings and areas					3,284,400
Engineering & civil works management (10%)					328,440
Total Civil Works					3,612,840

(1) Outdoor area

3.3 Total capital expenditure for Testing Laboratory establishment

Table D4 – 5 summarizes the required capital costs for the two envisaged Stages of the National Testing Laboratory.

Table D4 – 5 – Testing Laboratory CAPEX

Capital Expenditure [Million USD]	Stage 1	Stage 2	
		Option A	Option B
Testing equipment	23.664	42.411	10.518
Civil works	17.433	3.440	0.173
Total	41.097	45.851	10.691



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4. Assessment of turnover trend for the Testing Laboratory

4.1 About the local testing market

The manufacturing industry in Bangladesh very partially covers the demand of the local power system. From the questionnaire filled by the Stakeholders results that the local electrical utilities purchase¹⁰:

- about 80% of the Low Voltage equipment (MCB, MCCB, RCD, RCCB, Assemblies, Cables) from domestic manufacturers;
- large portion (ranging from 60% to 80% for the different products) of the Medium and High Voltage equipment from international manufacturers (ABB, Siemens, Schneider Electric, Toshiba, Hitachi, CG Power, Genus, Hyosung, Shandong).

The above implies a very poor demand of testing services aimed at qualifying new products to be placed on the market. In other terms the **local testing market is not yet structured** and it has to be developed by means a political, legal and regulatory framework defined by the public institutions in collaboration with the main Stakeholders (both the manufactures and the electrical utilities that ultimately have to bear the costs related to the testing services).

On the other hand, Bangladesh, similarly to China 25-30 years ago or India 15 -20 years ago, is a country undergoing strong demographic and economic growth with an expanding electricity sector thanks to an ambitious investment plan (Vision 41 program) which can help the development of the local manufacturing sector.

The establishment of a National Testing Laboratory supporting the local manufacturing industry is a significant step forward in the development and production of electrical equipment capable of replacing those from the international market.

But it must not miss the push at Government level and by the electric utilities to request type tests on the equipment to be installed on the network. Otherwise the expected results will not be achieved. Cases of failure of this kind occurred in several countries.

The commercial success of **TERTEC** Low Voltage Laboratory (Taiwan) was achieved only after about ten years from its commissioning and when the Taiwanese Electricity Company pushed the local manufacturers to carry out tests in this laboratory.

CPRI commissioned at the end of 1990s a new Laboratory powered by a 2500 MVA Short Circuit Generator that began to be fully exploited for its potential when the Indian government has encouraged, trough incentives, Indian utilities to use the laboratory by large manufacturers (including BHCL, Compton Greaves).

4.2 About the price policy of the testing services

It should be emphasized that the **pricing policy of the Testing Laboratory will have to be based exclusively on the market considerations** (prices of the competitors for the requested services) and not on the costs related to test execution.

¹⁰ See the Deliverable 2-1: Conceptual configuration of the Testing Laboratory, rev. 1, paragraph 3.1.



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The price policy of the Laboratory has to be discussed and agreed between the Top Management and the main Stakeholders, including the local manufacturers and the public electrical utilities that ultimately have to bear the cost for the testing services.

The following considerations must be taken into account when defining the price policy:

- at the beginning of the Laboratory commercial operation, the reference prices must be lower than those of CPRI which has already laboratories known at International level;
- the price may increase only when the brand of the Bangladesh Testing Laboratory gets stronger on the market and comparable with the competitors;
- to encourage the use of the Laboratory by local industry, the price for development tests required during the development of new products must be lower than those related to type tests performed on the final product before its placing on the market;
- multi-year framework Agreements with the main manufacturers able to define the number and type of tests to be carried during the year must be favoured, also by decreasing prices as the number of the required testing services increases.

The Consultant proposes that at the beginning of the commercial operation the prices practiced by the Laboratory must be at least 20% lower than those of CPRI and at least 35 - 40% lower than those of the most important international laboratories (such as CESI-Kema and Keri).

The suggested reference price for the type tests of some equipment are listed in Annex 5.

It has to be outlined that the defined pricing policy will **constitute a price list for internal use only**. The price proposed for a required testing service have to take into consideration the potential competitors and the specific characteristics of the customer.

The proposed price to a customer may also be significantly different (increasing or decreasing) from that proposed to other customers for similar services.

The Laboratory **will not offer for a specific testing service the same price for all customers**.

An effective explanation of how a competitive analysis may lead to an appropriate and more convenient price concerns the 'gross price' related to the execution of a type test. In addition to the price for the type test the manufacturer must bear the cost for the equipment transport to and from the testing laboratory as well as the cost for the technicians in charge of assembly and disassembly of the equipment and test witnessing.

The 'gross cost' is the sum of all this cost and it may be much greater than the 'net cost' related to type test execution. For large power transformer the transport cost is comparable to 'net cost'. The performing of the type test in the local laboratory, in so avoiding large part of the complementary costs, can be offered at higher price still allowing benefit for the customer.

4.3 The services offered by the Testing Laboratory in its development path.

The Testing Laboratory portfolio include three services interconnected with each other:

- **the testing services**, including the type tests performed on the prototype of a new product before its placing on the market and the development tests required by the manufacturers during the developing phase of the new product;

- **the inspection service** that are complementary to the type test and in any case an important lever for testing activities; in a type test program of an equipment the Standard require that some tests (such as short-circuit tests) must be carried out in an independent testing laboratory while for other tests (e.g. dielectric and mechanical tests) allow that they can be carried out in accredited laboratories of manufacturers provided that an inspector witness the test provided that an inspector attends the test after verifying that it is performed in accordance with Standards; moreover, in the initial phase during which the Laboratory is under construction some tests could be carried out in other laboratories and witnessed by an inspector; it should be noted that the National Testing Laboratory may perform the inspection activities through their own inspectors or involving reputable bodies already existing;
- **the engineering services** that may be supplied after some years of operation and related experience and skills of the Laboratory staff acquired in testing several types of equipment; these services are mainly addressed to the following clients:
 - Manufacturers, in supporting the development of equipment, especially in the event of test failure;
 - Electrical Utilities, supporting them in the preparation of the purchase specifications of the equipment, paying particular attention to the specifications of the tests (Type Tests and Acceptance Tests) that must be carried out on the purchased equipment.

Considering the Testing Laboratory development through subsequent phases, these three services will have different evolution.

During the **Phase 0**, starting with the decision to establish the Laboratory (T_0 time) and lasting 3 years, in parallel of the different processes related to the building of the different testing facilities, inspection services can be carried out by the Laboratory through their own inspectors or involving reputable bodies already existing.

In the **Phase 1**, lasting 3 years, all the testing facilities of the Laboratory in the Stage 1 configuration can supply testing services as well as the inspection services.

At the end of the sixth year from the time T_0 , the Stage 2 configuration will be also commissioned and the Laboratory, in this **Phase 2**, will be fully commercial operating and may start also the engineering services.

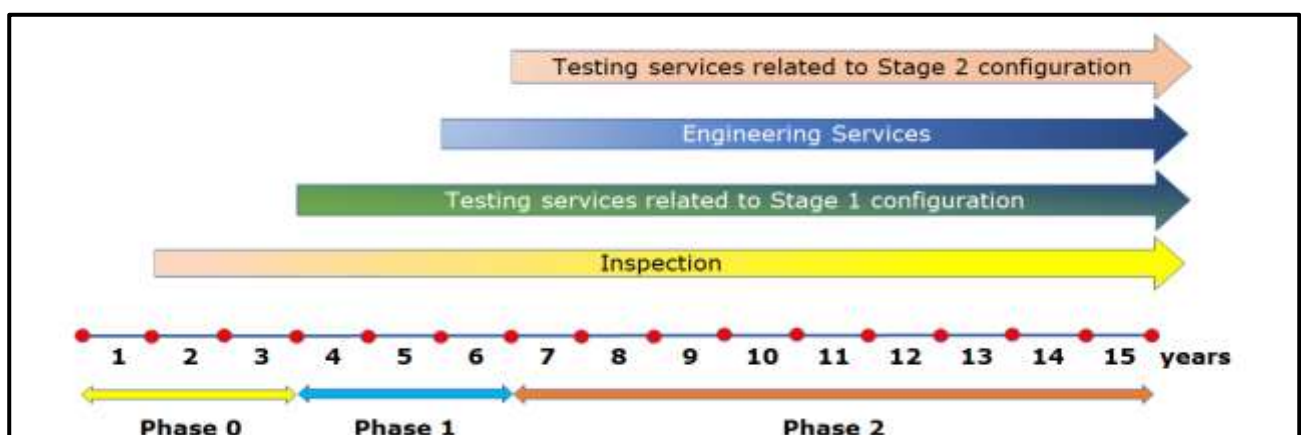


Figure D4 – 10 – Services supplied by the Testing Laboratory during its first 15 years

4.4 Turnover of the Testing Laboratory

As stated at paragraph 4.1 the **local testing market is not yet structured** and therefore for the evaluation of the Laboratory turnover trend cannot be adopted the Bottom-up approach¹¹ based on the development plant of the manufacturing industry to cope the demand of equipment by the local power system.

The adopted solution by the Consultant consists in assuming the turnover trend of laboratories in country with a development rate of the local electromechanical industry similar to that expected in Bangladesh.

For the three services described at paragraph 4.3 the Compound Annual Growth Rates (CAGR)¹² listed in Table D4 - 6 have been considered for the different phases of the Testing Laboratory development.

Table D4 – 6 – CAGR of the testing Laboratory services over 15 years

	Inspection services	Engineering services	Testing services by Stage 2 configuration	Testing services by Stage 2 configuration
up to 6 th year	56%	-	60%	-
from 7 th up to 10 th year	16%	46%	24%	50%
from 11 th up to 15 th year	9%	27%	10%	18%

The following consideration applies to the data of Table D4-6:

- the growth of inspection services and engineering services is linear over time: the former starts from the second year while the latter only from the seventh year after the experience and skills of the laboratory staff has reached an adequate level,
- the growth from the 3rd to the 6th year of the testing services provided by the facilities of stage 1 of the laboratory is related to the need to submit to type tests the LV voltage equipment already produced by local manufacturers (about 60% of this equipment purchased by public electrical utilities is produced by the local industry),
- the higher prices of the testing services provided by the facilities of stage 2 compared to them provided by the facilities of stage 1 determine their greatest growth in the period from the 10th to the 15th year.

The revenues related to the different services, expressed in current currency 2023 and derived from Table D4-6 are below listed in Table D4 -7. Fig. D4 -11 shows the total yearly turnover in the first 15 years of the Laboratory operation.

¹¹ See the Deliverable 2-3: Testing market assessment and direct & indirect benefit evaluation, rev.1.

¹² CAGR (Compound Annual Growth Rate) measures the compound annual growth rate of an investment or of company business.

Table D4 – 7 – Yearly turnover of the Testing Laboratory [Thousand USD]

Year	Inspection services	Engineering services	Testing services by Stage 1	Testing services by Stage 2	Yearly turnover
Phase 0	1	0	0	0	0
	2	24	0	0	24
	3	56	0	0	56
Phase 1	4	84	0	230	314
	5	113	0	398	511
	6	142	20	598	760
Phase 2	7	171	31	797	1444
	8	199	46	997	1958
	9	228	67	1198	2585
	10	257	93	1399	3249
	11	286	125	1600	3951
	12	315	161	1802	4689
	13	343	203	2004	5464
	14	372	250	2207	6276
	15	401	303	2410	7127

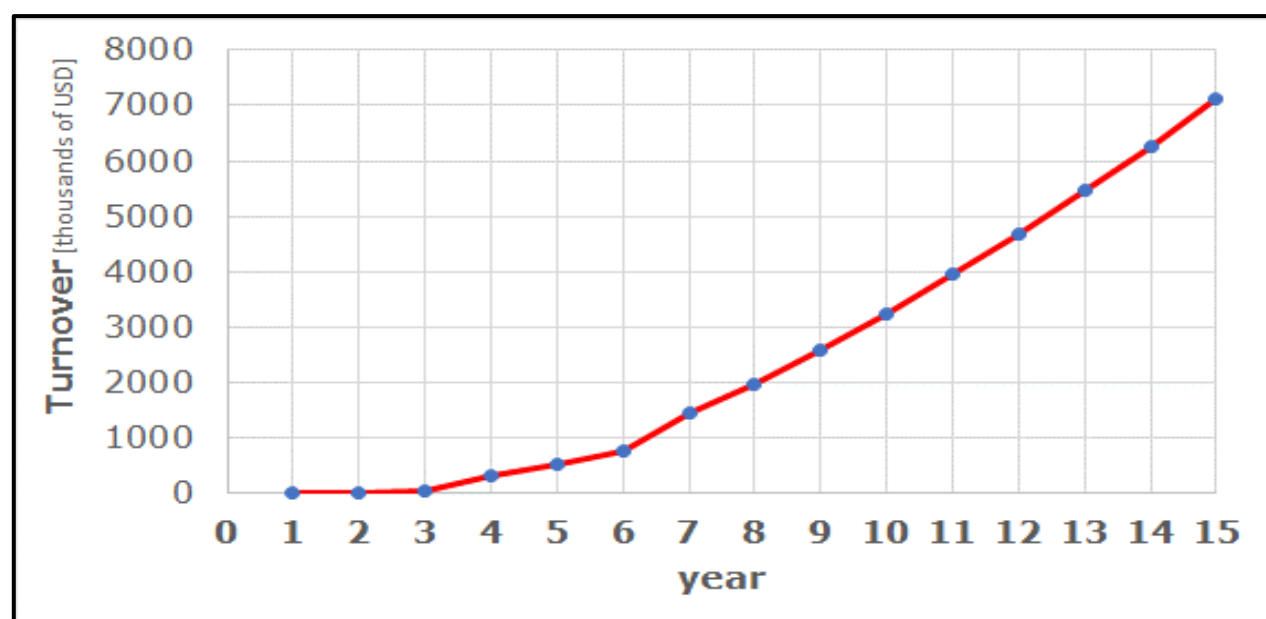


Figure D4 – 11 –Testing Laboratory turnover

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It has to be outlined again that the estimated revenues shown in the above Figure and in Tab. D4 – 7 have been evaluated on the basis of turnover trend of laboratories in country with a development rate of the local electromechanical industry similar to that expected in Bangladesh. **They have to be considered as a possible target to be achieved** only through the push at Government level and by the electric utilities to request type tests on the equipment to be installed on the network.

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5. Operating costs of Testing Laboratory

5.1 Staff Cost

The following Table D4-8 summarizes the cost of all the Operational Functions¹³ of the Test Laboratory, for each of which the personnel necessary to perform the assigned task has been defined in terms of quantity and required skills.

The staff of the Testing, Inspection, Engineering services Function, the most numerous one, has been defined on the basis of the expected revenues at 10th year of Laboratory operation, that is 4 year following the commissioning of the Stage 2 configuration. The staff of the function will certainly be lower both during Phase 0 (in which the construction of the laboratory is in progress) and Phase 1 (where the only testing facilities of Stage 1 are operational). On the other hand, the staff of the function will grow in the years from 10th to 15th of the operation period of the Laboratory and therefore the staff considered in Table D4-8 can be assumed as the average over 15 years.

The staff of the Function covers all the provided services: there are no employee dedicated to only one of the three services considering that both the inspection activities and the engineering services require testing skills to be carried out effectively. In the same way the personnel engaged in the testing activities must be able to operate on at least 3 of the existing testing facilities (one of which must necessarily be one of the three High Power testing facilities) in order to ensure an efficient resources employment in relation to the market demand.

Therefore, all other functions have been defined with reference to the 10th year of Laboratory operation period.

As regards the annual cost of each professional figure, reference was made to that of public utilities in Bangladesh, considering all the items contributing to the actual annual cost. In addition to the basic salary were taken into account the costs related to the Festival bonus, the house rent provision and the different allowances (transportation, medical, contributory provident fund, educational) until the full-time vehicle facility for the top-level managers.

In line with the previous evaluation of the expected revenues, the staff cost is in current currency 2023.

¹³ See D3–2: National Testing Laboratory Organization, rev.1

Table D4 – 8 – Staff cost of the Testing Laboratory

Function/Employees	Number of Employees	Employee annual cost [USD]	Total cost [USD]
Managing Director	1	44000	44000
Testing, Inspection, Engineering services			
Executive Technical Director	1	32000	32000
Responsible of testing services	1	17000	17000
Responsible of inspection services	1	17000	17000
Responsible of engineering services	1	17000	17000
Senior engineer (Short circuit Generator)	1	14000	14000
Test engineer	4	14000	56000
Test operator and inspectors	12	11000	132000
Workman	12	6000	72000
Quality management			
Manager	1	21500	21500
Senior engineer	1	14000	14000
Junior engineer	1	11500	11500
Organization and human resources			
Executive Director	1	32000	32000
Senior engineer	1	14000	14000
Commercial & Communication			
Executive Director	1	32000	32000
Senior engineer	5	14000	70000
Administration & General services			
Executive Director	1	32000	32000
Facility management			
Senior engineer	1	11000	11000
Junior engineer	2	11500	23000
Security guard	3	4800	14400
Cleaner	4	4500	18000
Procurement			
Senior engineer	1	11000	11000
Junior engineer	2	11500	23000
Administration			
Senior Accountant	1	21500	21500
Junior Accountant	2	7000	14000
Audit Accountant	1	7000	7000
Other Services			
Security guard	3	4800	14400
Cleaner	4	4500	18000
Total	70		803300

5.2 Consumables

The main part of these costs is related to the energy consumption:

- the electricity powering the testing facilities,
- the electricity for lighting the buildings and the areas of the Laboratory,
- energy for air conditioning of the buildings.

Other consumable costs concern the:

- water consumption and fuels for vehicles.
- protective clothing (gloves, coveralls, etc.) for the personnel involved in testing activities,
- lubricants, cleaning detergents, office supplies,

that can be evaluated in 150,000 USD/year.

Overall the costs related to energy consumption are around:

- 8% of the revenues coming from the testing facilities supplied by the network (all those of the Stage 1 configuration and the HV Power Cables facility)
- 12 % of the revenues coming from the testing facilities supplied by the Short-circuit Generator (the High-Power MV and the Transformer facilities).

Considering all the Testing Laboratory revenues over the period of 15 years:

- 18.478 Million USD related to Stage 2 configuration,
- 15.640 Million USD related to Stage 1 configuration,
- 4.290 Million USD related to inspection and engineering services,

an average value of 8,75% of the yearly revenue may be assumed.

The below table lists the estimated cost, in current currency 2023, for consumables over the 15 years of Testing Laboratory operation period.

Table D4 – 9 – Consumable cost of the Testing Laboratory

year	Revenues [Thousand USD]	Consumable costs [Thousand USD]
1	0	150
2	24	152
3	56	155
4	314	177
5	511	195
6	760	216
7	1444	276
8	1958	321
9	2585	376
10	3249	434
11	3951	496
12	4689	560
13	5464	628
14	6276	699
15	7127	774

5.3 Maintenance cost

La maintenance costs of the testing equipment and buildings may, including the cost of repairing works and of spare parts, may be evaluated equal to:

- 1% of the involved capital cost in the first operation year after the completion of the construction,
- 2% of the involved capital cost in the 10th operation year after the completion of the construction,
- 3% of the involved capital cost in the 15th operation year after the completion of the construction.

Considering the year of operation of the buildings and facilities and the relevant involved capital cost, the resulting maintenance over the period of 15 years of Laboratory operation are listed in the below Table D4 - 10.

Table D4 – 10 – Maintenance cost of the Testing Laboratory

Laboratory configuration	Stage 1		Stage2 with Option B		
Capital Expenditure [Mil. USD]	41,097		56,542		
year	Maintenance cost		Maintenance cost		Total Maintenance cost
	% of Capex	Amount [Thousand USD]	% of Capex	Amount [Thousand USD]	[Thousand USD]
1					0
2					0
3					0
4	1.00	411			411
5	1.05	434			434
6	1.13	462			462
7	1.21	497	1.00	565	1,062
8	1.31	538	1.05	597	1,135
9	1.42	584	1.13	636	1,220
10	1.54	633	1.21	684	1,317
11	1.68	690	1.31	741	1,431
12	1.83	752	1.42	803	1,555
13	2.00	822	1.54	871	1,693
14	2.16	888	1.68	950	1,838
15	2.35	966	1.83	1034	2,000

6. Gros Operating Margin of Testing Laboratory in its first 15 years

The below Fig. D4 -11 displays the Gross Operating Margin (EBITDA) resulting from data listed in the previous Tables from D4 - 7 up to D4 – 10.

Table D4 – 11 – Gros Operating Margin of Testing Laboratory

year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Revenues	0	24	56	314	511	760	1444	1958	2585	3249	3951	4689	5464	6276	7127
Staff cost	803	803	803	803	803	803	803	803	803	803	803	803	803	803	803
Maintenance cost	0	0	0	411	434	462	1063	1135	1220	1317	1431	1555	1693	1838	2000
Consumables	150	152	155	177	195	217	276	321	376	434	496	560	628	699	774
EBITDA	-953	-988	-902	-1077	-921	-722	-698	-301	186	695	1221	1771	2340	2936	3550

The trend of the Gros Operating Margin over the first 15 years of operation of the Testing Laboratory in shown in Fig. D4 – 12.

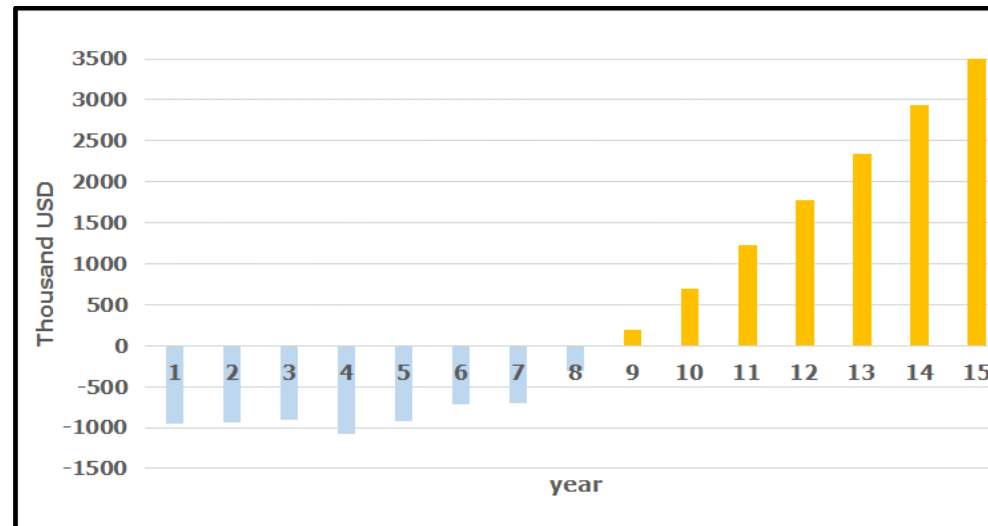


Figure D4 – 12 – Trend of Gros Operating Margin of Testing Laboratory



7. Legal issues related to the setting up of Electrical Testing Laboratory in Bangladesh

Objective of this Section is a review of the current laws, policies, regulations, standards, and practices pertaining the establishing of an Electrical Testing Laboratories and make recommendations for their statutory incorporation.

The adopted approach will be to first look at the acquisition laws in Bangladesh to acquire the land which is required in setting up the testing facility. Then, looking at the laws in relation to setting up a testing facility according to the national laws.

7.1 Acquisition Laws

Anytime an organization believes it needs to occupy land or other mobile property, it must first submit a written request for requisition and transfer of the property to the Ministry of Land through the relevant ministry. The application should also include a detailed statement outlining the area of the land, the probable uses for the site, as well as other information. The application is examined by the Ministry of Land before being forwarded to the relevant Deputy Commissioner for further action. The Additional Deputy Commissioner (Land) is then given the go-ahead by the Deputy Commissioner to create and carry out a requisition plan.

The Deputy Commissioner must specify if there is any infrastructure or construction for purposes against public interest on the land.

The Additional Deputy Commissioner (Land) is then given the go-ahead by the Deputy Commissioner to create and carry out a requisition plan. With a view to resolving concerns connected to payment of compensation to the owner or owners of the property or any other person or persons entitled to compensation, as well as any other relevant issues, the Additional Deputy Commissioner in turn makes a public notice regarding the request. He creates plans for the payment of compensation based on the property's average market value over the previous twelve months.

Compensation must be given to the owner or owners of the property who have been determined in compliance with legal requirements in cases of requisition. Additionally, the government's decision in cases of requisition of movable property is regarded as final. The property owner is entitled to compensation calculated in accordance with the rules. All constructions, buildings, corridors, huts, trees, or standing crops thereon are covered by this settlement. An appeal can be made in instances of any issues with the Commissioner within seven working days, everyone has the right to object to a request in writing. After giving the applicants a chance to speak, the Deputy Commissioner gives a decision within 15 days. This decision is final.

7.1.1 Acquisition of land

As per Section 14 of The Electricity Act 2018 if acquisition of land is required for establishment of testing lab, it shall be deemed to have been necessary for public interest and the existing laws and regulations on acquisition of land shall have to be followed. If any private company holding license requires any land



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for constructing any testing lab the licensee may purchase or acquire such land from the concerned land owner in accordance with the existing laws and regulations regarding land acquisition.

7.2 The Electricity Act

Under the Schedule of the Electricity Act of 1910 the following provisions were made regarding testing and inspection.

7.2.1 Licensee to establish testing stations and keep instruments for testing.

XIII. The licensee shall establish at his own cost and keep in proper condition such number of testing stations, situated at such places within reasonable distance from any distributing main, as the Government may direct for the purpose of testing the pressure or periodicity of the supply of energy in the distributing main, and shall supply and keep in proper condition thereat, and on all premises from which he supplies energy, such instruments for testing as an Electric Inspector may approve, and shall supply energy to each testing station for the purpose of testing.

XIV. The licensee shall afford all facilities for inspection and testing of his works and for the reading, testing and inspection of his instruments, and may, on each occasion of the testing of his works or the reading, testing or inspection of any instruments, be represented by an agent, who may be present, but shall not interfere with the reading, testing or inspection.

XV. On the occasion of the testing of any works of the licensee by an Electric Inspector reasonable notice thereof shall be given to the licensee; and the testing shall be carried out at such suitable hours as, in the opinion of the Electric Inspector, will least interfere with the supply of energy by the licensee, and in such manner as the Electric Inspector may think fit; but, except under the provisions of an order made in each case in that behalf by the Government, the Electric Inspector shall not be entitled to have access to, or interfere with, the works of the licensee at any points other than those at which the licensee himself has access to the same: Provided that the licensee shall not be held responsible for any interruption or irregularity in the supply of energy which may be occasioned by, or required by the Electric Inspector for the purpose of, any such testing as aforesaid: Provided, also, that the testing shall not be made in regard to any particular portion of the works oftener than once in any three months, unless in pursuance of an order made in each case in that behalf by the Government.

The updated Electricity Act of 2018 made such provisions in the body or the schedule.

7.2.2 Civil Works and related issues

If any licensee is permitted to establish any electrical testing equipment within the area of supply or, subject to the terms of his license, beyond the area of supply, the licensee may, as soon as may be, do necessary civil works, with intimation to the concerned person or the local authority, as the case may be, for supplying electricity to that area. In case of doing civil works on, below, along or across road or any part thereof, railway, canal or waterway or underground, the licensee shall have to give written notice to the person concerned or the local authority. On receiving notice under the above provision,



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the person or local authority, if aggrieved, may prefer an appeal to the Government, and the licensee may do civil works after the disposal of such appeal.

A) Laying of power supply lines adjacent to underground drains, pipes or existing power supply lines or civil works

The activities of laying power supply lines or doing civil works adjacent to underground drains, pipes or existing power supply lines or civil works shall be rendered in such manner as may be prescribed for the establishment of electrical equipment testing.

B) Reconstruction of damaged roads, railways, underground drains, sewers, tunnels

If any road, railway, underground drain, sewer or tunnel is damaged in consequence of civil works, the part excavated shall have to be filled up by soil, the part damaged shall have to be repaired and the garbage shall have to be removed immediately after such works as before.

C) Notice to telecommunication and internet service providers

If any licensee intends to carry out any new civil works or repair or modification thereof on any service line or power supply line running through any part of telephone or internet lines, he shall issue notice in writing to the concerned telecommunication or the internet service provider agency regarding such works.

D) Compensation

If any damage, harm or inconvenience is caused while doing civil works under this Act for the purpose of establishment of testing lab, the licensee shall, in such manner as may be prescribed by rules, pay compensation to the person affected or the owner of the land affected for acquiring land for construction of testing lab. If any dispute arises from the amount payable as compensation under the above provision, the provisions of the Commission Act shall apply to settle such dispute.

E) Protection and Safety Measures:

Protection of railways, highway, airports, waterways, channels, docks, wharves and jetties and pipes- No licensee shall harm or obstruct or interfere with railways, highways, airports, waterways, channels, docks, wharves and jetties and pipes, during establishment of testing lab and shall, in co-ordination with the concerned authority, take measures for protection and safety of the same.

F) Protection of telegraph, telephone, internet or electromagnetic signal emitting lines

The licensee shall take all logical precautions during construction establishment of testing lab and doing civil works so as not to have any harmful effect on the communication system of telegraph, telephone or electromagnetic signal emitting lines by way of induction or any other means.

G) Notice of accidents and investigation

If any accident occurs or any risk arises due to construction the person affected or the person having knowledge of it, as the case may be, may give notice in writing to the Authority of such incidence or damage.



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Explanation: for carrying out the purposes of this Act, 'Authority' means the Chief Electricity Inspector or any Authority specified by the Government, from time to time. The Authority shall, on receipt of notice under the above provision, conduct investigation in such manner as may be prescribed.

H) Chief Electricity Inspector and Electricity Inspector

The Government may, by notification in the official Gazette, appoint a Chief Electricity inspector and such other Electricity inspectors as may be deemed necessary. The appointment, duties, powers and conditions of service of the Chief Electricity inspector and Electricity inspectors shall be prescribed by rules.

7.3 Electricity Rules 2020

The Government of Bangladesh may establish electrical equipment testing laboratory in Bangladesh. The transformer and other private electrical equipment preparer company may test their prepared electrical equipment in the established testing laboratory and after that to receive the certification from the authority.

Any private company, all purchased electrical equipment's before purchase, must testify their electrical equipment and for that may pay the fee as prescribed by the Government of Bangladesh.

7.4 Environment

The owner must acquire both a location clearance certificate from the Department of Environment and an environmental clearance certificate from the Department of Environment in order to create a new industrial unit or project that is labelled yellow, orange, or red. Owners of industrial projects and units that fall under the green category only need to obtain an environmental clearance certificate. For industrial units and projects established in government and private export processing zones, economic zones, and industrial cities of Bangladesh Small and Cottage Industries Corporation, an exception applies. Regardless of how they are classified, they are only required to obtain an environmental clearance certificate; a location clearance certificate is not necessary.

The Bangladeshi government has released the Environmental Conservation Rules 2023 and immediately revoked the previous ones, which were passed in 1997, in order to lessen environmental pollution. Similar to the previous regulations, industrial projects and units are divided into four groups based on their environmental pollution levels and activities: green, yellow, orange, and red.

Orange denotes those that have a harmful effect on the environment and human health, and the effect must be reduced to maintain a healthy environment. Red denotes those in industries that have a severe impact on the environment and human health, which must be reduced to maintain a healthy environment. Green denotes lower environmental impact. Yellow denotes medium environmental impact. Without a location clearance certificate from the Department of Environment, no one is allowed to build infrastructure.

New industrial units or projects that are labelled as yellow, orange, or red cannot get gas, electricity, water, or other necessary services until they have secured a location clearance certificate.



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Location clearance certificates and environmental clearance certificates must be obtained from the district office or metropolitan office, as appropriate, if there isn't a Department of Environment office close to the industrial unit or project.

7.5 Conclusion and Recommendations

With these facilities established, labs will continue to play a vital role in how the nation goes forward in the electricity industry. It is thus important to maintain compliance with local rules and regulations. Failing to adhere to these procedures means facilities could face severe penalties, fines, and investigations. Documentation proves that all regulations and establishes compliance throughout the facility must be followed. It is recommended that getting all necessary documentation is obtained in addition to following all proper channels of establishment. It is suggested to take into account the land acquisition requirements.

In Bangladesh, establishing an electrical testing facility entails many legal considerations and regulatory compliance. Here are some important legal factors to remember, such as to register the business entity with the relevant government agencies, use business registration, acquiring a trading license from the municipality or local city corporation where the said facility is situated. With the help of this license, the company will have the right to legally operate in the specified territory. Environmental Licensing is crucial so the facility may have to get environmental clearance or permissions from pertinent environmental bodies depending on the size and environmental impact of the facility in respect with Bangladesh's laws and standards on electrical safety. It is important to make sure the testing equipment that is in use complies with all safety and certification standards. Make that the facility's building conforms with all applicable building codes, safety requirements, and fire safety laws. Particular regulatory approvals or certificates from appropriate government bodies depending on the kinds of tests conducted must also be taken into consideration.



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8. Environmental Aspects

8.1 Background

Over the last three decades, Environmental Assessment (EA) has become a major tool for effective environmental management. Over the years, the focus of EA changed towards making it a useful tool for environmental sustainability, which can be very effectively put to use to ensure that all important factors are included and unnecessary factors are revealed and dropped. This contributes towards ensuring that the environmental sinks and resources are not so excessively stressed as to cause any reduction in the assimilative capacity.

The proposed project comprises of construction and operation of high voltage electrical testing lab. Hence, a significant area of concern with the project relates to environmental issues. Therefore, it necessitates the environmental assessment to identify the principal requirements of the Project.

EA Study is conducted with the intention of incorporating environmental issues and concerns in this project; so that likely adverse impacts arising from project implementation are identified and mitigation measures are proposed early in the project implementation process.

As a part of the Interim Report for Feasibility Study, the environmental study is performed in order to give a brief idea about the basic environmental considerations required.

8.2 Policy, Legal Administrative and Regulatory Framework

8.2.1 Environmental Conservation Rules, DoE

The Project is committed to environmental protection in accordance with the existing environmental laws, rules and regulations of Bangladesh. The project authority is also keen to abide by the international conventions and standards for making the project environment friendly.

The Environmental Conservation Act (ECA, 1995) of DoE is the main legislative framework related to environmental protection in Bangladesh. This umbrella Act includes laws for conservation of the environment, improvement of environmental standards, and control and mitigation of environmental pollution. In accordance with this Act, the proposed project will need to be cleared by DoE before commencing the project following procedures given in the Environment Conservation Rules (ECR) 2023. ECR 23 classify the projects in to various categories (Green, Yellow, Orange and Red) for the purpose of environmental clearances. In ECR 2023, this project is not directly included in the project categorization list. However, initially it can be considered as Red Category Project based on the adverse impacts to be analysed in details during detailed design phase. The project categorization also can be finalized during the detailed design phase upon discussion with DoE, Bangladesh.

Formal guidelines in Bangladesh are set out in “Rules and Regulations under the 1995 Environmental Protection Acts” as published in the official Gazette on August 27, 1997. Any proponent planning an industrial project is currently required under Paragraph 12 of the Environmental Protection Acts, 1995 to obtain “environmental clearance:” from the Department of Environment.



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8.2.2 Bangladesh National Building Code (BNBC)

Bangladesh National Building Code widely known as BNBC Code is the ultimate code that is followed in Bangladesh to build safe houses and buildings. Earthquakes and wind effect of different building systems are incorporated in this code. Requirements of fire protection of different building systems are also incorporated in this Code under Part 4. Moreover, this code is almost similar to ACI code which is recognized as one of the most practiced building code of the world. However, there are some differences in that, it incorporates modifications by keeping in view the biological, environmental and geological factors in Bangladesh. Moreover, socio-economic factors have also been taken into consideration while preparing this code. This code is very helpful to the related professionals like architects and town planners as it takes into account the conditions specific to Bangladesh.

8.2.3 Firefighting System for Fire Protection

The design of Fire Fighting System in respect of fire safety as the functional usage requires building of large number of people at a single location and any emergency must be ensuring minimum disruption in operations.

A Fire Fighting system needs to be designed focusing the following consideration:

- Life safety of occupants;
- Property protection;
- Compliance with all relevant statutory requirements;
- Minimum disruption during emergency to the operations.

The design and planning of fire protection and detection shall be done keeping in view the following codes and standards (Latest editions):

- Bangladesh National Building Code (BNBC), 2006
- National Building Code: 2005 and local bylaws
- BIS: 3844, 15105, 2189 and other relevant standards
- Local Fire Authority
- NFPA 13, Sprinkler System
- NFPA 14, Hydrant System
- NFPA 72, Fire Alarm System
- NFPA 10, Fire Extinguishers

The proposed system needs to be included -fire hydrant, wet riser cum down comer, fire detection and alarm and fire extinguishers. As per BNBC any building more than two storied needs fixed firefighting equipment like hydrant system.

The matrix below summarizes fire safety rules and regulation in Bangladesh with requirements.

Table D4 -12: Fire Safety Rules and Regulation in Bangladesh

Sl. No	Aspect	Reference	Responsibility	Recommended Action
1)	Stairway Safety	Rule 54 (5), Bangladesh Labour Rules, 2015 3.10.5, Part 4, BNBC,	Base Building Authority	Make provision of a durable double handrails for both stairways. Such handrails to be made of non-conducting and fire-resistant material.
2)	Electrical Safety	NFPA-4.16.7.1; BNBC-2006, Part-8, 2.11.5.1	Base Building Authority	Rubber mat to be provided in front of DB/SDB.
3)	Electrical Safety	Code of Practice for the Electricity (Wiring) Regulations (2015)	Base Building Authority	All electrical cables to be properly organized and insulated.
4)	Fire Fighting Equipment's	In accordance with Bangladesh Labor Rules-2015, Rules-56, 55(7)	Base Building Authority	Authority to mark equipped with operational instruction in a language understood by all occupants in the building.
5)	Emergency Exits & Signage's	Section 62, Bangladesh Labour Act, 2006	Base Building Authority	Mark all exits with appropriate signages to ensure proper identification.
6)	Signage	NFPA, Chapter 14 Section 62, Bangladesh Labour Act, 2006	Base Building Authority	Install signage and user instruction for the hose reel and fire extinguisher.
7)	Maintenance	NFPA 25, Chapter 6 NFPA 10, Chapter 7	Base Building Authority	Establish an inspection, testing and maintenance procedure of the installed hydrant system as per NFPA 25. For fire extinguishers NFPA 10, Chapter 7 shall be followed.
8)	Risk Assessment	Bangladesh Labor Rules 2015, Section-58(3),58, 60	Base Building Authority	Authority to conduct risk assessment in the facility.
9)	Housekeeping Policy	BNBC 2006, Part 4, Appendix D20	Base Building Authority	To reduce or minimize fire hazard, good housekeeping within and outside shall be strictly maintained.
10)	Emergency Assembly Point		Base Building Authority	Proper assembly point signage to be placed.
11)	Aisle Marking	Rule 59, Bangladesh Labour Rules, 2015	Base Building Authority	Ensure minimum 1 m width walkway and aisle marking with exit direction towards the emergency exit door.
12)	Generator Room		Base Building Authority	Ensure CO ₂ fire extinguisher for generator room.
13)	Housekeeping	BNBC 2006, Part 4, Appendix D20	Base Building Authority	Need to remove unnecessary materials and sort out the necessary materials.
14)	Provision and maintenance of fire extinguishers	Rule 55 (2), Bangladesh Labour Rules 2015	Project/lab building owner	Fire extinguisher to be placed as per requirement.



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Sl. No	Aspect	Reference	Responsibility	Recommended Action
15)	Emergency Exit/Evacuation	Rule 55 (8), Bangladesh Labour Rules 2015	Project/lab building owner	Evacuation plan layout to be prepared and displayed in such conspicuous area like corridor, exit door or common area.
16)	Emergency Exit/Evacuation	Rule 54 (10), Bangladesh Labour Rules 2015	Project/lab building owner	There will be at least one window without grill that will be hinged so that one can come down with ladder or rope after opening the hinge in emergency situation.
17)	Emergency Lighting	BNBC 2006, Section: D.12.3	Project/lab building owner	to install the emergency lighting throughout the entire facility.
18)	Emergency Exits & Signage's	Section 62, Bangladesh Labour Act, 2006	Project/lab building owner	Mark all exits with appropriate signages to ensure proper identification.
19)	Fire Alarm	Bangladesh Labour law, 2006, Section-62: BNBC 2006, Section-D 17.2 and D.17.2.D, D 17.1, 5.8.2	Project/lab building owner	to install fire alarm system in the facility and which has to be synchronized with the base building fire alarm system.
20)	First Aid Box	Rule 76, Bangladesh Labour Rules, 2015	Project/lab building owner	Identify and display the name of trained personnel in charge of the first aid boxes kept in each of the work areas. Such personnel to wear a badge for ease of identification and undertake quarterly supervision of the first aid boxes with records maintained.
21)	Electrical Safety	Code of Practice for the Electricity (Wiring) Regulations (2015)	Project/lab building owner	All electrical cables to be properly organized and insulated.
22)	Fire Fighting Planning	Rule 55, Bangladesh Labour Rules 2015	Project/lab building owner	Develop and implement a Fire Safety Plan for this facility.
23)	Smoking in the office and prohibition of open lighter/ignition source	Rule 66, Bangladesh Labour Rules 2015	Project/lab building owner	Uses of the sources of ignition at this facility to be strictly prohibited.
24)	Risk Assessment	Bangladesh Labor Rules 2015, Section-58(3),58, 60	Project/lab building owner	Authority to conduct risk assessment in the facility.
25)	Housekeeping Policy	BNBC 2006, Part 4, Appendix D20	Project/lab building owner	To reduce or minimize fire hazard, good housekeeping within and outside shall be strictly maintained.

Sl. No	Aspect	Reference	Responsibility	Recommended Action
26)	Safety Record Book	Section 90, Bangladesh Labour Act, 2006 Rule 80, Bangladesh Labour Rules, 2015	Project/lab building owner	Maintain a Safety Record Book which shall bear the following information/details viz. List of equipment's and chemical products that might pose severe health hazard or risk; preventive measures taken against hazardous products, possible effects of them upon the health of the employees and the arrangement of primary aid; Complete list of instruments; date on which fire drill was conducted and the number of participants in it; date of refilling the fire-extinguishing instruments and containers; Information about the electrical wiring and the tests conducted about the usefulness of the instruments; and list of the members of safety committee and the date of arranging training related therewith and the number of trainees in it. Key data/information from the Safety Record Book has to be displayed in the Safety Information Board.

Table D4 – 13: Additional fire safety requirements

Sl. No	Aspect	Reference	Recommended Action	Responsibility
1.	Means of Egress	BNBC-2006, Part 4; 3.3.2	An exit shall at no time be used for any purpose that would interfere with its use as a means of escape.	Project/lab building owner
2.	Means of Egress	BNBC-2006, Part 4; 3.9.4	No sliding or hanging door shall be used as a means of exit.	Project/lab building owner
3.	Means of Egress	BNBC-2006, Part 4; 3.9.8	All exit doors shall be openable from the side they serve without the use of a key.	Project/lab building owner
4.	Signage	NFPA, Chapter 14 Section 62, Bangladesh Labour Act, 2006	Install signage and user instruction for the hose reel and fire extinguisher.	Project/lab building owner
5.	Signage	BNBC-2006, Part 4; 3.16.1.2 Graphics	The colour and design of lettering, arrows and other symbols on exit signs shall be in high contrast with their background. Words on the signs shall be at least 150 mm high with a stroke of not less than 20 mm.	Project/lab building owner



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Sl. No	Aspect	Reference	Recommended Action	Responsibility
6.	Fire Fighting Equipment's	In accordance with Bangladesh Labor Rules-2015, Rules-56, 55(7)	Authority to mark equipped with operational instruction in a language understood by all occupants in the building.	Project/lab building owner
7.	Fire Fighting Equipment's	Rule 55 (1), Bangladesh Labour Rules 2015	Fire hose reel shall be tested on an annual basis with records maintained.	Project/lab building owner
8.	Fire Fighting Equipment's	BLR 55, (7)	Fire Extinguisher to fixed on the wall as 1000 mm above from the ground to bottom of fire extinguisher	Project/lab building owner
9.	Fire Fighting Equipment's	Rule 55 (9), Bangladesh Labour Rules 2015	Spear charge of adequate quantity should be stored for the fire extinguisher of each type in each facility.	Project/lab building owner
10.	Emergency Response & First Aid Team	Rule 55 (9), Bangladesh Labour Rules 2015	All staffs or at least 18% of the staffs employed in each department have to be trained on fire-fighting, emergency rescue operation, first aid and the usage of portable fire-repellent instruments.	Project/lab building owner
11.	Emergency Response & First Aid Training	Rule 55 (14), Bangladesh Labour Rules 2015	Fire drills and emergency evacuation drills have to be arranged at least once in every six month period and the same has to be preserved in respective record books, in accordance with Form- 22.	Project/lab building owner
12.	Electric Wiring	Rule 58 (7), Bangladesh Labour Rules 2015	All of the electric wiring and switch boards have to be complete by the no passing elements through 'conceal wiring'.	Project/lab building owner
13.	Certification of Electric Wiring	Rule 58 (8), Bangladesh Labour Rules 2015	In accordance to the Bangladesh Labour Rules, 2015, any business or service, is required to take an appropriate certificate on electric wiring and earthing of the facility from any person or institution approved by the government. Such review has to be undertaken every one year or following expiry of the certification whichever is earlier.	Project/lab building owner
14.	Electric Wiring Maintenance	Rule 58 (9), Bangladesh Labour Rules 2015	The duty of electric wiring and keeping the same cannot be given any other persons except the person certified from the government or the company approved by the government.	Project/lab building owner



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Sl. No	Aspect	Reference	Recommended Action	Responsibility
15.	Lifting Equipment Safety and Certification	Rule 60, Bangladesh Labour Rules 2015	Maintain an inventory of lifting equipment, tools and tackles being used at facility. Ensure all lifts are subjected to examination by a competent prior to their usage and also annually with records being maintained in Form 24.	Project/lab building owner
16.	Chemical and Hazardous Materials	Bangladesh Labor Rules 2015, Section - 68(10)	If any hazardous chemicals or highly flammable materials to be kept in the facility, authority to ensure secondary containment, MSDS displayed in chemicals stores all chemicals/materials are labelled as per instruction/MSDS.	Project/lab building owner
17.	Hot Work Permit System	NFPA 51B	Develop a hot work permit program. The program must comply with the requirements of NFPA 51B. In general, this program should address process of request and approval authorities, necessary checks prior approval, standby fire watch and firefighting equipment, sounding of alarm procedure, duration and expiry of permit and re-approval procedure etc.	Project/lab building owner

8.3 The Envisaged Project Activities and Implementation Process

The location of the proposed testing lab is not yet finalized. However, it is assumed that the location will be in the Dhaka area. The project is to be implemented in two stages.

Details of the project components and implementation process are discussed in the separate technical section. Hence, to avoid repetition this section does not include any detail discussion on the technical issue. Nevertheless, this section gives primary information about the project activities, procedure and machinery & equipment to be used for construction work which are related to the environmental impacts.

Building construction activities can be divided in to two categories sub-structural and super-structural work which comprises of Civil & Structural, Mechanical and Electrical Components. The specific project activities include foundation works for lab buildings and other facilities, super-structural works for lab buildings and other facilities.

Construction work will involve cutting of trenches, excavation, concreting, masonry work etc. Mechanical work will involve extensive use of mechanical equipment for storage, and transportation. Electrical components include wiring, fitting & fixing of the switch, sockets, lighting facilities, and installation of the other facilities like high voltage transformers. All the activities are related with environmental impact.



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Execution of the project activities will require operation of heavy equipment like hydraulic cranes & excavator, asphalt plant, mechanical compactor, bulldozer, concrete mixers, vibrator, hoists, welding sets etc. are associated with the environmental impacts.

8.4 Anticipated Environmental Impacts and Mitigation Measures

Development of the testing lab facilities will have a significant contribution relating to economic aspects. At the same time, it may also create adverse impacts on the surrounding environment if the adverse impacts will not manage properly. These impacts on the natural environment (physical and ecological resources) and social environment (economic development and social and cultural resources) will be either adverse or beneficial. Implementation of the project will cause impacts that may be either short-term or long-term. These impacts may be as direct, indirect and cumulative impacts.

Judgment of the environmental specialist along with the Rapid Environmental Assessment (REA) checklist will be applied to find out the potential environmental impacts (either negative or positive). Some common measurements to qualify an impact are its duration, its spatial effect, its ability to reverse and to mitigate. Potential environmental impacts associated with the proposed project activities are classified as: (i) impacts during pre-construction and construction phase and ii) impacts during operation phase.

During pre-construction phase, the impacts associated with the land use, land acquisition & compensation if require, demolition and removal of structures & removal of trees if require. During construction phase, the major impact associated with environmental quality like air, noise, water, and soil quality might be degraded. Dust generation due to movement of the construction machineries and gaseous emissions from vehicular transport and machineries may deteriorate the air quality of the local area. Noise quality can be deteriorated due to the operation of various machineries and equipment. Various grease and oily substances may be released from the construction machineries may discharge in the soil. Soil quality may also be deteriorated due to leaching of various oily substances to the soil. All the impacts will be very much localized in nature.

Other impacts associated with construction of labour-shed, operation and management, material transportation, handling and storage, impacts on common property resources, impacts on traffic movement, visual amenity, labour influx impacts, health & safety of the labours, cultural resources, employment opportunity etc. Such type of impacts will be mainly localized in nature and not anticipate any major adverse impact to the project.

During operation phase, dust generation due to movement of the vehicles and gaseous emissions from machineries may deteriorate the air quality of the local area. Noise could be generated from the movement of vehicle and operation of the machineries. Soil impacts during operation phase are limited to accidental spillage of lubricant, fuel and other chemicals that may potentially cause soil degradation. Other impact issue like ecology, waste generation will not be significant for the project.

An environmental impact assessment is being conducted by the study team which will be included in the detailed design of the Laboratory. This section summarized key relevant issues need to addressed.



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- a. **Resource Consumption:** The proposed Electrical Testing Lab will consume resources such as energy (fuel & gas indirectly, and electricity directly), water, and raw materials. Efficient planning and use of natural resources is very important. The implementation of the lab by installing energy-efficient machinery and water recycling systems to reduce consumption and reduce loss need to be considered.
- b. **Hazardous Materials:** Improper management of hazardous waste may lead to impacts on soil, water, visual environment, in addition to health and safety. Hence, identification and proper management of hazardous materials used in the proposed lab will be ensured. It is also to ensure safe storage, handling, and disposal of hazardous materials.
- c. **Waste Management:** Improper management of non-hazardous and hazardous waste may lead to impacts environment in many ways. Hence, induced impacts from the waste need to be minimized through waste management plan. A mitigation plan to minimize waste generation, recycle materials when possible and safely dispose of hazardous waste will be ensured. There are DoE enlisted vendors in Bangladesh for recycle of the scraped materials. Design of the lab building also needs to be considered a separate place for safe storage before recycle and or discharge.
- d. **Emissions and Pollution Control:** Due to the project implementation, there is a possibility of degradation of the air quality, and noise quality. Due to discharge of untreated waste water from various sources, there is a possibility of the degradation of the surface water quality of the adjacent surface water system. Hence, induced impacts need to be minimized through management plan. A mitigation plan to minimize air pollution & dust pollution, noise pollution and water pollution is considered. Environmental quality testing needs to be done in a regular interval and test results will compare with local environmental regulations.
- e. **Biodiversity Protection:** There is a possibility of impacts of the lab on local ecosystems and biodiversity. To minimize the impacts necessary measures will be taken to protect nearby natural areas and wildlife.
- f. **Transformer oil fires and placement of high voltage transformers:** To avoid and or minimize risks of transformer oil fires, the high voltage transformers need to be placed within the blasting walls. This is common practice in everywhere for the high voltage transformers installation. To minimize the oil spillage pollution, a gird is usually placed under the transformer that will allow collection of the oil through a channel to the soak well/tank. The oil spill from the transformers is usually not huge. Hence, it can be collected locally and supply to the vendors for further process.
- g. **Green Certifications:** Power Cell will seek obtaining green certifications to demonstrate environmental responsibility and compliance with best practices.

So, project facilities development and operation should, therefore, be planned with careful consideration of the environmental impacts. To minimize/mitigate the impacts, the project proponent will have to follow the Environmental Management Plan (EMP) properly in all phases of the project.

8.5 Climate Change Analysis

In any development project in Bangladesh needs to assess and include climate issues in the project design and implementation.



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a. **Emissions Reduction:** The project may have associated benefits with respect to Greenhouse Gas (GHG) emission reduction. GHG emission reduction is anticipated due to (i) adoption of renewable energy in the internal use, (ii) adoption of energy efficient process in the design, & installation of electrical appliances and (iii) carbon offset programs.

b. **Climate Resilience:** Facility's vulnerability to climate change impacts, such as increased temperatures, extreme weather events, and changes in water availability and development of adaptation strategies to mitigate risks needs to be considered in the design and implementation. Basic design principle of the green building such as solar energy, rain water harvesting, tree plantation at ground & terrace side, landscaping, sensor based electrical and sanitary system, and glass wall for access natural light needs to be considered.

8.6 Assessment of Disaster Resilience of the Project

Project Location: According to GSB, Bangladesh has three seismic zones. Dhaka and its surrounding area fall in Zone II, i.e. medium intensity seismic zone of the country. The project area is not subjected to severe flood events and cyclone except extreme case.

Impact of hazards: There are four main types of disasters and risks namely: Natural Disasters, Environmental Emergencies, Complex Emergencies, and Pandemic Emergencies. An initial workplace wide risk assessment is undertaken to identify significant hazards and risks associated with the overall project activities.

The most important risks associated to the Project are:

- Fire;
- Earthquake;
- Severe Bad Weather Condition (Cyclone, Kalbaaishakhi and Flooding);
- Hazardous, Toxic and Infectious Waste;
- Spills;
- Severe diseases like Dengue, COVID-19 etc.

In order to be in a state of readiness to face adverse effects of accidents, a separate emergency response plan is required to be prepared which includes on-site and off-site emergency. Power Cell is responsible to develop a separate emergency response plan prior to the implementation of the project. In addition to the separate emergency response plan, EIA Study to be conducted for the project will also include the disaster issue in a separate section.

8.7 Conclusion

DoE is the only regularity body in Bangladesh to give environmental permit to any project to operate. Hence, Environmental Assessment (EA) of the proposed Project need to be carried out following DoE guidelines. The project proponent needs to be prepared an EIA prior to the project implementation and submit it to DoE with other technical documents for their review and physical inspection at the project site. A details environmental assessment will be included in the detailed design report of the Laboratory.



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ANNEX 1

List of the testing equipment, with their main ratings, for the Testing Laboratory
in Stage 1 configuration.

Table D4 – 14 -Testing equipment of High-Power LV-MV facility

Equipment	Quantity	Main ratings
230 kV Substation		
Voltage transformer (1-ph)	3	Rated Voltage 245 kV, Isc 40 kA sym, rated insulation 245/460/1050 kV
Disconnecter (3-ph)	1	Rated Voltage 245 kV, Isc 40 kA sym, rated insulation 245/460/1050 kV
Earthing Switches (3-ph)	1	Rated Voltage 245 kV, Isc 40 kA sym, rated insulation 245/460/1050 kV
Current Transformers(1-ph)	3	Rated Voltage 245 kV, Isc 40 kA sym, rated insulation 245/460/1050 kV
Back up circuit breaker	1	Rated Voltage 245 kV, Isc 40 kA sym, rated insulation 245/460/1050 kV
Master circuit breaker	1	Rated Voltage 245 kV, Isc 40 kA sym, rated insulation 245/460/1050 kV
HV/MV Transformer		
Prymary Disconnectors (1-ph)	6	Rated Voltage 245 kV, Isc 40 kA sym, rated insulation 245/460/1050 kV
Neutral Earthing Switch (1-ph)	1	Rated Voltage 245 kV, Isc 40 kA sym, rated insulation 245/460/1050 kV
Surge Arrester (1-ph)	3	Rated Voltage 230 kV, Isc 40 kA sym, rated insulation 230/460/1050 kV
HV/MV Short-circuit Transformer Bank	3	3x 1200 MVA, Vn1= 230/√3 kV ± 4 x 4.5%, Vn2= 4 x 10 kV, Y/y-d
Disconnectors (1-ph) motor operated for MV Ratio Changer	42	Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
Earthing Switches (1-ph) motor operated for MV Ratio Changer	4	Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
MV Switchboard & MV Reactors Room		
Wall Bushing	3	Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
Disconnectors (1-ph)	3	Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
Earthing Switches (1-ph)	3	Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
Reactors banks (1ph)	3	rated insulation 36/70/170 kV
Resistors bank (1ph)	3	rated insulation 36/70/170 kV
Making Switch	3	Rated Voltage 36 kV, Making capacity= 50 kA rms and 125 kA peak, Isc 63 kA sym, rated insulation 36/70/170 kV
Shunts	3	Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
Voltage dividers	3	Rated Voltage 36 kV, rated insulation 36/70/170 kV
Wall Bushing	3	Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
MV Power feeder & MV test cell		
Disconnecter (1-ph)	3	Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
Earthing Switch (1-ph)	3	Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
MV Switchboard	3	5 panels (1 incoming , 3 outcoming, 1 measure);Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
36 kV cable line for power distribution	100	Rated Voltage 36 kV
Power supply busbars	40	Rated Voltage 36 kV, Isc 63 kA sym

Table D4 – 14 -Testing equipment of High-Power LV-MV facility (continue)

Equipment	Quantity	Main ratings
LV test cell		
MV Master circuit breaker (3 ph)	1	Rated Voltage 36 kV, Isc 20 kA sym, rated insulation 36/70/170 kV
MV/LV Transformer	1	250 MVA, Vn1= 36 kV $\pm 2 \times 6\%$, Vn2= 2 x 0.26 kV, Y/y-d
Voltage transformers (1-ph)	3	Rated Voltage 1 kV, secondary windings >2
Shunts	3	Isc 500 kApeak, rated insulation 1 kV
Rogowsky coils	12	rated insulation 1 kV
Voltage dividers	12	Rated Voltage 1 kV, rated insulation 1 kV
Earthing Switches (3-ph)	2	Rated Voltage 1 kV, Isc 20 kA sym
Making Switch	3	Maximum capability 200 kArms and 500 kApeak, rated insulation 1 kV
LV Loads		
Earthing Switches (1-ph)	1	Rated Voltage 1 kV, Isc 20 kA sym
Disconnectors (1-ph)	1	Rated Voltage 1 kV, Isc 20 kA sym
Reactor Banks (1-ph)	3	Rated Voltage 1 kV
Resistor Banks (1-ph)	3	Rated Voltage 1 kV
Control, Protection, Automation and Measurement Systems		
Control Panels for 220 kV Substation, HV/MV Transformers and Ratio Changer, MV Switchboard & MV Reactors Room, MV Power feeder & MV test cell,	1	
Control Panel for LV Loads and LV test bat	1	
Test Sequencer for LV test bay	1	
Data Acquisition Systems for High-Power LV and MV TEST bay		
DAS Mainframe	2	
Differential inputs card	10	
Received cards	7	
Fiber Optical isolated transmitter	6	
DAS software	2	
Cables and optical fibers	100	
Control room for High-Power LV and MV test bay	1	
GPS clock with antenna	1	
IRIG-B dispenser	1	
Control and Monitoring System servers	4	
IEC 61850 communication Ethernet switches	4	
Patch-panel for optical fibers	2	
Industrial PC	4	
Monitors	4	
LED display 55"	2	
Colour laser printer	2	
Event printer	2	
Software licences and development	1	

Table D4 – 15 -Testing equipment of High Voltage facility

Equipment	Quantity	Main ratings
Power Distribution System		
MV Switchboards	1	7 panels (1 incoming , 5 outcoming, 1 measure);Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
cable line	400 m	400 V
Lightning impulse system		
Impulse Voltage Generator	1	600 kV,60 kJ
Charging rectifier	1	100 Kv rated output voltage ,60 mA rated output current
Multi Chopping Spark Gap	1	400 kV
Voltage Measurement System	1	400 kV
Power frequency System		
Power frequency source	1	150 kV, 1 A
Regulator Transformer	1	25 kVA rated power, 0 ÷ 400 V output voltage
Compensative Reactors	1	No. 3 units single-phase , each one with 50 kVAR
AC Voltage Measurement System	1	100 kV
Combined Voltage System		
Power frequency source	1	50 kV, 0.2 A, single phase
Regulator Transformer	1	10 kVA rated power, 0 ÷ 400 V output voltage
AC Voltage Measurement System	1	50 kV
Low Voltage Power Frequency System		
Power frequency source	1	20 kV, 0.05 A, single phase
AC Voltage Measurement System	1	20 kV
PD and RIV measurement system		
Coupling Capacitor (1-ph)	3	Rated Voltage 30 kV, rated capacitance 1 nF ±5%, frequency range 40 ÷ 200 Hz
Measuring impedance (1-ph)	3	Rated Voltage 30 Kv, max allowed current 0,5 A
PD detector(including PD calibrator and accessories)	1	Measuring range 0.1 ÷ 1000 pC in the range 40 ÷ 800 kHz
RIV detector		Bandwidth 9 kHz, Tunable center frequency 10 kHz ÷ 10 MHz, selectable measuring level 10 μV ÷ 100 mV
Test and measurement on Transformers		
Static Frequency Converter (3-ph)	1	Rated Power 200 kVA, Output Voltage 0 ÷ 400 V, frequency range 50 ÷ 200 Hz
Step-up Transformer (3-ph)	1	Rated Power 200 kVA, Primary Voltage 400 V, Secondary Voltage 1000 V, Terziary Voltage 3200 V
Step-up Transformer (3-ph)	1	Rated Power 200 kVA, Primary Voltage 400 V, Secondary Voltage 24500 V
Capacitor Bank (3-ph)	1	n. 21 Capacitors 800 V, 10 kVAR; n. 69 Capacitors 3300 V, 25 kVAR;
Regulator Transformers (1-ph)	1	Rated Power 25 kVA, Output Voltage 0 ÷ 240 V
Power Frequency source	1	Output Voltage 100 kV, rated current 0.2 A
Current Tranformers (1-ph)	3	Rated Voltage 30 kV, ratio 300 A/5A
Voltage Transformers (1 ph)	3	Rated Voltage 30 kV, ratio 36/√3 kV/100 V
Capacitive Voltage Divider	3	Rated Voltage 100 kV, ratio 100 kV/50 V
Resistance meter for measuring windings resistance	1	Output Voltage 30 Vdc, Current range 0.01 A ÷ 10 A, Resistance range 0.1 μΩ ÷ 2000
Automatic Ratio Meter for measurement of	1	Output Voltage 8 V-40 V-100 V, Max Output Current 1 A, Measurement ratio range
Automatic Measuring System for measurement of no load loss & currentand the measurement of short	1	Voltage range 0.5 kV-2.5 kV-5 kV-10 kV, Current range 10 A-100 A-500 A, Voltage and Corrent measurement accuracy 0,1%, Power measuremenre accuracy 0,3%
Tan δ and capacitance measurement	1	Rated Voltage 100 kV, Measurement range 1 ÷ 100 pF
Insulated thermocouples	20	Rated insulation 36 kV

Table D4 – 15 -Testing equipment of High Voltage facility (continue)

Equipment	Quantity	Main ratings
Dielectric tests on surge arrester		
Reactor Banks (1-ph)	1	Rated Voltage 1 kV
Resistor Banks (1-ph)	1	Rated Voltage 1 kV
Current Transformers (1-ph)	1	Rated Voltage 30 kV, ratio 300 A/5A
Voltage Transformers (1 ph)	1	Rated Voltage 30 kV, ratio 36/√3 kV/100 V
Tan δ measurement for power cable		
Automatic system	1	Output voltage up to 5 kVrms, measurement range 0 ÷ 100, accuracy 0,5%
Insulation resistance meter for power cable		
Automatic system	1	Output voltage 80 ÷ 500 Vdc, Measurement range 0.5 ÷ 40 MΩ with accuracy 2.5%
Heating system for power cables		
Heating transformer (1-phase)	2	Ratio voltage 400/15 V, max output current 2000 A
Automatic capacitive compensation	1	Rated power 400 V, rated capacitance 30 kVAr
Regulator transformer (1 -phase)	1	Rated power 10 kVA, output voltage 0 ÷ 400 V
Current Transformer	1	Primary current 2000 A, Secondary current 5 A, accuracy 0.1%
Shielded Room		
Dimension	1	10 x 15 x 4 m (L x W x H)
Control, Protection, Automation and Measurement		
Control Panel for tests on Transformers	1	
Control Panel for tests on Power Cables	1	
Data Acquisition Systems		
<i>DAS Mainframe</i>	1	
<i>Differential inputs card</i>	6	
<i>Received cards</i>	5	
<i>Fiber Optical isolated transmitter</i>	4	
<i>DAS software</i>	1	
<i>Cables and optical fibers</i>	100 m	
Control room	1	
<i>GPS clock with antenna</i>	1	
<i>IRIG-B dispenser</i>	1	
<i>Control and Monitoring System servers</i>	4	
<i>IEC 61850 communication Ethernet switches</i>	4	
<i>Patch-panel for optical fibers</i>	2	
<i>Industrial PC</i>	4	
<i>Monitors</i>	4	
<i>LED display 55"</i>	2	
<i>Colour laser printer</i>	2	
<i>Event printer</i>	2	
Software licences and development	1	

Table D4 – 16 - Testing equipment of Temperature rise facility

Equipment	Quantity	Main ratings
Power Supply		
MV/LV transformer	1	Rated power 5 MVA, 33 kV/0.4 kV voltage ratio
LV Switchboards	1	5 panel (1 incoming, 4 outgoing, 1 measure), rated insulation 1 kV
Disconnecter and Earthing Switch	1	Rated Voltage 36 kV, Isc 10 kA sym, rated insulation 36/70/170 kV
Temperature rise system		
Static Frequency Converter	1	Rated power 200 kVA, output voltage 40 ÷ 400 V, 50 Hz and 60 Hz output frequency
Heating transformer (1-ph)	6	primary voltage 230 V, secondary voltage 15 V, 7000 A
Capacitor bank (1-ph)	3	80 capacitors, 5kVAr rated power, 230 rated voltage
Resistor banks (1-ph)	3	12 resistors, 5 mΩ rated resistance, 800 A rated current
Current transformer (1-ph)	3	800-1600-3150 and 6300 A primary current, 5 A secondary current, accuracy 0,1%
Current transformer (1-ph)	1	50-100 and 200 A primary current, 5 A secondary current, accuracy 0,1%
Power source for Expulsion and Current limiting Fuses	1	Rated power 3500 VA, Output Voltage 10 ÷ 440 V
Insulated Thermocouples	20	rated insulation 250 V
Connections	1	Set of busbars, copper braids, cables
Control, Protection, Automation and Measurement Systems		
Control Panel for Test facility	1	
Control Panel for Auxiliary Power Supply	1	
Control Panel for involved general services	1	
Data Acquisition Systems		
<i>DAS Mainframe</i>	1	
<i>Received cards</i>	6	
<i>DAS software</i>	1	
<i>Cables and optical fibers</i>	40 m	
Control room	1	
<i>GPS clock with antenna</i>	1	
<i>IRIG-B dispenser</i>	1	
<i>Control and Monitoring System servers</i>	4	
<i>IEC 61850 communication Ethernet switches</i>	4	
<i>Patch-panel for optical fibers</i>	2	
<i>Industrial PC</i>	4	
<i>Monitors</i>	4	
<i>LED display 55"</i>	2	
<i>Colour laser printer</i>	2	
<i>Event printer</i>	2	
Software licences and development	1	

Table D4 – 17 -Testing equipment of Mechanical testing facility

Equipment	Quantity	
LV Switchboards		
MV/LV transformer	1	Rated power 0.5 MVA, 33 kV/0.4 kV voltage ratio
LV Switchboards	1	4 panel (1 incoming, 2 outcoming, 1 measure), rated insulation 1 kV
Disconnecter and Earthing Switch	1	Rated Voltage 36 kV, Isc 10 kA sym, rated insulation 36/70/170 kV
Automatic test system		
Automatic test system	2	Performing up to 10000 automatic cycles, for each of them the auxiliary circuits of the equipment under tests is fed in order to perform opening-closing operation
Mobile equipment		
Resistance meter	1	Output Voltage 500 Vdc, Measuring range 0,5 ÷ 40 MΩ, accuracy 1%
Automatic measuring system	1	Measurement of Close-Open time, Open-Close time, Minimum trip Voltage, Contact Resistance and Travel (stroke, speed and damping of the Contacts)
Portable Microhometer	1	Measuring range 0 ÷ 1000 mΩ, Output dc current 50 ÷ 200 A, Output voltage 5 Vdc at 100 A, max ripple on output voltage 80 mVpp, accuracy ± 20 μΩ for R=10 mΩ
Power Sources		
Single phase DC power source, 500 W	6	Output Voltage 5 ÷ 275, Rated Power 500 W over the whole voltage regulation range
Single phase DC power source, 1500 W	6	Output Voltage 5 ÷ 275, Rated Power 1500 W over the whole voltage regulation range
Single phase AC power source, 500 W	6	Output Voltage 20 ÷ 275, Rated Power 500 VA over the whole voltage regulation range
Single phase AC power source, 1500 W	6	Output Voltage 20 ÷ 275, Rated Power 1500 VA over the whole voltage regulation range
Control, Protection, Automation and Measurement Systems		
Control Panel for Test facility	1	
Control room	1	
GPS clock with antenna	1	
IRIG-B dispenser	1	
IEC 61850 communication Ethernet switches	2	
Industrial PC	4	
Monitors	4	
LED display 55"	2	
Colour laser printer	2	
Event printer	2	
Software licences and development	1	



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ANNEX 2

List of the testing equipment, with their main ratings, for the Testing Laboratory
in Stage 2 configuration.

Table D4 – 18 -Testing equipment of High-Power MV facility

Equipment	Quantity	Main ratings
Short-circuit Generator system		
Current Transformers(1-ph)	1	Rated Voltage 17.5 kV, Isc100 kA sym, rated insulation 17.5/45/110 kV
Star point impedance	1	Resistor 17,5 kV
Current transformers (1-ph)	9	Rated Voltage 17.5 kV, Isc 100 kA sym, rated insulation 17.5/45/110 kV
Short-circuit Generator	1	Rated power 2500 MVA, Rated Voltage 17,5 kV, Isc 100 kA sym
Auxiliary systems	1	Driving system, Cooling system, Lubrification system
Excitation and Super-Excitation system	1	
Automation, Protection and Control system	1	
Short-circuit Generator feeder		
Current Transformers(1-ph)	9	Rated Voltage 17.5 kV, Isc 100 kA sym, rated insulation 17.5/45/110 kV
Surge arrester (1 ph)	3	Rated Voltage 17.5 kV
Voltage transformer (1-ph)	6	Rated Voltage 17.5 kV/110 V
Master circuit breaker (1 ph)	3	Rated Voltage 17.5 kV, Isc 100 kA sym, rated insulation 17.5/45/110 kV
Making Switch (1 ph)	3	Rated Voltage 17.5 kV, Isc 100 kA sym, Ipeak 270 kApeak, rated insulation
Earthing Switches (1-ph)	3	Rated Voltage 17.5 kV, Isc 100 kA sym, rated insulation 17.5/45/110 kV
Current limiting Reactors (1-ph)	3	Rated Voltage 17.5 kV, Reactance range 10 + 200 mΩ, up to 110 kA
Coaxial Busbars (1-ph)	3	Rated Voltage 17.5 kV, Isc 100 kA sym, rated insulation 17.5/45/110 kV
MV/MV Transformer		
Primary side Disconnectors motor operated (1-ph)	6	Rated Voltage 17.5 kV, Isc 60 kA sym, rated insulation 17.5/45/110 kV
MV/MV Short-circuit Transformer Bank	3	Rated power 900 MVA 1s, Primary Voltage 17,5 kV, Secondary Voltage 4x 10 kV
Secondary side Disconnectors motor operated (1-ph)	42	Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
Earthing Switches (1-ph) motor operated for MV Ratio Changer	3	Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
Voltage transformers (1-ph)	3	Rated Voltage 21 kV/110 V
MV Switchboard & MV Reactors Room		
Wall Bushing	3	Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
Disconnectors (1-ph)	3	Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
Earthing Switches (1-ph)	3	Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
Reactors banks (1ph)	3	rated insulation 36/70/170 kV
Resistors bank (1ph)	3	rated insulation 36/70/170 kV
Making Switch (1-ph)	3	Rated Voltage 36 kV, Making capacity 63 kArms and 160kApeak, Isc 63 kA sym, rated insulation 36/70/170 kV
R-C TRV regulation circuit (3-ph)	1	rated insulation 36/70/170 kV
Switchboard	1	4 panels (1 incoming, 3 outgoing), Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
Shunts (1-ph)	9	Isc 63 kA sym
Voltage dividers (1-ph)	9	Primary voltage 36 kV, Secondary voltage 110 V
Wall Bushing (1-ph)	9	Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
MV test cell and Loads		
Earthing Switch (1-ph)	6	Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
Earthing Switch (1-ph)	6	Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
Shunts (1-ph)	6	Isc 63 kA sym
Voltage dividers (1-ph)	6	Primary voltage 36 kV, Secondary voltage 110 V
Switchboard	1	3 panels (3 incoming, 1 outgoing), Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
Capacitors Bank (1-ph)	3	Rated power 20 MVAR, Rated Voltage 36 kV, rated insulation 36/70/170 kV
Reactor Banks (1-ph)	3	Rated power 18 MVAR, Rated insulation 36/70/170 kV
Resistor Banks (1-ph)	3	Rated power 18 MW, Rated insulation 36/70/170 kV
36 kV cable line for power distribution	100	Rated Voltage 36 kV
Power supply busbars	40	Rated Voltage 36 kV, Isc 63 kA sym
Control, Protection, Automation and Measurement Systems		
Control Panels for Short Circuit Generator system and feeder, MV/MV Transformers and Ratio Changer, MV Switchboard & MV Reactors Room	1	
Control Panel for MV test cell Loads and Loads	1	
Test Sequencer for MV test cell	1	
Data Acquisition Systems for High-Power MV test cell		
DAS Mainframe	2	
Differential Inputs card	10	
Received cards	7	
Fiber Optical isolated transmitter	6	
DAS software	2	
Cables and optical fibers	100	
Control room for High-Power LV and MV test bay	2	
GPS clock with antenna	2	
IRIG-B dispenser	2	
Control and Monitoring System servers	2	
IEC 61850 communication Ethernet switches	8	
Patch-panel for optical fibers	4	
Industrial PC	4	
Monitors	4	
LED display 55"	2	
Colour laser printer	2	
Event printer	2	
Software licences and development	1	

Table D4 – 19 -Testing equipment of High Voltage facility

Equipment	Quantity	Main ratings
Power Distribution System		
MV Switchboards	1	7 panels (1 incoming , 5 outcoming, 1 measure);Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
cable line	200 m	400 V
Lightning impulse system		
Impulse Voltage Generator	1	2800 kV,420 kJ
Charging rectifier	1	200 kV rated output voltage ,200 mA rated output current
Multi Chopping Spark Gap	1	2800 kV
Voltage Measurement System	1	2400 kV
Power frequency System based on transformers		
Power frequency source	1	1200 kV, 2.5 A
Regulator Transformer	1	2800 kVA rated power, 0 ÷ 400 V output voltage
Tunable Compensative Reactors	1	No. 3 units single-phase , each one with 50 kVAR
Adaptation Transformer		400 V primary voltage, 6000 V secondary voltage
AC Voltage Measurement System	1	1000 kV
Power frequency source based on resonant system		
Tunable Modular Reactors	1	Rated voltage 800 kV, Rated current 2 A, Compensative capacitance up to 8 nF
Excitation Transformer	1	50 kVA rated power, 400 V primary voltage, 30 kV secondary voltage
Regulator Transformer	1	50 kVA rated power, 0 ÷ 400 V output voltage
Adaptation Transformer	1	400 V primary voltage, 6000 V secondary voltage
AC Voltage Measurement System	1	700 kV
PD and RIV measurement system		
Coupling Capacitor (1-ph)	3	Rated Voltage 1000 kV, rated capacitance 2 nF ±5%, frequency range 40 ÷ 200 Hz
Coupling Capacitor (1-ph)	3	Rated Voltage 800 kV, rated capacitance 1 nF ±5%, frequency range 40 ÷ 200 Hz
Measuring impedance (1-ph)	3	Rated Voltage 800 Kv, max allowed current 0,8 A
PD detector(including PD calibrator and accessories)	1	Measuring range 0.1 ÷ 1000 pC in the range 40 ÷ 800 kHz
RIV detector	1	Bandwidth 9 kHz, Tunable center frequency 10 kHz ÷ 10 MHz, selectable
Heating system for Type test on Power Cables		
Heating Transformers	2	400/15 primary/secondary voltage, 4000 A max output current
Automatic Capacitive Compensation	1	180 kVAR capacitive compensation
Regulator transformer	1	Rated Power 15 kVA, 0 ÷ 400 V output voltage
Current transformer	1	primary current 1000-2000-4000 A, 5 A secondary current, accuracy 0.1%
System for temperature rise on Voltage transformers		
Programmable Burden	1	Rated power 1 ÷ 200 VA, Power factor 0.5 ÷ 1, rated voltage 100-110-115-120-230 V
Test and measurement on Transformers		
Static Frequency Converter (3-ph)	1	Rated Power 2000 kVA, Output Voltage 0 ÷ 690 V, frequency range 50 ÷ 200 Hz
Step-up Transformer (3-ph)	1	Rated Power 2000 kVA, Primary Voltage 690 V, Secondary Voltage 1,5 ÷ 120 kV
Additional Step-up Transformer (3-ph)	1	Rated Power 2000 kVA, Primary Voltage 120 kV, Secondary Voltage 450 kV
Capacitor Bank (3-ph)	1	n. 192 Capacitors each having 30/√3 kV rated voltage and 480 kVAR
Current Transformers (1-ph)	3	primary current 1250-2500 A, secondary current 5A, accuracy 0.1%
Voltage Transformers (1 ph)	3	primary voltage 450/√3 kV, secondary voltage 100 V, accuracy 0.1%
Automatic Measuring System for loss measurement	1	Voltage range 1-2-5-10-20-50-100-200 kV, Current range 10-20-50-100-200-500-1000-2500 A, Voltage and Corrent measurement accuracy 0.08%, Power measurement accuracy 0.13%



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Table D4 – 20 -Testing equipment of High Voltage Power Cable facility

Equipment	Quantity	Main ratings
Power Distribution System		
LV Switchboards	1	3panels (1 incoming , 1 outcoming, 1 measure);Rated Voltage 36 kV, Isc 63 kA sym, rated insulation 36/70/170 kV
Cables	100 m	400 V
Power frequency source for pre-qualification tests of Power Cables		
Tunable Modular Reactors	1	Rated voltage 800 kV, Rated current 2 A, Compensative capacitance up to 8 nF
Excitation Transformer	1	50 kVA rated power, 400 V primary voltage, 30 kV secondary voltage
Regulator Transformer	1	50 kVA rated power, 0 ÷ 400 V output voltage
Adaptation Transformer	1	400 V primary voltage, 6000 V secondary voltage
AC Voltage Measurement System	1	700 kV
Heating System for pre-qualification tests of Power Cables		
Heating Transformers	2	400/15 primary/secondary voltage, 4000 A max output current
Automatic Capacitive Compensation	1	180 kVAR capacitive compensation
Regulator transformer	1	Rated Power 15 kVA, 0 ÷ 400 V output voltage
Current transformer	1	primary current 1000-2000-4000 A, 5 A secondary current, accuracy 0.1%
Control, Protection, Automation and Measurement		
Control Panel for tests on Transformers	1	
Control Panel for tests on Power Cables	1	
Data Acquisition Systems		
<i>DAS Mainframe</i>	1	
<i>Differential inputs card</i>	6	
<i>Received cards</i>	5	
<i>Fiber Optical isolated transmitter</i>	4	
<i>DAS software</i>	1	
<i>Cables and optical fibers</i>	100 m	
Data Acquisition Systems for pre-qualification test of Power Cable	1	
<i>DAS Mainframe</i>	1	
<i>Differential inputs card</i>	10	
<i>Received cards</i>	7	
<i>Fiber Optical isolated transmitter</i>	6	
<i>DAS software</i>	2	
<i>Cables and optical fibers</i>	100	
Control room for High-Power LV and MV test bay	1	
<i>GPS clock with antenna</i>	1	
<i>IRIG-B dispenser</i>	1	
<i>Control and Monitoring System servers</i>	1	
<i>IEC 61850 communication Ethernet switches</i>	1	
<i>Patch-panel for optical fibers</i>	5	
<i>Industrial PC</i>	2	
<i>Monitors</i>	2	
<i>LED display 55"</i>	2	
<i>Colour laser printer</i>	1	
<i>Event printer</i>	1	
Software licences and development	1	



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Table D4 – 21 -Testing equipment for Option B of Stage 2

Equipment	Quantity	Main ratings
MV/HV Transformer		
Primary side Disconnectors motor operated (1-ph)	2	Rated Voltage 17.5 kV, Isc 100 kA sym, rated insulation 17.5/45/110 kV
MV/HV Short-circuit Transformer Bank	1	Rated power 1500 MVA, Vn1= 17,5 kV, Vn2= 4 x 65 kV
Secondary side Disconnectors motor operated (1-ph)	8	Rated Voltage 230 kV, Isc 16 kA sym, rated insulation 230/460/1050 kV
Earthing Switches (1-ph) motor operated for MV Ratio Changer	2	Rated Voltage 230 kV, Isc 16 kA sym, rated insulation 230/460/1050 kV
Voltage transformers (1-ph)	1	Primary voltage 230/ $\sqrt{3}$ kV, Secondary voltage 110 V
Transformer test cell		
Shunts (1-ph)	4	Isc 20 kA sym
Voltage dividers (1-ph)	1	Primary voltage 36 kV, Secondary voltage 110 V
Busbar	m 60	Rated Voltage 230 kV, Isc 16 kA sym, rated insulation 230/460/1050 kV
Control, Protection, Automation and Measurement Systems		
Control Panels for MV/HV Transformer and Transformer test facility	1	
Test Sequencer for Transformer testing facility	1	
Data Acquisition Systems for High-Power MV test cell		
<i>DAS Mainframe</i>	1	
<i>Differential inputs card</i>	5	
<i>Received cards</i>	4	
<i>Fiber Optical isolated transmitter</i>	6	
<i>DAS software</i>	2	
<i>Cables and optical fibers</i>	100	



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ANNEX 3

Capital Expenditure of testing equipment in Stage 1 configuration

Table D4 – 22 -High Power LV-MV testing facility

Equipment	Quantity	Unitary price [USD]	Total price [USD]
230 kV Substation			253400
Voltage transformer (1-ph)	3	11000	33000
Disconnecter (3-ph)	1	18000	18000
Earthing Switches (3-ph)	1	4500	4500
Current Transformers(1-ph)	3	16500	49500
Backup circuit breaker	1	67000	67000
Master circuit breaker	1	67000	67000
Busbars, Insulators, Clamps	80 m	180	14400
HV/MV Transformer			8129000
Primary Disconnectors (1-ph)	6	8000	48000
Neutrl Earthing Switch (1-ph)	1	5500	5500
Surge Arrester (1-ph)	3	3500	10500
Busbars, Insulators, Clamps	150 m	180	27000
HV/MV Short-circuit Transformer Bank	3	2500000	7500000
Disconnectors (1-ph) motor operated for MV Ratio Changer	42	10000	420000
Earthing Switches (1-ph) motor operated for MV Ratio Changer	4	2500	10000
Busbars, Insulators, Clamps for MV Ratio Changer	660 m	180	108000
MV Switchboard & MV Reactors Room			820300
Wall Bushing	3	6000	18000
Disconnectors (1-ph)	3	13500	40500
Earthing Switches (1-ph)	3	1100	3300
Reactors banks (1ph)	3	48000	144000
Resistors banks (1ph)	3	40000	120000
Making Switch	3	13500	40500
Shunts	3	45000	135000
Voltage dividers	3	75000	225000
Wall Bushing	3	6000	18000
Busbars, Insulators, Clamps	80 m	450	36000
36 kV cable line for power distribution	400 m	100	40000
MV Power feeder & MV test cell			239800
Disconnectors (1-ph)	3	3500	10500
Earthing Switches (1-ph)	3	1100	3300
MV Switchboard	3	66000	198000
36 kV cable line for power distribution	100 m	100	10000
Power supply busbars	40 m	450	18000

Table D4 – 22 -High Power LV-MV testing facility (continue)

Equipment	Quantity	Unitary price [USD]	Total price [USD]
LV test cell			3044750
MV Master circuit breaker (3 ph)	1	20000	20000
Supply busbars	90 m	450	40500
MV/LV Transformer	1	2400000	2400000
Voltage transformers (1-ph)	3	2350	7050
Shunts	3	45000	135000
Rogowsky coils	12	2500	30000
Voltage dividers	12	5500	66000
Earthing Switches (3-ph)	2	600	1200
Making Switch	3	115000	345000
LV Loads			537300
Earthing Switches (1-ph)	1	600	600
Disconnectors (1-ph)	1	1200	1200
Reactor Banks (1-ph)	3	98000	294000
Resistor Banks (1-ph)	3	78000	234000
Busbars, Insulators, Clamps	30 m	250	7500
Control, Protection, Automation and Measurement Systems			613500
Control Panels for 220 kV Substation, HV/MV Transformers and	1	158000	158000
Control Panel for LV Loads and LV test cell	1	73000	73000
Test Sequencer for LV test cell	1	84500	84500
Data Acquisition Systems for MV and LV cells	1	186000	186000
Control room for MV and LV test cells	1	32000	32000
Software licences and development	1	80000	80000
Subtotal for all the listed equipment			13638050
Miscellaneous (3%)			409142
Transport (4%)			561888
On site assembly and commissioning (7%)			983303
Contingency (3%)			467771
EPC charge on procured equipment (10%)			1460908
EPC engineering & project management (5%)			803008
High Power MV/LV testing facility			18324070

Table D4 – 23 -High Voltage testing facility

Equipment	Quantity	Unitary price [USD]	Total price [USD]
Power Distribution System			61000
MV Switchboards	1	21000	21000
cable line	400 m	100	40000
Lightning impulse system	1	250000	250000
<i>Impulse Voltage Generator</i>			
<i>Charging rectifier</i>			
<i>Multi Chopping Spark Gap</i>			
<i>Voltage Measurement System</i>			
Power frequency System	1	160000	160000
<i>Power frequency source</i>			
<i>Regulator Transformer</i>			
<i>Compensative Reactors</i>			
<i>AC Voltage Measurement System</i>			
Combined Voltage System	1	65000	65000
<i>Power frequency source</i>			
<i>Regulator Transformer</i>			
<i>AC Voltage Measurement System</i>			
Low Voltage Power Frequency System	1	15000	15000
<i>Power frequency source</i>			
<i>AC Voltage Measurement System</i>			
PD and RIV measurement system			48000
Coupling Capacitor (1-ph)	3		
Measuring impedance (1-ph)	3		
PD detector(including PD calibrator and accessories)	1		
RIV detector	1		
Temperature rise System for Transformers			529000
Static Frequency Converter (3-ph)	1	140000	140000
Step-up Transformer	1	28000	28000
Step-up Transformer	1	40000	40000
Capacitor Bank	1	85000	85000
Regulator Transformers (1-ph)	1	28000	28000
Power Frequency source	1	36000	36000
Current Transducers (1-ph)	3	8000	24000
Voltage Transformers (1 ph)	3	5500	16500
Capacitive Voltage Divider	3	11500	34500
Resistance meter for measuring windings resistance	1	5000	5000
Automatic Ratio Meter for measurement of voltage ratio and check phase displacement	1	13000	13000
Automatic Measuring System for measurement of no load loss & current and the measurement of short-circuit impedance and load loss	1	17000	17000
Tan δ and capacitance measurement	1	28000	28000
Insulated thermocouples	40	850	34000

Table D4 – 23-High Voltage testing facility (continue)

Equipment	Quantity	Unitary price [USD]	Total price [USD]
Dielectric tests on surge arrester			41500
Reactor Banks (1-ph)	1	15600	15600
Resistor Banks (1-ph)	1	12400	12400
Current Transformers (1-ph)	1	8000	8000
Voltage Transformers (1 ph)	1	5500	5500
Tan δ measurement for power cable			18000
Automatic system	1	18000	18000
Insulation resistance meter for power cable			5000
Automatic system	1	5000	5000
Heating system for power cables			110500
Heating transformer 2000 A max output current	2	25000	50000
Automatic capacitive compensation	1	37000	37000
Regulator transformer	1	18000	18000
Current Transformer	1	5500	5500
Shielded Room	1	85000	85000
Control, Protection, Automation and Measurement Systems			296000
Control Panel for tests on Transformers	1	52000	52000
Control Panel for tests on Power Cables	1	18000	18000
Data Acquisition Systems			144000
Control room	1	32000	32000
Software licences and development	1	50000	50000
Subtotal for all the listed equipment			1684000
Miscellaneous (3%)			50520
Transport (4%)			69381
On site assembly and commissioning (7%)			121416
Contingency (3%)			57760
EPC charge on procured equipment (20%)			360780
EPC engineering & project management (10%)			198308
High Voltage testing facility			2542165

Table D4 – 24 -Temperature rise testing facility

Equipment	Quantity	Unitary price [USD]	Total price [USD]
Power Supply			40500
MV/LV transformer	1	15000	15000
LV Switchboards	1	18000	18000
Disconnecter and Earthing Switch	1	7500	7500
Temperature rise system			534000
Static Frequency Converter	1	100000	100000
Heating transformer (1-ph)	6	24000	144000
Capacitor bank (1-ph)	3	25000	75000
Resistor banks (1-ph)	3	48000	144000
Current transformer (1-ph)	3	7500	22500
Current transformer (1-ph)	1	2500	2500
Power source for Expulsion and Current limiting Fuses	1	15000	15000
Insulated Thermocouples	20	850	17000
Connections	1	14000	14000
Control, Protection, Automation and Measurement Systems			225300
Control Panel for Test facility	1	52000	52000
Control Panel for Auxiliary Power Supply	1	16000	16000
Control Panel for involved general services	1	18000	18000
Data Acquisition Systems			87300
Control room	1	32000	32000
Software licences and development	1	20000	20000
Subtotal for all the listed equipment			799800
Miscellaneous (3%)			23994
Transport (4%)			32952
On site assembly and commissioning (7%)			57666
Contingency (3%)			27432
EPC charge on procured equipment (20%)			171349
EPC engineering & project management (10%)			94184
Temperature rise testing facility			1207377

Table D4 – 25 -Mechanical testing facility

Equipment	Quantity	Unitary price [USD]	Total price [USD]
Power Supply			31300
MV/LV transformer	1	2800	2800
LV Switchboards	1	21000	21000
Disconnecter and Earthing Switch	1	7500	7500
Automatic test system			132000
Automatic test system	2	65000	130000
Auxiliary connections			2000
Mobile equipment			26500
Resistance meter	1	5000	5000
Automatic measuring system	1	18000	18000
Portable Microhometr	1	3500	3500
Power Sources			86520
Single phase DC power source, 500 W	6	4500	27000
Single phase DC power source, 1500 W	6	5500	33000
Single phase AC power source, 500 W	6	4000	24000
Single phase AC power source, 1500 W	6	5000	2520
Control, Protection, Automation and Measurement Systems			115000
Control Panel for Test facility	1	16000	16000
Control Panel for Auxiliary Power Supply	1	16000	16000
Control Panel for involved general services	1	16000	16000
Control room	1	32000	32000
Software licences and development	1	35000	35000
Subtotal for all the listed equipment			391320
Miscellaneous (3%)			11740
Transport (4%)			16122
On site assembly and commissioning (7%)			28214
Contingency (3%)			13422
EPC charge on procured equipment (20%)			83836
EPC engineering & project management (10%)			46082
Mechanical testing facility			590736

Table D4 – 26 -Auxiliary facilities and general services

Equipment	Quantity	Unitary price [USD]	Total price [USD]
Assembly and Dissassembly Hall for Distribution and Power Transformers			180000
Bridge crane	2	20000	40000
Dielectric oil system	1	100000	100000
Forklifts and trolleys	1	15000	15000
Mechanical tools	1	25000	25000
Calibration facilities			25000
Multimeters, current clamps, resistance meter, oscilloscope, frequency meters ,voltmeters; , thermometers,	1	25000	25000
Workshop			30000
lathe, milling, welding machine, mechanical tools, trolley	1	17000	17000
Warehouse			13000
Bridge crane	1	10000	10000
Trolleys ,reach trucks	1	3000	3000
Main services			415000
Fire protection system	200000	1	200000
Compressed air system	35000	1	35000
Telecommunication and CCTV systems	80000	1	80000
AC Low voltage supply system	20000	1	20000
SF6 system	80000	1	80000
Subtotal for all the listed equipment			663000
Miscellaneous (3%)			19890
Transport (4%)			27316
On site assembly and commissioning (7%)			47802
Contingency (3%)			22740
EPC charge on procured equipment (20%)			142041
EPC engineering & project management (10%)			78075
Auxiliary facilities and general services services			1000864



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ANNEX 4

Capital Expenditure of testing equipment in Stage 2 configuration

Table D4 – 27 -High Power MV and Transformer testing facilities

Equipment	Quantity	Unitary price [USD]	Total price [USD]
Short-circuit Generator system			19156500
Current Transformers(1-ph)	1	5000	5000
Star point impedance	1	6500	6500
Current transformers (1-ph)	9	5000	45000
Short-circuit Generator	1	11500000	11500000
Auxiliary systems	1	3850000	3850000
Excitation and Super-Excitation system	1	1950000	1950000
Automation, Protection and Control system	1	1800000	1800000
Short-circuit Generator feeder			1314600
Current Transformers(1-ph)	9	5000	45000
Surge arrester (1 ph	3	5000	15000
Voltage transformer (1-ph)	6	12000	72000
Master circuit breaker (1 ph)	3	180000	540000
Making Switch (1 ph)	3	100000	300000
Earthing Switches (1-ph)	3	1000	3000
Current limiting Reactors (1-ph)	3	110000	330000
Coaxial Busbars (1-ph)	m 12	800	9600
MV/MV Transformer			4018500
Primary side Disconnectors motor operated (1-ph)	6	10000	60000
MV/MV Short-circuit Transformer Bank	3	1200000	3600000
Secondary side Disconnectors motor operated (1-ph)	42	8000	336000
Earthing Switches (1-ph) motor operated for MV Ratio Changer	3	2500	7500
Voltage transformers (1-ph)	3	5000	15000
MV Switchboard & MV Reactors Room			3166800
Wall Bushing	3	6000	18000
Disconnectors (1-ph)	3	13500	40500
Earthing Switches (1-ph)	3	1100	3300
Reactors banks (1ph)	3	480000	1440000
Resistors bank (1ph)	3	40000	120000
Making Switch (1-ph)	3	100000	300000
R-C TRV regulation circuit (3-ph)	1	85000	85000
MV Switchboard	1	26000	26000
Shunts (1-ph)	9	45000	405000
Voltage dividers (1-ph)	9	75000	675000
Wall Bushing (1-ph)	9	6000	54000

Table D4 – 27 -High Power MV and Transformer testing facilities (continue)

Equipment	Quantity	Unitary price [USD]	Total price [USD]
MV test cell and Loads			909200
Earthing Switch (1-ph)	6	1100	6600
Earthing Switch (1-ph)	6	1100	6600
Shunts (1-ph)	6	35000	210000
Voltage dividers (1-ph)	6	55000	330000
MV Switchboard	1	22000	22000
Capacitors Bank (1-ph)	3	32000	96000
Reactor Banks (1-ph)	3	36000	108000
Resistor Banks (1-ph)	3	28000	84000
36 kV cable line for power distribution	100 m	100	10000
Power supply busbars	40 m	900	36000
Control, Protection, Automation and Measurement Systems			1018000
Control Panels for Short Circuit Generator system and feeder, MV/MV Transformers and Ratio Changer, MV Switchboard & MV Reactors Room	1	175000	175000
Control Panel for MV test cell Loads and Loads	1	75000	75000
Test Sequencer for MV test cell	2	96000	192000
Data Acquisition Systems for High-Power MV test cell	2	186000	372000
Control room for High-Power LV and MV test bay	2	32000	64000
Software licences and development	2	70000	140000
Subtotal for all the listed equipment			29583600
Miscellaneous (3%)			887508
Transport (4%)			1218844
On site assembly and commissioning (7%)			2132978
Contingency (3%)			1014688
EPC charge on procured equipment (5%)			1584498
EPC engineering & project management (2,5%)			870940
High Voltage and Transformer testing facilities			37293056

Table D4 – 28 -High Power MV and Transformer testing facilities

Equipment	Quantity	Unitary price [USD]	Total price [USD]
Power Distribution System			46000
MV Switchboards	1	26000	26000
cable line	200 m	100	20000
Lightning impulse system	1	750000	750000
Power frequency System based on transformers	1	540000	540000
Power frequency source based on resonant system	1	320000	320000
PD and RIV measurement system	1	86000	86000
Heating system for Type test on Power Cables			97000
Heating Transformers	2	18000	36000
Automatic Capacitive Compensation	1	38000	38000
Regulator transformer	1	18000	18000
Current transformer	1	5000	5000
System for temperature rise on Voltage transformers			9500
Programmable Burden	1	9500	9500
Test and measurement on Transformers			872500
Static Frequency Converter (3-ph)	1	650000	650000
Step-up Transformer (3-ph)	1	32000	32000
Additional Step-up Transformer (3-ph)	1	40000	40000
Capacitor Bank (3-ph)	1	85000	85000
Current Transformers (1-ph)	3	8000	24000
Voltage Transformers (1 ph)	3	5500	16500
Automatic Measuring System for loss measurement	1	25000	25000
Subtotal for all the listed equipment			2721000
Miscellaneous (3%)			81630
Transport (4%)			112105
On site assembly and commissioning (7%)			196184
Contingency (3%)			93328
EPC charge on procured equipment (20%)			582947
EPC engineering & project management (10%)			320425
High Voltage testing facility			4107619

Table D4 – 29 - HV Power Cables testing facility

Equipment	Quantity	Unitary price [USD]	Total price [USD]
Power Distribution System			21100
MV Switchboards	1	1	21000
Cables	100 m	100	100
Power frequency source for pre-qualification tests of Power Cables	1	320000	320000
<i>Tunable Modular Reactors</i>			
<i>Excitation Transformer</i>			
<i>Regulator Transformer</i>			
<i>Adaptation Transformer</i>			
<i>AC Voltage Measurement System</i>			
Heating System for pre-qualification tests of Power			97000
Heating Transformers	2	18000	36000
Automatic Capacitive Compensation	1	38000	38000
Regulator transformer	1	18000	18000
Current transformer	1	5000	5000
Control, Protection, Automation and Measurement			231000
Control Panel for tests on Power Cables	1	35000	35000
Data Acquisition Systems	1	46000	46000
Data Acquisition Systems for pre-qualification test of Power Cable	1	48000	48000
Control room for High-Power LV and MV test bay	1	52000	52000
Software licences and development	1	50000	50000
Subtotal for all the listed equipment			669100
Miscellaneous (3%)			20073
Transport (4%)			27567
On site assembly and commissioning (7%)			48242
Contingency (3%)			22949
EPC charge on procured equipment (20%)			143348
EPC engineering & project management (10%)			78793
HV Power Cable testing facility			1010073

Table D4 – 30 – Option B – Transformer testing facility

Equipment	Quantity	Unitary price [USD]	Total price [USD]
MV/HV Transformer			8124000
Primary side Disconnectors motor operated (1-ph)	2	8000	16000
MV/HV Short-circuit Transformer Bank	1	8000000	8000000
Secondary side Disconnectors motor operated (1-ph)	8	10000	80000
Earthing Switches (1-ph) motor operated for MV Ratio Changer	2	10000	20000
Voltage transformers (1-ph)	1	8000	8000
Transformer test cell			434000
Shunts (1-ph)	4	50000	200000
Voltage dividers (1-ph)	1	180000	180000
Busbar	60 m	900	54000
Control, Protection, Automation and Measurement Systems			129000
Control Panels for MV/HV Transformer and Transformer testing facility	1	35000	35000
Test Sequencer for Transformer testing facility	1	42000	42000
Data Acquisition Systems for High-Power MV test cell	1	52000	52000
Subtotal for all the listed equipment			8687000
Miscellaneous (3%)			260610
Transport (4%)			357904
On site assembly and commissioning (7%)			626333
Contingency (3%)			297955
EPC charge on procured equipment (2%)			186110
EPC engineering & project management (1%)			102298
Stage 2 Option B -Transformer facility			10518211



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ANNEX 5

Reference prices for testing services

Table D4 – 31 – Reference prices for the type test program of some equipment

Equipment	Reference price [USD]
LV Circuit Breakers for industrial uses	8,000
LV Fuses	7,200
LV Switchgears and Controgears Assembly	10,000
LV Busbar Trunking	18,000
MV Circuit Breakers	12,000
Generator Circuit Breakers	30,000
MV Disconnectors and Earthing Switches	10,000
MV Switches	28,000
MV Expulsion Fuses	12,000
MV Surge Arresters	24,500
MV Gas Insulated Switchgears and Controlgears	47,000
MV Busducts	29,000
Distribution Transformer	28,000
Power Transformers up to 50 MVA	75,000
Current Transformers	14,000
Inductive Voltage and Combined Transformers	10,000
Ceramic, glass and polymeric insulators	8,000
Power Cables with rated Voltage up to 36 kV	13,000
Power Cables with rated Voltage above 170 kV	68,000



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Ministry of Power, Energy & Mineral Resources
Govt. of the People's Republic of Bangladesh

**Consultancy Services for Setting Up Electrical Testing
Laboratory**
(Contract Package: S-10)



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1. Summary

This document constitutes the Feasibility Study of the Testing Laboratory on the basis of the information collected from the Stakeholders¹ (electrical utilities, manufacturers, technical bodies) on the need of testing services to improve the quality and performances of electrical equipment used in the Bangladesh power system.

After a synthesis of the envisaged two configurations of the Laboratory, the testing facilities for each configuration are defined and described in term of their power sources and of the main testing equipment.

The Automation, Control & Protection and Measurement Systems managing all the operating functions of the Laboratory (from the setting up of the testing circuits until test execution and relevant results acquisition and recording) are considered.

The additional auxiliary facilities of the Laboratory are described as well as the specific requirements of the Laboratory utilities (earthing system, compressed air, lighting, etc.) are described.

A preliminary layout of the Testing Laboratory covering both the Stage 1 and Stage 2 configurations as well as the possible future expansion of the testing capability is shown.

The criteria to be taken into consideration for the selection of the Laboratory are defined on the basis of the main Laboratory requirements (power sources, access roads, socio-economic impact).

The Annex 1 lists for all the equipment to be tested the relevant type tests and the main test ratings for the two Testing Laboratory configurations.

The Client and Stakeholders' observations about release 0 were taken into account in this rev. 1 of the document.

¹ D2-1: Conceptual Configuration of the Testing Laboratory, rev.1



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2. Testing Laboratory configurations and the equipment to be tested

As per D2-Interim Report² two different configurations have been considered for the Testing Laboratory:

- Stage 1: in this configuration the Laboratory is supplied by an external power line at 230 kV with 250 MVA short-circuit power and takes around three years to get fully operational;
- Stage 2: the Laboratory is equipped with a 2500 MVA Short-circuit Generator and its complete build takes approximately 6 years; for this configuration two options have been considered: Option A and Option B, having the latter a wider testing capability for Power Transformers.

These two configurations allow different test ratings in connection with their different level of the available short-circuit power. They may be built in parallel in order to enable an initial period of operation of the laboratory of about three years. From the seventh year onwards, the Laboratory can operate at its maximum testing capability.

Testing Laboratory at its maximum capability has to be able to perform type tests on the following families of equipment:

- a) LV equipment with rated current up to 690 V;
- b) MV equipment with rated voltage from 3.6 kV up to 36 Kv;
- c) Distribution transformers with voltage ratio 11/0.4 kV; 13.8/0,4 kV; 33/0.4 kV;
- d) Power Transformers with primary voltage from 33 kV up to 230 kV;
- e) Current transformers and Inductive Voltage transformer up to 400 kV;
- f) Ceramic, glass and polymeric insulators up to 400 kV;
- g) Power Cables with extruded insulation from 1.6 kV up to 400 kV.

Annex 1 lists for each above family of equipment the type tests considered and the allowed maximum test ratings in the two considered configuration of the testing Laboratory: Stage 1 and Stage 2, considering for the latter the two options A and B.

² D2-1: Conceptual Configuration of the Testing Laboratory, rev.1



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3. Testing Laboratory power sources

In Stage 1 configuration the Laboratory shall be supplied by a 230 kV external power line coming from one of the twelve 230/132 kV Station located around Dhaka and having not less than 5000 MVA short-circuit power. The short-circuit power drawn by the Testing Laboratory in this configuration is not higher than 250 MVA for a duration time of 0.3 s. Such conditions have been deemed technically feasible by Power Grid Company of Bangladesh³ that have already identified 3 potentially suitable power stations.

Moreover, the Laboratory will be supplied by a 33 kV power line with a power of 40 MVA addressed to all the auxiliary services and to feed the testing facility non interested by short-circuit tests.

In the Stage 2 configuration the Laboratory shall also equipped with a 2500 MVA 3-phase Short-circuit Generator allowing a significant improving of the testing capability. In this configuration the power of the 33 kV external power line has to be increased at 135 MVA considering the requirements for the speed driving and the excitation system of the Short-circuit Generator.

³ D2-1: Conceptual Configuration of the Testing Laboratory, rev.1 -Annex 3

4. The testing facilities of the Testing Laboratory

4.1 Testing facilities in the Stage 1 configuration of the Laboratory

The involved testing facilities in this configuration of the Testing Laboratory is shown in Tab. D3-1-1.

Table D3-1-1 The testing facility in the Stage 1 configuration

Testing Facilities	Tested equipment	Test performed	Maximum test ratings
High-Power LV - MV	Low Voltage	All tests listed in page 34, excluding: - Dielectric tests - Temperature rise test - Mechanical Operation	- Rated voltage: up to 690 V - Rated current: up to 6300 A - Rated Short time current: up to 200 kA, 1s - Rated Short-circuit current: up to 200 kA (1)
	Medium Voltage	All tests listed in page 35 excluding: - Dielectric tests - Temperature rise test - Mechanical Operation	- Rated voltage: up to 36 kV - Rated current: up to 6300 A - Rated Short time current: up to 63 KA, 1s (2)
	Distribution Transformers	Ability to withstand short circuits	- Primary volt.: up to 13.8 kV - Secondary voltage: 0.4 kV - Rated Power: 4 MVA - Short-circuit impedance 4%÷6%
	Power Transformers	Ability to withstand short circuits	- Ratio voltage 33/11 kV - Rated Power: 20 MVA - Short-circuit impedance 4%÷8%
High Voltage		- Dielectric tests on LV & MV equipment and Power Cables - All the tests on Distribution and Power Transformers except the ability to withstand short circuit	
Temperature Rise		Temperature rise on LV and MV equipment	
Mechanical		Mechanical and endurance test on LV and MV equipment	

(1) Referred to LV Circuit Breakers

(2) Referred to MV Circuit Breakers

For the power supply of the **High-Power LV-MV testing facility** a 3 phase 2000 MVA Short Circuit Transformer bank, having 220 kV primary voltage, is used to obtain secondary voltages in the range 3,6 ÷ 40 kV through four secondary windings series or parallel connected. Downstream this HV/MV Transformer a MV/LV 3-phase 250 MVA Short Circuit Transformers, having 36 kV primary voltage and



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secondary voltage in the range 220-690 V, is able to supply the power circuits for all the tests concerning LV equipment (see page 35 in Annex 1).

The secondary voltage of HV/MV Short Circuit Transformers is also used to feed the power circuits for:

- the tests on MV equipment listed in page 36 of Annex 1,
- the ability to withstand short circuits of the Distribution and Power Transformers listed in page 39 of Annex 1 for the Stage 1.

The high short circuit power of HV/MV Transformers with ratio voltage 220/3,6÷40 kV is to be put in connection with the need to protect themselves in the event of a secondary terminal short-circuit that can occur in the event of failure of a short-circuit tests on 20 MVA Power Transformer having 4% of short-circuit impedance.

From the above it is evident that in the High-Power LV-MV testing facility only one test can be performed at a time, be it on LV equipment or MV equipment or on Transformer. This does not constitute a serious impediment to the productivity of the Laboratory as adopting appropriate separations (through fences) in the testing facility it is possible to prepare the test circuits (not powered) in one of the segregated areas while in another area is running a test.

The **High Voltage testing facility** is addressed to perform:

- the dry dielectric test (lightning impulse, power frequency and radio interference voltage) on the Low Voltage equipment (see page 35 in Annex 1) and Medium Voltage equipment (see page 36 in Annex 1);
- all the tests on Distribution and Power Transformers listed in page 39 of Annex 1 for Stage 1 with the only exception of the test for the ability to withstand short circuit;
- all the test on the Power Cables listed in page 42 of Annex 1 for the Stage 1.

In the testing facility is also installed a shielded room allowing to perform Partial Discharge test in compliance with Standards.

In a corner of the High Voltage testing facility a dedicated test bay is addressed to perform the special dielectric tests on surge arresters by means of dedicated testing circuits.

The Temperature rise the Mechanical testing facilities are able to perform on the equipment LV and MV equipment all the envisaged temperature rise and mechanical & endurance tests, respectively.

The Temperature Rise, High Voltage and Mechanical testing facilities are supplied by the 33 kV external. In these facilities it is possible to operate in parallel (one test in each facility at the same time) given the reduced power required by any individual tests.

4.2 Testing facilities in the Stage 2 configuration of the Laboratory

The involved testing facilities in the Option A of the Stage 2 configuration of the Testing Laboratory is shown in Tab. D3-1-2.

The **High-Power LV facility** will continue to perform the same tests on LV equipment as in Stage 1.

Table D3-1-2: The testing facility in the Stage 2 configuration-Option A

Testing Facilities	Tested equipment	Test performed	Maximum test ratings
High-Power LV	Low Voltage	All tests listed in page 34 excluding: - Dielectric tests - Temperature rise test - Mechanical Operation	- Rated voltage: up to 690 V - Rated current: up to 6300 A - Rated Short time current: up to 200 kA, 1s - Rated Short-circuit current: up to 200 kA (1)
High-Power MV	Medium Voltage	All tests listed in page 35 and 36, excluding: - Dielectric tests - Temperature rise test - Mechanical Operation	- Rated voltage: up to 36 kv - Rated current: up to 6300 A - Rated Short time current: up to 63 KA, 1s - Rated Short-circuit current: up to 31.5 kA at 36 kV (2)
	Current, Inductive and Combined Transformers	All tests listed in page 40 excluding: - Dielectric tests - Temperature rise test	- Rated voltage: up to 400 kV - Rated short-time current: up to 6300 A, 1s - Short-circuit power up to 1500 MVA
Transformer	Distribution Transformers	Ability to withstand short circuit	Distribution Transformers having the operating ratings listed in page 39 of Annex 1 under the columns related to Stage 2 Option A
	Power Transformers	Ability to withstand short circuit	Power Transformers having the operating ratings listed in page 39 of Annex 1 under the columns related to Stage 2 Option A
HV Cables	HV Cables	All tests listed in page 41 referred to Stage 2, excluding: - Bending - Dielectric tests	Rated Voltage above 36 kV and up to 400 kV
High Voltage		- Dielectric tests on LV & MV equipment and Power Cables - All the tests on Distribution and Power Transformers except the ability to withstand short circuit - All the tests on ceramic, glass and polymeric Insulator	
Temperature Rise		Temperature rise on LV and MV equipment	
Mechanical		Mechanical and endurance test on LV and MV equipment	

(1) Referred to LV Circuit Breakers

(2) Referred to MV Circuit Breakers



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The **High-Power MV facility** shall be powered by a 2500 MVA 3-phase short-circuit generator with output voltage in the range 14÷20 kV (the output voltage will have to be defined with the selected supplier).

The Short-circuit Generator will feed a Short-circuit Transformer bank with output voltage in the range 11÷60 kV suitable for MV equipment and Distribution & Power transformers testing.

The Internal Arc Tests to be carried out on MV Switchgears and Controlgears have to be executed in an appropriate containment structure located outside and in the vicinity of the High-Power MV facility.

The Short-circuit Transformer bank feeds the High-Power MV facility or alternatively the **Transformers facility** through switched on/off disconnectors.

The tests concerning HV Power Cables, with the exclusion of the dielectric ones, require the engagement of the involved testing equipment for significant time period (i.e.: some weeks for heating cycles on cables rated 36 ÷ 170 kV; one year for Pre-Qualification tests on cables with rated voltage higher than 170 kV). So, the **HV Power Cables Testing facility** is an outdoor area equipped with dedicated power transformer, voltage regulator and heating transformers (induced voltage type).

The **Temperature Rise, High Voltage and Mechanical testing facilities** are the same of the Stage 1 configuration.

4.2.1 The Option B of the Stage 2 configuration of the Laboratory

In the Option B of the Stage 2 configuration the Laboratory testing capability is increased regarding the power transformers. As listed in page 39, one of the phases of power transformers having a 3-phase power up to 160 MVA, a primary voltage up to 230 kV and short-circuit power in the range 15%÷22% can be tested⁴.

This Option requires an additional Short-circuit Transformers fed by the Short-circuit Generator and having a short-circuit power of 1500 MVA and secondary voltages in the range 15%÷22%.

The size of the Transformers, High Voltage and Temperature rise are significantly increased by choosing the Option B for the Laboratory Stage 2 configuration.

4.3 Short description of the testing facilities and the relevant power sources

4.3.1 High-Power LV-MV (Stage 1 configuration)

This facility is supplied by the 230 kV external power line through an outdoor substation including the instrument transformers for current and voltage measuring, earthing switches and a circuit breaker. A HV/MV 3-phase Short-circuit Transformers bank having 230 kV primary voltage provides all the required testing voltage through a ratio changer system that connects in series and/or parallel the terminals of the 4 secondary windings of transformers.

A dedicated room houses the MV switchgears that alternatively dispatch the power:

- to the testing area for distribution and power transformers (during the Stage 1 configuration of

⁴ D2-1: Conceptual Configuration of the Testing Laboratory, rev.1-Chapter 5



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the Laboratory), or

- to the MV/LV short-circuit Transformers feeding the power circuits for testing LV and MV equipment.

To regulate the test current and its power factor, reactors and resistors banks are foreseen on the MV side of the two above mentioned Transformers banks.

During the Stage 1 of the Laboratory the testing area of the facility has to be subdivided in two parts: one addressed to test transformers while the second one dedicated to LV and MV equipment testing. The two areas are fed via power cables. Due to the high testing currents in this facility the testing equipment shall be installed in such a way to minimize the length of the interconnections and the stray impedance.

The area of the testing facility addressed to test LV and MV equipment is equipped with:

- a 3-phase making switch, for making the current with high accuracy (short and constant closing time are required in order to regulate the closing angle of the short-circuit current in relation to the supplying voltage) and high repeatability in time;
- a medium voltage master breaking for the breaking operations;
- a voltage transformer for the measuring of the no-load secondary voltage of the short circuit transformer;
- a set of high current compensated shunts for high accuracy measurement of the test current;
- resistive voltage dividers to record the supply side and load side phase voltages of the test object during the test.

Moreover, reactors and resistors banks are installed to simulate the load circuit and then to regulate the current and the power factor during the load and overload tests on low voltage switchgears and controlgears.

Similarly, **in the area of the testing facilities addressed to tests the distribution and power transformers** the following equipment has to be considered:

- a voltage transformer to measure the no-load secondary voltage of the short circuit transformer;
- high current compensated shunts to measure the test currents test upstream the transformer under test;
- a medium voltage three-phase making switch; in order to perform tests both in pre-set and in post-set method on transformers, this equipment shall be assembled on a trolley in order to be placed either upstream or downstream the transformer to be tested;
- Resistive Voltage dividers to record the supply side and load side phase voltages of the transformer during the test.

Considering the small sizes of the transformers to be tested in the facility during the Stage 1 configuration of the Laboratory only an adequate fire-fighting system has to be provided.

High-power LV/MV testing facility is provided with control rooms, where control desks for managing the control and digital measuring system of the laboratories are located.



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The buildings housing the testing facility shall be capable to contain the foreseen test circuits and the relevant auxiliary systems, as well as to withstand safely every fault event that can occur during a high-power test.

4.3.2 Short-circuit Generator (Stage 2 configuration)

The Stage 2 configuration of Testing Laboratory is supplied also by a Short Circuit Generator (in the following ScG), which allows to perform tests at 50 and 60 Hz. Based on the test requirement on MV equipment and power transformers ScG must have a short-circuit power of 2500 MVA for 1 s.

ScG is located in a dedicated building that also houses all the generator subsystems:

- driving system (a motor coupled to the rotor),
- cooling system,
- lubrication system,
- excitation system providing, in addition to the normal operating condition, the super-excitation operation in which the excitation current of the generator is increased to provide a constant stator current during the test current flowing in case of long duration of the highest short-circuit test currents,
- automation and protection,
- auxiliary equipment and accessories.

To the ScG star point side they are connected:

- reactors limiting the output current from few kA up to the maximum capability of the generator,
- resistor banks, series connected to reactors, used to limit the amplitude of the first current peak, according to IEC Standards.

In order to reduce the risk of fault at the ScG terminals (as short as possible to minimize the circuit stray inductance) coaxial busbars have to be adopted.

4.3.3 High Power MV (Stage 2 configuration)

The Short-circuit Generator will feed a Short-circuit Transformer bank with output voltage in the range 11÷60 kV suitable for MV equipment and distribution & power transformers testing. The required testing voltage is obtained through a ratio changer system connecting in series or parallel the terminals of the 4 secondary windings of the secondary windings of the Short-circuit Transformer. The series or parallel connection are made by operating remote controlled disconnecting switches.

Switched on/off disconnectors downstream the Short-circuit Transformer bank allow to feed the High-Power MV facility or alternatively the Transformers facility.

The High-Power MV facility includes a dedicated building housing:

- MV bus-bar system,
- disconnector and making switch, to control the closing angle during asymmetrical tests,
- reactor bank, to control the short-circuit current during tests,
- TRV control system, consisting of capacitor and resistors,



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- current (or shunts) and voltage transformers (or voltage dividers),

The same building also houses the MV load circuit consisting of:

- one three-phase reactor bank, star-connected, with variable manual configuration
- one three-phase resistor bank, star-connected, with variable manual configuration
- two three-phase capacitor banks (to cover single capacitor bank and back-to-back tests), suitable to be star or delta connected either to the load bus-bar or the supply bus-bar, with variable manual configuration
- two three-phase capacitor banks (to cover cable switching tests), star connected either to the load bus-bar or the supply bus-bar, with variable manual configuration.

Given the expected workload for MV voltage equipment testing, two MV test bays seems to be envisaged. (one test bay for test execution while in the other the next test object is under preparation). They are directly connected to the bus-bar system via wall bushings and disconnectors with earthing switch.

The test bays shall be fitted with two three-phase bus-bar systems: one connected to the supply side and one connected to the load side, both arranged horizontally on the walls of the test bay, to allow an easy connection of the test objects. Each bus-bar shall be fitted with measurement transducers (shunts and voltage dividers).

The test bays shall be provided with measurement and control panels to ensure the electric supply for the operation of the test objects and the transmission of measurement data.

High-power MV testing facility is provided with control rooms, where control desks for managing the control and digital measuring system of the laboratories are located.

4.3.4 Transformers (Stage 2 configuration)

This testing facility is mainly devoted to perform short circuit tests on distribution and power transformers. According to the Standard this test can be carried out according three schemes:

- a) three-phase test scheme for three-phase transformers;
- b) “equivalent single-phase” scheme for three-phase transformers;
- c) two-phase test scheme for single-phase transformers.

Two testing method may be used:

- Short-circuit post-established,
- Short-circuit pre-established.

The testing facility is equipped with:

- voltage dividers (one for each phase) used to measure voltages on the conductors connected to the transformer under test; they must have a wide band frequency response to correctly measure voltage transients during the tests;
- three high current shunts compensated for measuring the provided test current;
- a making switch, mounted on trolley, used for post-set testing method.

The Transformer testing facility is an open-ceiled reinforced-concrete test cell, large enough to easily



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handle test objects and relevant fittings. The facility shall be located as close as possible to the MV/MV short-circuit transformers and to a large Assembly and Disassembly Hall where the transformers shall be prepared before the tests, to minimise the path to be covered and to make transport operation easier. The open ceiling of the facility allows to connect the transformer under test by means of removable droppers and high voltage conductors passing over the whole test cell and supported by insulators placed on the top of walls of the test Cell.

A fire-fighting systems, CCTV monitoring, trenches for oil collection and drainage shall be also considered for the facility that is provided with a control rooms including the control desks for managing the control and digital measuring systems.

The Option B of the Stage 2 configuration the Laboratory requires the installation of an additional Short-circuit Transformers fed by the Short-circuit Generator testing capability is increased regarding the power transformers. As listed in page A5 of the Annex 1, one of the phases of power transformers having a 3-phase power up to 350 MVA, a primary voltage up to 230 kV and short-circuit power in the range 15%÷22% can be tested⁵.

This Option requires an additional Short-circuit Transformers fed by the Short-circuit Generator and having a short-circuit power of 1500 MVA and secondary voltages in the range 15%÷22%.

The size of the Transformers, High Voltage and Temperature rise are significantly increased by choosing the Option B for the Laboratory Stage 2 configuration.

4.3.5 HV Power Cables (Stage 2 configuration)

While the test on MV power cables can be carried out in the High Voltage testing facility (with the only exclusion of the heating cycle voltage test) and are therefore of short duration, the HV power cables require type test involving a significant engagement of the testing equipment. The heating cycles on power cables with rated voltage in the range 36 ÷ 170 kV require some weeks and the pre-qualification test on cables with rated voltage above 170 kV have duration of one year. These tests are aimed to verify the service life of the cables by means of accelerated aging.

While the heating cycle on MV power cables may performed in the High-Power LV testing facility, for testing the HV power cables a dedicated outdoor testing facility has to be provided where the cables must be laid for lengths of several tens of meters in the real condition of the foreseen installation (underground, galleries, etc.) for a long duration.

The dedicated testing equipment for this facility include power transformers, voltage regulator, heating transformers (induced voltage type) and reactors for capacitive load compensation.

⁵ D2-1: Conceptual Configuration of the Testing Laboratory, rev.1-Chapter 5



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4.3.6 High Voltage

In this facility are performed the dielectric test on all the equipment: from the LV equipment up to the HV power cable and the power transformers. The more frequent tests are:

- power frequency voltage,
- lightning impulse voltage,
- partial discharge measurements,
- $\tan\delta$ and loss measurements.

Therefore, the facility should be mainly equipped with:

- Power frequency voltage transformer,
- Impulse generator,
- Coupling capacitor,
- Voltage dividers.

The constructive solutions of such testing equipment consist of a skid mounted structure housing all the involved devices and apparatuses (measuring instrument and data acquisition system included) for a specific test. Only Voltage dividers are placed between the source end the test object.

The High Voltage testing facility is supplied by the 33 kV line.

In the testing facility is also installed a shielded room allowing to perform Partial Discharge test in compliance with Standards and with suitable dimensions to accommodate the power transformers tested by the Laboratory in the Stage 2 configuration.

Nearby to the High Voltage testing facility a dedicated test bay is addressed to perform the special dielectric tests on surge arresters by means of dedicated testing circuits.

4.3.7 Temperature rise

This testing facility is addressed to perform temperature rise tests on all the equipment.

Based on the operating ratings of the LV and MV equipment and power cables listed in Annex 1, the facility must be able to supply the equipment with a continuous 3-phase current up to 6.3 kA applying to tests circuit a voltage equal to the voltage drop due to testing circuit resistance. This test may be performed using a transformer and a voltage regulator having a rated power of some hundreds of kVA and secondary voltage of some hundreds of Volt. Another solution is based on the use of heating transformers (induced voltage type) able to induce on the test circuit a voltage equal to voltage drop due to circuit resistance.

Quite different is the case of distribution and power transformers. In the case of the more powerful power transformers tested in Stage 2 configuration of the Laboratory the continuous current flow to be injected is about 220 A. In such case in order to reduce the reactive current drawn from the MV line a capacitor bank has to be used.

The test circuit has to be very compact in order to avoid unnecessary length of the bus-bar connections among the testing equipment and the equipment under test.



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A certain number of disconnectors, current and voltage transformers for the measurements are installed in the power circuit. Several thermocouples have to be installed on the equipment under test.

The Temperature rise testing facility is fed by the 33 kV line.

4.3.8 Mechanical

In this facility are tested the following equipment:

- LV Circuit Breakers for industrial uses (the Operational performance capability with current may be conveniently carried out in the High-Power LV testing facility),
- LV Switches, disconnectors, switch-disconnectors and fuse combination units,
- LV Electromechanical Contactors and Motor Starters,
- LV Switchgear and Controlgear Assemblies,
- LV Busbar Trunking,
- MV circuit breakers and Generator Circuit Breakers,
- MV Disconnectors and Earthing Switches
- MV Gas Insulated, Metal Enclosed and Solid Insulation Enclosed Switchgears & Controlgears,
- MV Switches,
- MV Switches-Fuse Combinations,
- MV Current and Voltage Transformers.

On this equipment the type tests to be performed may be:

- application of static loads on terminals or/and
- manual manoeuvring cycle on the removable parts or/and
- mechanical operation tests.

The mechanical operation tests consist of closing-opening operation made by the operating devices of the equipment (without current on the main circuit). Based on the technical characteristics of the operating devices of the commercial equipment, the facility has to be equipped with a set of:

- dc power sources having out voltage covering the range 10÷450 V and output power under load condition covering the range 500÷1500 V;
- 1-phase ac power supply having out voltage covering the range 10÷400 V and output power under load condition covering the range 500÷1500 V;
- 3-phase ac power supply, having out voltage covering the range 40÷400 V and output power under load condition covering the range 500÷1500 V.

The availability of a set of power sources, with different output voltage and power, allow to perform the mechanical/endurance operation in parallel on different equipment, considering that these tests may have a duration of several days.



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5. Automation, Control & Protection and Measurement Systems

Testing activities in Testing Laboratory shall be conducted by operating the following systems:

- Control and Protection Systems (hereinafter also referred to as CPS),
- Measurement and Data Acquisition Systems (hereinafter also referred to as MS).

The above systems will strongly interact with each other during the various phases involved for the execution of tests.

The functions of these two systems are below described in order to provide an effective picture of how a modern testing laboratory works in full compliance with safety (considering the presence of high voltages and currents) and efficiency criteria.

5.1 Automation, Control and Protection Systems

This kind of systems performs several tasks:

- **Access Control and Safety:** CPS watches over safety of people working in the testing facilities and over access to the various testing facilities, for example to perform circuit connections and maintenance on the installed equipment;
- **Test Circuit Configuration:** CPS configures the test circuit (at least partially, being some of the operations carried out manually);
- **Test Process Control:** CPS, operating together with the dedicated Control Units of the power sources, prepares the selected power sources for the test, monitors the status of test circuit equipment and of some of the test parameters (voltage and current) and interacts with the Measurement system; in the testing facilities where short-time tests are carried out (typically in the High-Power ones), tight requirements exist for the synchronization of operation of equipment that are switched on and off during the test: therefore, the use of a special apparatus called Test Sequencer is foreseen in such laboratories; the Test Sequencer automatically provides a sequence of commands required for the performance of the test, intentionally started by the operator and carried out automatically according to a pre-established timing, independently from the operator control;
- **Protection:** CPS controls the test circuits protection relays and related alarms of the involved testing equipment.

5.1.1 Access Control and Safety functions

CPS shall monitor the status information (open-closed) of all equipment that are relevant to the safety conditions inside each test facility.

At the beginning of the test configuration process, the Test Engineer selects the resources (power sources, areas hosting test circuit equipment, test bays) that will be used for the test. An association of areas is so created that also defines an operational area where safety is supervised by the Control System. Each area can be selected by only one user.

The presence of people in an area should be monitored directly by the CS.



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The following provisions can be adopted:

- locks and limit switches shall be installed on access doors or gates: they are used to let the CPS know about the position of the doors/gates;
- the keys of the locks of the main doors/gates are kept inside key panels located in the Control Rooms of the testing facility; the presence of the keys in the panels shall be controlled by the Control system;
- when CPS detects the opening of a door/gate and/or that a key is taken from the key panels, the procedure for putting the relevant area in safety conditions is activated;
- a Door Diagram shall be implemented in the Supervision workstation in the Control rooms, where the status of each doors/gates is shown. Signalling of the status of each area shall also be made locally at the area entrances with lights of red and green colours.

5.1.2 Test Circuit Configuration functions

5.1.2.1 *Setting-up the test configurations*

The complexity of the test circuit configuration depends significantly on the type of test to be carried out. The following description is mainly focused on procedures applicable to High Power testing facility (LV or MV).

For other Test Facilities this phase can be significantly simpler, due to a smaller number of equipment to be configured and less available options, but some general criteria can be easily adapted also to such cases.

The typical sequence of operations managed from the CPS during the Test Circuit Configuration consists in the following actions:

- a) Selection of the Operating Mode to be used for the test: an Operating Mode corresponds to a specific combination of power source providing the requested current and voltage, Laboratory transformers (if any), power feeders needed to dispatch the power and the test cell where tests will be carried out; upon completion of the selection procedure, the selection is validated and is blocked; usual selections shall be listed (in a table); alternative selections shall also be permitted and might require a second validation;
- b) Prepare the test object for test:
 - connect the test object to the selected test circuit output,
 - connect the test object auxiliary circuits to the appropriate supply sources and controls on the test bay panels,
 - connect the measuring transducers to the requested measuring points;
- c) Set-up the test circuit scheme:
 - set the correct position of disconnectors, earthing switches and other switching equipment not operated during the test sequence,
 - set the proper winding connections on the involved Laboratory transformers,



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- set the proper value of adjustable test circuit parameters (i.e. reactors, resistors, capacitors, etc.).

When operations of items b) and c) require to enter inside one of the selected Laboratory areas, the Control system watches over the fulfilment of the prescribed safety conditions.

5.1.2.2 Level of automation in the set-up the test circuit scheme

In principle, the configuration of some parts of the test circuit could be done manually by inserting/removing manual links instead of using remotely controlled disconnectors or switches. Manual links represent a cheaper solution and might be an obliged choice in some cases, for example where severe space constraint do not allow solutions based on disconnectors. However, adoption of solutions based on remotely configurable and controlled equipment is generally recommended because of the benefits related to:

- increased operational efficiency, thanks to the reduction of the time needed to set-up the tests circuit;
- lower risks of accidents to working people, as there is less need to access to potentially dangerous work places;
- lower risks of accident to equipment, caused by improper fixing or tightening of connections with possible arcing phenomenon;
- lower probability to set improper circuit schemes (and consequent failures): the test circuits configured by the users, blocking the selection and operation of those

5.1.2.3 Selection of Laboratory transformers scheme

In the High-Power testing facilities, the power available from the power sources (Short-circuit Generator or network) will be dispatched to the test cells through one or more banks of power transformers. Typically, the voltage on the secondary side of the HV/MV or MV/LV or MV/MV transformer used for short-circuit tests is dependent on the connection scheme of the individual units (series/parallel connections between the windings of each transformer) as well as the connections between different transformers (primary and secondary side).

In a design solution with high level of automatization, the connections will be attained by means of a system consisting of remotely controlled disconnectors (ratio changer).

Therefore, the voltage value is dependent on the positions of the disconnectors. The requested voltage shall be selected by the operator and the set-up of the corresponding circuit arrangement shall be managed by the CPS.

5.1.2.4 Configuration of remotely controlled test circuit components

Test circuit parameters needed to obtain the requested test conditions will be calculated by the Test Engineer (possibly with the aid of suitable SW tools). The CPS shall implement the control functions related to the automatic definition and set-up of the configuration of testing equipment remotely adjustable via disconnectors. The selection of configuration shall be directly made (or at least guided) by CPS on the basis of the requested value of circuit parameter (capacitance, inductance, resistance).



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5.1.3 Test Process Control functions

5.1.3.1 *Operations to carry out the test*

The description of operations and control functions provided hereinafter is mainly applicable in case of tests carried out in the High-Power testing facilities and, to some extent, in other testing facilities for which the tests imply much simpler operation that are directly managed by the local Control Units of the involved test system, with very limited interactions with other equipment and circuits of the Laboratory.

The typical sequence of operations managed from the CPS during the test phase consists in the following actions:

- validation of the Test Circuit configuration (see par. 5.1.2.1),
- set-up and start of the power sources used for the tests: short-circuit generators or the network,
- put the circuit breakers (master breaker, auxiliary breakers), the making switches and the test object in the initial position for the test,
- inform the Test Sequencer that the test circuit is ready for test and start the test,
- continuously monitor the status of the Laboratory equipment involved in the test and execute the commands received from the Test Sequencer,
- at the end of test sequence, put the test circuit in safety conditions,
- manage the alarms that might occur during the preparation and execution of the tests.

Referring to High Voltage testing facility, the Control System shall manage similar operations, with obvious differences deriving from the different kind of tests carried out in these test Facilities:

- Step 1: test circuit configurations are generally simpler, as generally each test system (e.g. impulse generator, AC test system, etc.) has a single dedicated power supply and a well-defined circuit to feed the test object,
- Step 2: typical power sources are impulse generators, AC test systems, converters for temperature rise tests, etc.
- Step 3: there is no need for a Test Sequencer but the Control Systems shall be able to program test cycle according to Standards requirements (e.g. heating cycles on cables).

5.1.3.2 *Control of operation of Short-circuit Generator*

The Short-circuit Generator will be supplied by the manufacturer with its own Control System appropriate to operate the and its specific auxiliary services:

- Driving system,
- Excitation and Super- generator excitation systems,
- Lubrication system,
- Cooling system.

The generator own Control System shall at least manage the following functions:



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- operation of the generator alone managing the procedures for start-up, reacceleration between current shots, excitation and super/excitation, stopping;
- interface to the Laboratory Control System and to the Test Sequencer;
- monitoring of the status of the sub-systems and components;
- management of generator alarms and protections.

Laboratory CPS shall be interfaced with Generator Control System for enabling the setup of main operating parameters and check the generator proper functioning directly from CPS Human Machine Interface.

5.1.4 Protection functions

The Protection Systems shall prevent or minimize damage to the Laboratory equipment and to the test objects in case a fault occurs.

The protection functions are typically provided by dedicated protection devices (digital relays). The system will basically consist of:

- Power sources own protection systems (e.g. Short-circuit Generator, network substation, voltage generators, etc.), intended to detect any fault that may stress the power sources beyond their ratings;
- Feeders and tests circuits protection systems, intended to detect whether the amplitude or the duration of the test current exceed significantly the test specifications and therefore may stress the equipment and the test object beyond their ratings.

Depending on the alarm detected, several actions can take place, such as: opening of circuit breakers, cut-off of the generator excitation and super-excitation, etc.

5.1.5 System architecture

The Testing Laboratory presents great differences in terms of:

- buildings and areas dedicated to the Test Facility, with consequent different needs in terms of safety provisions, zoning criteria and access control;
- involved power and voltage sources and associated distribution circuits (main busbars and feeders);
- type of tests to be managed, complexity and number of available test circuits and operation procedures to be implemented.

Considering the above differences, it is convenient to foresee that each testing facility is equipped with its own Control Room

The CPS will consist of the following main functional parts:

- a Laboratory general Supervision system with HMI composed by fully configured workstations installed in the Control Rooms of the test facilities with relevant control software package that provides the requested range of supervisory control and monitoring functions;



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- a number of Control Units based on Intelligence Electronic Devices (IEDs) for control and monitoring each of the testing facilities and test bays, access control and safety, protection and for auxiliary systems.
- a number of Remote I/O Terminal Units, installed in suitable and convenient Laboratory areas, consisting of input/output modules for interfacing the controlled equipment with the Control system;
- redundant communication network between control system devices;
- peripheral equipment like printers, GPS equipment, redundant workstation, etc.
- AC and DC auxiliary power supplies, to generate the requested auxiliary voltages (typically including batteries and battery chargers and inverters);
- Distribution boards AC and DC, to provide the auxiliary voltages requested for equipment operation to the Equipment local panels.

5.2 Measurement System

The Measurement System (MS) shall measure, acquire, store and evaluate the measurement data requested for the tests carried out in the testing facilities. These measurement data shall be made available in the corresponding Control Room.

In general terms the Measurement Systems mainly consist of:

- measurement transducers, with specific metrological features that depend on the signals to be measured (range, bandwidth, wave shape, etc.); the transducers can be located in the test bays or in other laboratory areas (e.g. the power feeders) and may be mobile or for fixed installation;
- measurement links to collect the signals from the transducers to the Data Acquisition System or measuring instrument; depending on measuring requirements and environmental conditions the use of optical links shall be considered;
- suitable Data Acquisition System (DAS) with dedicated input channels, hardware and run-time software/firmware that are able to perform the acquisition of measurement data during test execution;
- software interface for the operator, typically a windows-based HMI running on a Personal Computer; by means of this interface the operator can set the parameters and triggers for measurements to be done in the test and exchange diagnostic information with the DAS hardware; dedicated software tools are usually available for data analysis and reporting.

5.2.1 Main requirements of the transducers

The technical specifications of the transducers will be defined during the detailed design of the Testing Laboratory taking into consideration the requirements stated in their applicable Standards.

It is remarked that:

- during test execution, high frequency acquisition up to some MS/s is requested for transient recordings of some signals in specific time windows of the test sequence (TRV, arc voltage, etc.);



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- data acquisition boards with a lower frequency acquisition rate (some hundreds of kS/s) are adequate for the other signals listed in the above table, mainly related to operating signals of apparatus in the Laboratory power circuit: it must be possible to correlate and synchronize the measurements from both type of data acquisition boards on the same oscillogram (that is on the same time base);
- the use of digital optical links shall be foreseen at least for voltage and current measurements as well as for other measuring signals coming from the test bays, when galvanic insulation and noise immunity to electromagnetic fields are requested.
- signals for which standard wiring to the Control room with shielded (twisted pair) cables can be acceptable, will be preferably connected to the DAS inputs channels

through isolation amplifiers; the use of isolation amplifiers has the purpose to protect the transient recorder by potentially dangerous interferences coming from the laboratory installations (damages should preferably affect the isolation amplifier rather than the transient recorder).

In principle, each Control Room will have its own Measurement system with an appropriate configuration of DAS (number and type of measuring boards to provide the requested number of channels).

Selection of Measurements signals will be made differently depending on the DAS configuration that will be chosen (Minimum or Maximum):

- Minimum Configuration: in a minimum configuration, the number of DAS input channels shall be sufficient for acquiring all the measurements and signals during a test in one of the test bays controlled by the Control Room, but is lower than the total number of transducers/sensors. Selection of measurement signals will be done through interface switchboards in the Control Room which allows to make, before each test, the association of DAS input channels to measurement devices of the test cell where the test will be carried out.
- Maximum Configuration: in a maximum configuration, the number of DAS input channels is sufficient to cover all the measurements signals in the test cells managed by the Control Room. Therefore, a fixed association between all transducers/sensors in the controlled test cell and one of the input channels of DAS can be made.

5.2.2 Basic requirements for Data Acquisition Systems

In the measurement systems, DAS software shall include at least the following features:

- Data acquisition setting: before starting the test, the operator shall set all the parameters necessary to perform a correct acquisition of test quantities: e.g. measuring range, sampling rate, etc.;
- Data Analysis: the software shall allow the operator to easily view the test data and perform evaluation of test results (such as: calculation of RMS values, peak values, time values, etc); the calculation methods shall comply with the procedures defined in the relevant applicable Standards;



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- Client Access: for some tests (for example in the High-Power Laboratories), the Measurement systems shall have a dedicated client PC in order to allow the Client to view test results immediately after test execution; in this case, allowed functions will be a subset of those available to the testing operator.
- Test Reports: oscillograms and calculation results shall be archived in a dedicated storage area in order to be easily found and ready to use by the operator to fill in the Test Reports.
- Traceability of test results: Raw Data from the measuring systems shall be recorded in a redundant and back upped data archive for traceability and recoverability purpose, as required from Quality Standards.



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6. The additional facilities and the main utilities of Testing Laboratory

6.1 Additional facilities

The testing facilities described in Chapter 4 include almost all the testing equipment of the Laboratory:

- the power sources (substation supplied by the grid, Short circuit Generator),
- Laboratory Transformers that make available the required voltages to the test circuits,
- reactors, capacitors and resistance banks through which the current on the equipment to be tested is controlled,
- All the measuring instruments.

There are other important facilities for the Laboratory operation, below described. following.

6.1.1 Control rooms and Client rooms

Each testing facility has its own control room in which through the Supervision workstation and other personal computers it is possible:

- to monitor all accesses to test areas in order to ensure the safety of staff,
- to control the output of the protection functions and resolve any inconvenience,
- to define the configuration of the test circuits (power sources, all testing equipment) using one of the predefined configurations,
- to execute of the automated set up the test circuits by means of remote-controlled switches and disconnectors,
- to start the test execution (and stop in the event of failure),
- display and storage all the measurements taken during test.

The Control Rooms are placed outside the test cells in a position allowing to watch a large part of the cell through a window with wired safety glasses.

In each Control Room is installed a 3-phase power transformer in delta/star connection in order to obtain the electrical decoupling of the supply of the control and measurement systems of the testing equipment installed in the testing hall.

For each testing room there also is a Client room addressed to accommodate the Client representatives that may watch the test performing and the relevant results through a subset of data available in the control room.

6.1.2 Assembly and Disassembly Halls

They are addressed to the assembly, maintenance and disassembly of the equipment to be tested by the engineers and workers of the Client. They must be equipped with all auxiliary services (source of electricity, compressed air, etc.), cranes, lifting platforms necessary for these operations.

ADH shall be placed as far as possible in the vicinity of the test facilities in order to minimize the route to be travelled and facilitate the transport of the equipment to be tested.



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ADH used for assembly operation on transformers must include an Oil Treatment and filling System: oil insulated power transformers, especially for the heavy and bulky ones, are transported without oil and are filled before testing and emptied after test execution. Hence the need to treat the oil for removing gas, moisture and solid particles before filling the transformer to be tested.

The ADH addressed to MV (and in perspective HV equipment) has to be provided with a mobile SF₆ treatment system performing the whole process of SF₆ refilling in the test object; it consists of a vacuum pump to evacuate air and moisture prior to filling the test object, a pump for SF₆ filling of the equipment to be tested and to evacuate SF₆ from the test object after the test. Moreover, a tank for SF₆ is required. Considering the multi customer operations of the Laboratory it is important that in ADH the confidentiality aspects are ensured according to what required by IEC 17025 at Clause 4.2.4 in this regard⁶.

6.1.3 Other auxiliary facilities

- **Workshop:** this facility is used both by the Laboratory staff and by the Customer's staff that has to provide the maintenance of the equipment under test.
- **Warehouse:** it has to be subdivided into three areas:
 - area housing the equipment to be tested in the period of time between their arrival at the Laboratory and the assembly activities preceding the test execution,
 - area used for the spare parts of the testing equipment and Laboratory consumables,
 - waste collection area such as scrap, discarded equipment parts, transformer oil leakage.
- **Calibration room:** used to carry out calibration operation and for the storage of the incoming and outgoing instrument to be calibrated at external laboratories; in this area the maintenance of electronic equipment is also usually carried out.
- **Offices and meeting rooms** for the Laboratory staff.
- **Internal Roads:** although this is not a facility it has to be mentioned being its importance to ensure a smooth flow of materials and equipment both during the erection and the operation of the Laboratory: the roads must allow an easy handling of the equipment as well as adequate yard for truck manoeuvring.

6.2 Main utilities

In this paragraph are considered the specific aspects that differentiate the utilities of the Test laboratory from the usual ones of an industrial structure.

- **Earthing System**

The **grounding system** of a Testing Laboratory should accomplish the following functions:

⁶ IEC 17025 at Clause 4.2.4 states: "Personnel <...> shall keep confidential all information obtained or created during the performance of laboratory activities, except as required by law".



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- to serve as return path for the currents on the ground side in the event of fault related to internal and external source of the Laboratory,
- to ensure the safety of personnel staying in the Laboratory, surrounding area included, by reducing the generated voltages to levels that the human being can tolerate,
- to provide protection to the electrical equipment by rapidly dissipating electric surges through a low impedance path to enable the discharge of the related currents to ground.

Concerning the safety of people, two main aspects have to be considered:

- *touch voltage* (V_t): is the potential impressed between one hand and feet of a person when touching a grounded structure during a flowing to the earth of a fault current and the earth itself acts as a return path;
- *step voltage* (V_s): is the potential difference experienced by a person walking on the floor over the grounding system and it is related to the voltage profile along the surface.

Moreover, in a High Voltage Laboratory the high voltage impulse may significant affect the control and measuring systems with significant disturbance generated during the tests. So, a **measuring earthing grid** has to be provided.

- **Compressed Air System**

In addition to the common uses, the compressed air in a Testing Laboratory may be used for the operation of pneumatic equipment (such as disconnectors).

The system includes a number of compressors operating at high pressure (typically 20-30 MPa), a storage system with a capacity not less than 50% of daily consumption, a control unit managing the start and stop of the compressor depending on the compressed air demand. The compressed air, oil free and at a pressure of about 1 MPa, is distributed through a grid interesting all the facilities.

- **Lighting System**

The luminous intensity in the testing facilities and AHD shall be such as to allow fine mechanical work (500 lux recommended), adjustable for at least 50 % of the lamps through a dimmer control in order to obtain darkened conditions to observe electrical discharges on the testing object.

To obtain a uniform distribution of the light, the lamps are to be conveniently arranged on the walls of the testing halls at two different heights: at 1/3 and 2/3 of the height of the building. In any case it is suggested to avoid lamps on the ceiling of the testing halls that would lead troubles in maintenance operations.

- **Catchment tank under Laboratory Power Transformers**

The Laboratory transformers will be surely oil insulated type. In order to prevent the oil leaking into the soil a catchment tank shall be provided under each Power and Regulator Transformer. The oil falls into the collecting sump where, through an oil busduct, is conveyed into the common

waste oil and water collecting tank located in Oil tank yard. In the event of fire, a gravel system inside the catchment tank prevents the oil to continue burning in the collecting sump.

This solution it has to be adopted in the Transformer testing facility for the oil insulated transformers to be tested.

Figure D3-1-1 shows a sketch of an oil catchment tank.

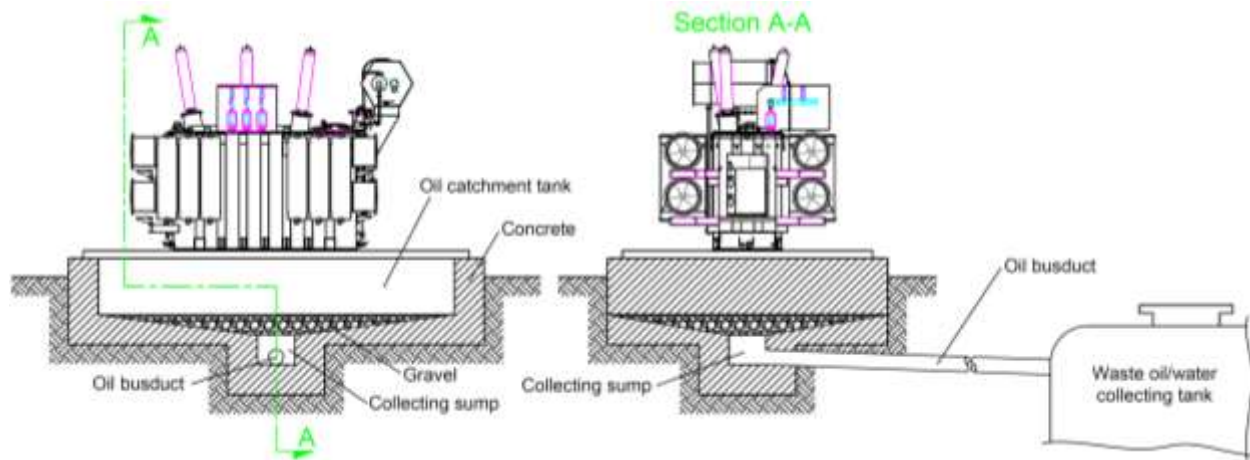


Fig. D3-1-1 Sketch of oil catchment tank under Laboratory Power Transformers



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7 The preliminary layout of Testing Laboratory

The layout of Fig. D3-1-2 shows the Testing Laboratory after the completion of the construction of the Stage 2 configuration and then it includes all the testing and auxiliary facilities of both Stage 1 and Stage 2 configurations.

Moreover, considering possible future expansions of the Laboratory testing capability, some suitable spaces have been provided for the installation of future testing facilities (such as a second Short-circuit Generator and a second area for HV Power Cable pre-qualification tests).

7.1 Design criteria for the proposed layout

- a) All the testing facilities are powered in order to be able to perform all the type tests listed in Annex 1 for the two configurations of the Laboratory;
- b) The dimensions of the testing facilities are such as to allow:
 - an easy access and handling both of the Laboratory testing equipment and of the equipment to be tested,
 - safety testing operations in connection with the involved high voltages and high currents,
 - adequate space for the maintenance of testing equipment (including the removal of damaged equipment for repair at the manufacturer's workshops);
- c) The movements of the testing equipment from the Assembly and Disassembly Hall to test facilities have been minimized;
- d) Adequate access gates to the Laboratory as well as internal roads and spaces have been provided for easy access to testing facilities and ADH;
- e) An area dedicated to the offices of Laboratory Direction and staff and to an Auditorium for conferences and international workshops has been planned.

7.2 Short layout view

Referring to Fig. D3-1-2, **on the left side** are located the main testing facility, each as far as possible to its power source:

- a) the High-Power LV/MV facility (the first testing facility of the Laboratory to be built), is located near to the Substation fed by the 220 kV external power line; downstream of the Substation is placed the HV/MV Laboratory Transformer whose ratio changer system makes available the required test voltage for Distribution/Power transformers and MV equipment during the Stage 1 configuration of the Laboratory; this transformer also feeds the MV/LV Transformer addressed to supply the power circuits for LV equipment testing;
- b) the High-Power MV testing facility fed by the Short-circuit Generator through a ratio changer system to obtain the test voltages for the short-circuit tests on MV equipment in the Stage 2



Power Cell



configuration of the Laboratory; close to the two MV test cells are placed the ADH for the assembly of the equipment to be tested;

- c) Placed between the two High-Power facilities is the Transformers facility supplied by the Short-circuit Generator and addressed to Distribution and Power transformers tests in the Stage 2 configuration of the Laboratory;
- d) An area available for the installation of a second Short-circuit Generator that in parallel operation with the first one could supply in the future a further testing facility for HV equipment testing.

In the **central part of the layout** are located:

- the High Voltage testing facility,
- the Temperature rise testing facility,
- the Mechanical testing facility,
- the workshop and the warehouse.

In this area there are spaces to install additional testing facilities not requiring short-circuit power.

In the **right part of the layout** are planned:

- the buildings housing the offices of the Top Managers and the staff,
- The Residential facility, a building with two floors for the accommodation of workers and engineers who live far from the Laboratory site,
- the Auditorium,
- the Canteen,
- the area used for pre-qualification tests of HV power cables.

A second test area for HV power cables is planned in the lower part taking into consideration of the long duration of the relevant tests (up to one year) and the expected increase of the testing demand for this equipment in connection with the huge growth of the country electrical system in the coming years.

The laboratory's proposed layout covers a space of 390 x 220 meters, which is equivalent to an area of 85,800 square meters.

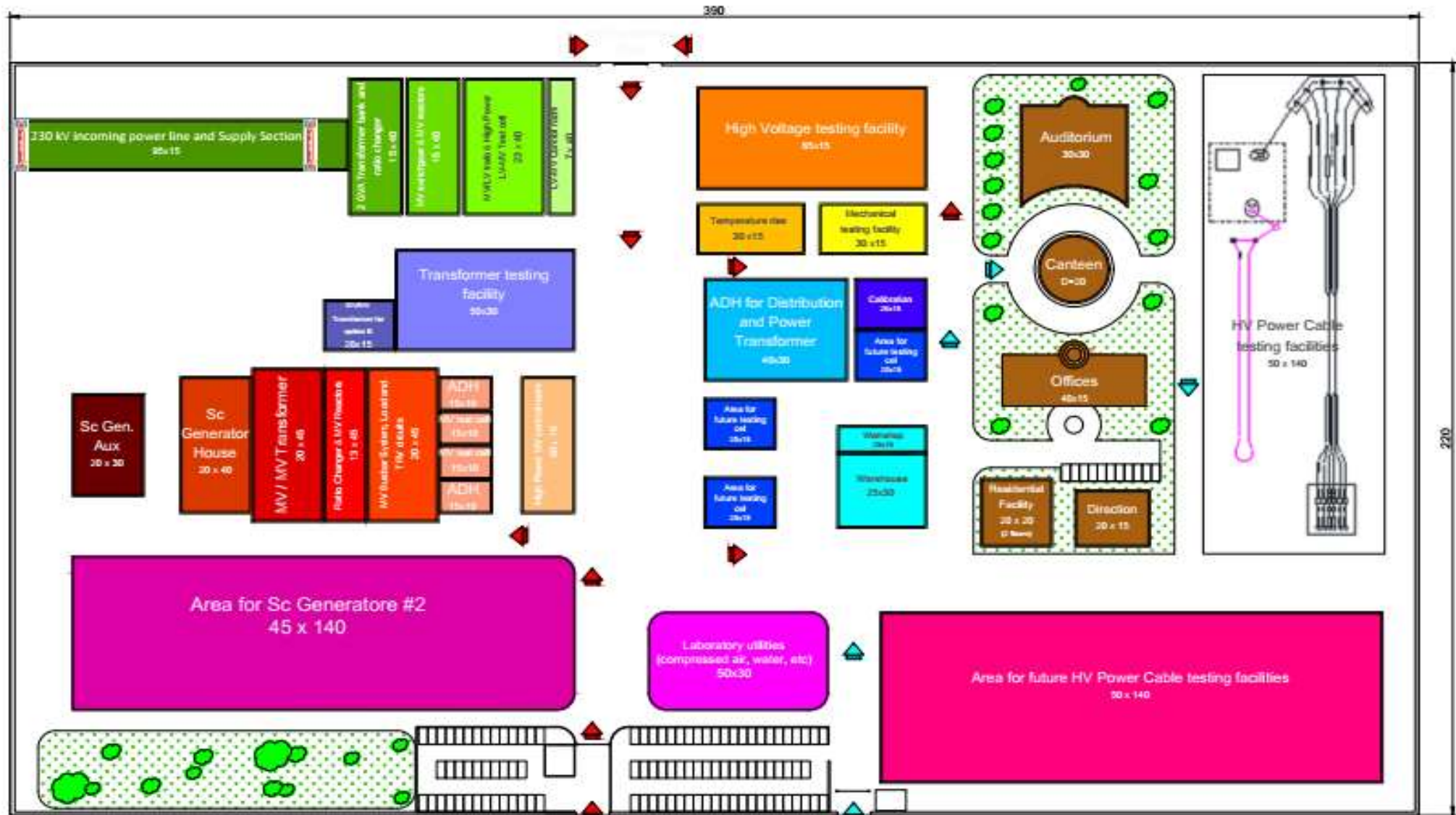


Fig. D3-1-2 - Testing Laboratory preliminary layout



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8 The criteria for the selection of Testing Laboratory site

The following issues have to be considered in the process aimed to define the Testing Laboratory location.

Once the power station powering the Laboratory through a 230 kV power line has been defined, it is appropriate that the choice of the Laboratory location takes into consideration the potential consequences of voltage fluctuations (within a maximum of 5%) on the network. Likely the laboratory should not be located near to the power plant in order to disturb as little as possible the sensitive loads served by the grid. On this aspect the Power Company grid of Bangladesh will be able to make useful indications following appropriate evaluations based on his in-depth knowledge of the local networks.

Another critical aspect to be taken into consideration concerns the access roads to the Laboratory starting from the nearest port where the bulky and heavy testing equipment will be delivered. In this regard, it must be considered that the transport of the Short-circuit Generator will require two 18-wheeler trucks for a total length not less than 80 meters and width of about 5 meters. Similarly, the HV/MV Short-circuit Transformer HV/MV (that will be fed by the 230 kV power Line) will require a convoy with a length of not less than 50 meters.

Environmental and socio-economic aspects must not be neglected. Although the Laboratory does not produce emissions or volatile pollutants it occupies an area of about 100,000 square meters and in the surrounding area will circulate many heavy vehicles for the transport of equipment to be tested. The Laboratory will have a positive social effect in the area in connection with the technicians, testing engineers and workmen employed in the Laboratory and the employment induced by the activities managed in outsourcing (such as some maintenance works, instrument calibration, chemical analysis, etc.) or related to the ordinary operation (guardian services, canteen services, etc.).

In the vicinity of the Laboratory a village, or equivalent solution, will have to be provided for the accommodation of the staff that resides at a considerable distance (over an hour of travel typically) and for the customers technicians that will have to assembly and disassembly the equipment to be tested and witness to tests execution.



Power Cell



ANNEX 1

Test performed on different type of equipment in Stage 1 and Stage 2 configurations of the Testing Laboratory

Table D3-1-3 - Low Voltage equipment

Equipment	Stage 1																									
	Rated Voltage [V]	Rated Current [A]	Max Rated Short-time current [kA]	Rated Short-circuit current [kA]	DT	SSCB	USCB	STC	SCB	TR	OP	MO	SCM	FSC	MB	SC	ISP	NFFC	TCC	BC	COC	I2T	PF	IV		
LV Circuit Breakers for industrial uses	220	up to 6300	100, 3s 200, 1s	up to 120	X	X	X	X	X	X	X	X														
	415			up to 140																						
	690			up to 200																						
LV Switches, Disconnectors, Switch-disconnectors, Switch-fuse combination units	220 415 690	up to 6300	80, 3s	from 25 up to 80	X			X		X	X	X	X	X	X											
Electromechanical Contactors, Motor - Starters		up to 5000	-	from 6 up to 50	X					X	X				X	X										
LV Fuses		up to 800	-	up to 80						X	X						X	X	X	X	X	X				
LV Switchgears and Controlgears Assemblies		up to 6300	100, 3s 200, 1s	(1)				X		X		X											X	X		
LV Busbar Trunking		up to 6300	120, 3s 160, 1s	(1)				X		X							X							X	X	

(1) Within a required short-circuit power not higher than 200 MVA

Legenda

DT	Dielectric test	MB	Making and breaking capacity
SSCB	Service short-circuit breaking capacity	SC	Short circuit
USCB	Ultimate short-circuit breaking capacity	ISP	Insulation properties
STC	Short-time withstand current and peak withstand current	NFFC	Verification of conventional non-fusing and fusing-current
SCB	Short-circuit capacity at maximum Short-time withstand current	TCC	Verification of time-current characteristics and gates
TR	Temperature rise test	BC	Verification of the breaking capacity
OP	Overload performance	COC	Verification of cut-off current characteristic
MO	Mechanical Operation	I2T	Verification of I ² t characteristic and overcurrent discrimination
SCM	Short-circuit making capacity	PF	Power frequency
FSC	Fuse protected short circuit withstand and making	IV	Impulse voltage

Table D3-1-4 – Medium Voltage equipment in Stage 1 configuration

Equipment	Stage 1																
	Rated Voltage [kV]	Rated Current [A]	Rated Short-time current [kA]	PF	LI	PD	ACC	VT	MR	TR	LHT	TS	RIV	MO	MST	CC	STC
Circuit Breakers	from 3.6 up to 36	from 630 up to 6300	up to 63,1 s	X	X	X	X	X	X	X	X			X			X
Generator Circuit Breakers				X	X	X	X	X	X	X	X			X			X
Disconnectors , Earthing Switches				X	X	X	X	X	(1)		X					(1)	X
Switches		from 400 up to 800	up to 20,3 s	X	X		X	X	X	X	X			X			X
Switches-fuse combination				X	X		X	X		X				X	X		X
Expulsion Fuses		from 16 up to 200	-	X	X					X							
Current limiting Fuses			-	X	X					X							
Surge Arrester (Lightning Arresters)		-	-	X	X								X				
Gas Insulated metal enclosed Switchgears and Controlgears		from 630 up to 6300	up to 63,3 s	X	X	X		X		X			X	X			X
Metal enclosed Switchgears and Controlgears (Ring Main Unit included)		from 630 up to 3150		X	X	X		X		X				X			X
Solid insulated-enclosed Switchgears and Controlgears				X	X	X		X		X		X		X			X
MV Busducts		from 630 up to 6300		X	X			X		X							X

(1) Only for Disconnectors

Table D3-1-5 – Medium Voltage equipment

Equipment	Stage 2																								
	Rated Voltage [kV]	Rated Current [A]	Rated Short-time current [kA]	Rated Short-circuit current [kA]	SCBM	CC	SDEF	OPMB	CCS	SSMB	LCB	GSMB	SCM	MB	MBI ² T	BRTC	BRTTC	TPAT	BT	TCC	TST	MBC	IA	SCT	
Circuit Breakers	from 3.6 up to 36	from 630 up to 6300	up to 63,1 s	up to 31.5	X	X	X	X	X																
Generator Circuit Breakers				up to 31.5				X		X	X	X													
Disconnectors , Earthing Switches				(1)									(3)												
Switches		from 400 up to 800	up to 20,3 s	(2)										X											
Switches-fuse combination				up to 20									X	X	X	X	X								
Expulsion Fuses		from 16 up to 200	-	up to 20																	X				
Current limiting Fuses			-	(2)															X		X				
Surge Arrester (Lightning Arresters)		-	-	(2)																				X	
Gas Insulated metal enclosed Switchgears and Controlgears		from 630 up to 6300	up to 63,3 s	(2)																			X		
Metal enclosed Switchgears and Controlgears (Ring Main Unit included)		from 630 up to 3150		(2)																			X	X	
Solid insulated-enclosed Switchgears and Controlgears				(2)																			X	X	

(1) Max short-circuit power on test object: 650 MVA

(2) Max short-circuit power on test object: 1500 MVA

(3) Only on Earthing Switches



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PF	Power Frequency voltage
LI	Lightning Impulse Voltage
PD	Partial discharge
ACC	Tests Auxiliary and Control circuits
VT	Voltage test as a condition check
MR	Measurement of the resistance of the main circuit
TR	Temperature rise test
TS	Thermal Stability
RIV	Radio Interference Voltage
LHT	Low and High temperature tests
MO	Mechanical Operation
MST	Mechanical Shock tests on fuses
STC	Short-time withstand current and peak withstand current
CC	Continuous current test

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SCBM	Short-circuit making and breaking
CC	Critical Current
SDEF	Single phase and double earth fault
OPMB	Out-of-phase making and breaking
CCS	Capacitive current switching
SSMB	System-source short-circuit making and breaking
LCB	Load current breaking
GSMB	Generator-source short-circuit making and breaking
SCM	Short-circuit making performance
MB	Making and breaking
TCC	Time current characteristics
MBI2T	Making and breaking at the maximum breaking I^2t
BRTC	Breaking test at the rated transfer current
BRTTC	Breaking test at the rated take-over current
TPAT	Thermal test with pre-arcing time
BT	Breaking tests (Test duty 1,2,3)
TST	Test of strikers
MBC	Verification of making and breaking capacity
IA	Internal arc
SCT	Short circuit test (on surge arrester)

Legenda for page 37

Table D3-1-6 – Distribution and Power Transformers

Equipment	Stage 1				Stage 2 Option A				Stage 2 Option B		
	Primary Voltage [kV]	Secondary Voltage [kV]	Short-circuit impedance	Rated Power [MVA]	Primary Voltage [kV]	Secondary Voltage [kV]	Short-circuit impedance	Rated Power [MVA]	Primary Voltage [kV]	Secondary Voltage [kV]	Rated Power [MVA]
Distribution Transformers	from 3.3 up to 13,8	0.4	4% ÷ 6%	4	11 and 13.8	0.4	2.5% ÷ 4%	2.5			
					33	0.4	4% ÷ 7%	5			
Power Transformers	33	11	4% ÷ 8%	20	33	11	4% ÷ 8%	28			
					66	11	7% ÷ 10%	28			
					132	11	15% ÷ 22%	50			
					132	33	15% ÷ 22%	50			
									up to 230	from 65 up to 230	160 ⁽¹⁾

1)160 MVA is the 3-phase power of the Transformer; the short-circuit test will be performed on one phase of the Transformer.

Legenda

Measurement of voltage ratio and check of phase displacement	Measurement of winding resistance
Measurement of no-load loss and current	Lightning Impulse voltage
Measurement of no-load loss and current at 90% and 110% of rated voltage	Temperature rise
Measurement of zero-sequence impedance(s) on three-phase transformers	Applied voltage
Determination of capacitances windings-to-earth and between windings	Line Terminal AC withstand voltage
Induced voltage test with partial discharge measurement	Measurement of dissipation factor (tan δ)
Measurement of d.c. insulation resistance each winding to earth and between windings	Induced Voltage
Measurement of frequency response (Frequency Response Analysis)	Ability to withstand short-circuit

Table D3-1-7– Current, Voltage and Combined Transformers

Instrument Transformers	Stage 2																	
	Rated Voltage [kV]	Rated Short-time current [kA]	Max Short-circuit power [MVA]	PD	LI	CLI	PFS	PFST	PFPT	RIV	IOV	MO	TR	SCT	SC	TA	IAF	
Current Transformers	up to 400	up to 6.3	up to 1500	X	X	X	X	X	X	X	X	X	X	X		X	X	
Inductive Voltage Transformers				X	X	X	X	X	X	X	X	X	X	X		X	X	X
Combined Transformers				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Legenda

PD	Partial discharge measurement
LI	Impulse voltage withstand test on primary terminals
CLI	Chopped impulse voltage withstand test on primary terminals
PFS	Power-frequency voltage withstand tests between sections
PFST	Power-frequency voltage withstand tests on secondary terminals
PFPT	Power-frequency voltage withstand tests on primary terminals
RIV	Electromagnetic compatibility
IOV	Inter-turn over voltage test
MO	Mechanical tests
TR	Temperature rise test
SCT	Short-time current tests
SC	Short-circuit withstand capability
TA	Test for accuracy
IAF	Internal arc fault test

Table D3-1-8 – Ceramic, glass and polymeric insulators

Equipment	Stage 2							
	Rated Voltage [kV]	LI	SLI	WPF	PT	PF	DPF	RIV
Ceramic and glass insulators	up to 400	X		X	X			X
Polymeric insulators			X			X	X	X

Legenda

LI	Lightning impulse voltage
SLI	Step-front Impulse voltage
WPF	Impulse voltage withstand test on primary terminals
PT	Puncture withstand test
PF	Reference dry power frequency
DPF	Dry power frequency voltage
RIV	Electromagnetic compatibility

Table D3-1-9 – Power Cables with extruded insulations

Power Cables with extruded insulations	Rated Voltage [kV]	BE	IR	IRT	LIPF	SI	PD	IV	IVV	Tan δ	VT	HT	HCPT	LIPT
Stage 1														
Rated voltage from 1.2 kV up to 3.6 kV	from 1.2 up to 3.6		X	X				X			X			
Cables having unscreened insulation	from 7.2 up to 36		X	X							X			
Cables having conductor screen and insulation screens		X					X		X	X	X	X		
Stage 2														
Rated voltage above 36 kV up to 170 kV	above 36 up to 170	X			X		X			X		X	X	X
Rated voltage above 170 kV up to 400 kV	above 170 up to 400	X			X	X	X			X		X	X	X

Legenda

IR	Insulation resistance measurement at ambient temperature	BE	Bending
IRT	Insulation resistance measurement at maximum conductor temperature	SI	Switching impulse voltage test
LIPF	Lightning impulse voltage test followed by a power frequency voltage	PD	Partial discharge
HCPT	Heating cycle voltage in prequalification tests	Tan δ	Tan δ measurement
LIPT	Lightning impulse voltage in prequalification tests	IV	Impulse Voltage
IVV	Impulse voltage followed by a voltage test	VT	Voltage test 4 h
HT	Heating cycle voltage		



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Ministry of Power, Energy & Mineral Resources
Govt. of the People's Republic of Bangladesh

**Consultancy Services for Setting Up Electrical Testing
Laboratory**
(Contract Package: S-10)



Deliverable	D3-First Informative Report
Document	2 – National Testing Laboratory Organization
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Client	Power Cell
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Power Cell

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1. Foreword

Referring to the document Conceptual Configuration of the Testing Laboratory¹ the development of the National Testing Laboratory will take place through 3 successive steps:

- Stage 0, lasting about 3 years from the time of the decision to establish the Testing Laboratory and the availability of the testing facilities related to the Laboratory in the Stage 1 configuration,
- Stage 1 with a duration of 3 years during which:
 - the Laboratory will supply the testing services allowed by the testing facilities powered by a 220 kV external line coming from a 220/132 kV power station,
 - it will be completed the building of the Laboratory according to the Stage 2 configuration.
- Stage 2 with the Laboratory able to operate at its maximum testing capability allowed by a 2500 MVA Short-circuit Generator.

So, it is during the initial Stage 0 that the Testing Laboratory must be organized and structured in order to be able to carry out:

- the recruitment and training of all the Laboratory staff (technical, commercial, administrative),
- the assignment of tasks for the execution of Basic design and Detailed Design of the Laboratory,
- the assignment of contracts for the construction of the Laboratory buildings and the related services (air conditioning, lighting, fire-fighting system, etc.),
- the procurement of all testing equipment and systems,
- the Laboratory erection and commissioning.

Moreover, during Stage 0 it will have to start the commercial, promotional and communication activities at national and international level in such a way that after the commissioning of the Stage 1 configuration the Laboratory can fully start its business operation.

The complete organization of the National Testing Laboratory, to be defined and implemented during the initial phase of the Stage 0, will be described in the following.

Remarks and comments raised by the Client and the Stakeholders were taken into account in this rev.1 of the document.

¹ see D2-1- Conceptual Configuration of the Testing Laboratory, rev.1



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2. The organization of National Testing Laboratory

NTL will have to operate in a very competitive market (international and regional laboratories) and will therefore have to be:

- **accredited** as concern the Laboratory Quality System but also **in term of market acceptance**; both accreditations are important but it should be emphasized that only commercial accreditation is capable of giving credibility to the Laboratory, that is such as to ensure the **same quality of international testing laboratory** (such as CPRI, Keri, CESI & Kema),
- **competitive**, in terms of **lower price** and **less waiting time to test an equipment**.
- The market acceptance of a conformity assessment body is usually based on the recognition of the conformity with the international practice that may be obtained after assessment by national or international accreditation bodies according to the relevant ISO IEC standards.

The above entails with:

- **high technical skills of the staff** (not only of the technical functions),
- **strong focus on the market**, in terms of communication and promotional policies and pricing strategies.

After some clarification concerning the technical accreditation of the Testing Laboratory, the following chapters take into consideration:

- the organizational issues of all processes related to testing activity (the most demanding in organisational terms)
- all the operating functions of the Laboratory.

2.1 Quality System and Accreditation

NTL shall work under the rules of a Quality System, managed by a Quality Manager, has to be certified complying with the ISO/IEC Standard 9001: "Quality management systems – Requirements".

In addition, as independent and referenced laboratory, an accreditation according to ISO/IEC Standard 17025: "General requirements for the competence of testing and calibration Laboratories" is strongly required.

Considering the inspection and certification activities of NTL, the accreditation to:

- ISO/IEC 17020: "Conformity assessment - Requirements for the operation of various types of bodies performing inspection",
- ISO/IEC 17065: "Conformity assessment -Requirements for bodies certifying products, processes and services",

are also required.



The above accreditations must be carried out with the **Bangladesh Accreditation Board (BAB)**; being BAB member of the **Asia Pacific Accreditation Cooperation (APAC)** and of the **International Laboratory Accreditation Cooperation (ILAC)** the accreditation will be internationally recognized.

Moreover, it may be convenient that NTL should also consider a certification complying with the following standards, relevant to “safety” and “environment”:

- OHSAS 18001: “Occupational Health and Safety Assessment Series - Occupational Health and Safety management Requirements”.
- ISO/IEC standard 14001: “Environmental management systems - Requirements with guidance for use”.

The above group of certifications and accreditations will impact on the organization of NTL in many ways, typically implementing an organizational structure for the management of the Quality System and a consistent set of procedures and tools.

2.2 Testing activities and relevant afferent processes

Each testing activity is the follow up of a commercial action whose final outcome is the Client order to perform type tests or development tests on a specified equipment. Type tests are to be performed according to the Standard specified by the Client while the development tests are to be carried out in compliance with a dedicated technical specification issued by the customer.

So, testing activity begins with the acquisition of an order for the provision of a testing service, with related delivery terms and condition, and ends with the issue of an invoice to the customer for the provided services. Along this path several processes are involved which are based in as many operational functions of the Testing Laboratory.

The block diaphragm of Fig. D3-2-1 represents such processes, below described, and the correlations between them.

2.2.1 Planning and Dispatching

This process is addressed to:

- schedule and ensure the best performance of the tests,
- manage the testing facility(ies) engagement for test(s) execution,
- dispatch and manage the personnel in charge of the test execution,
- dispatch and manage power sources and any other resource required for carry out the test,
- plan the logistics and maintenance activities.

Planning and dispatching tasks are based on customers' requirements and they aim to:

- check the type of the equipment to be tested and all the requested tests to be carried out,
- identify the involved testing facility(ies) to be used for the tests as well as the test duration,

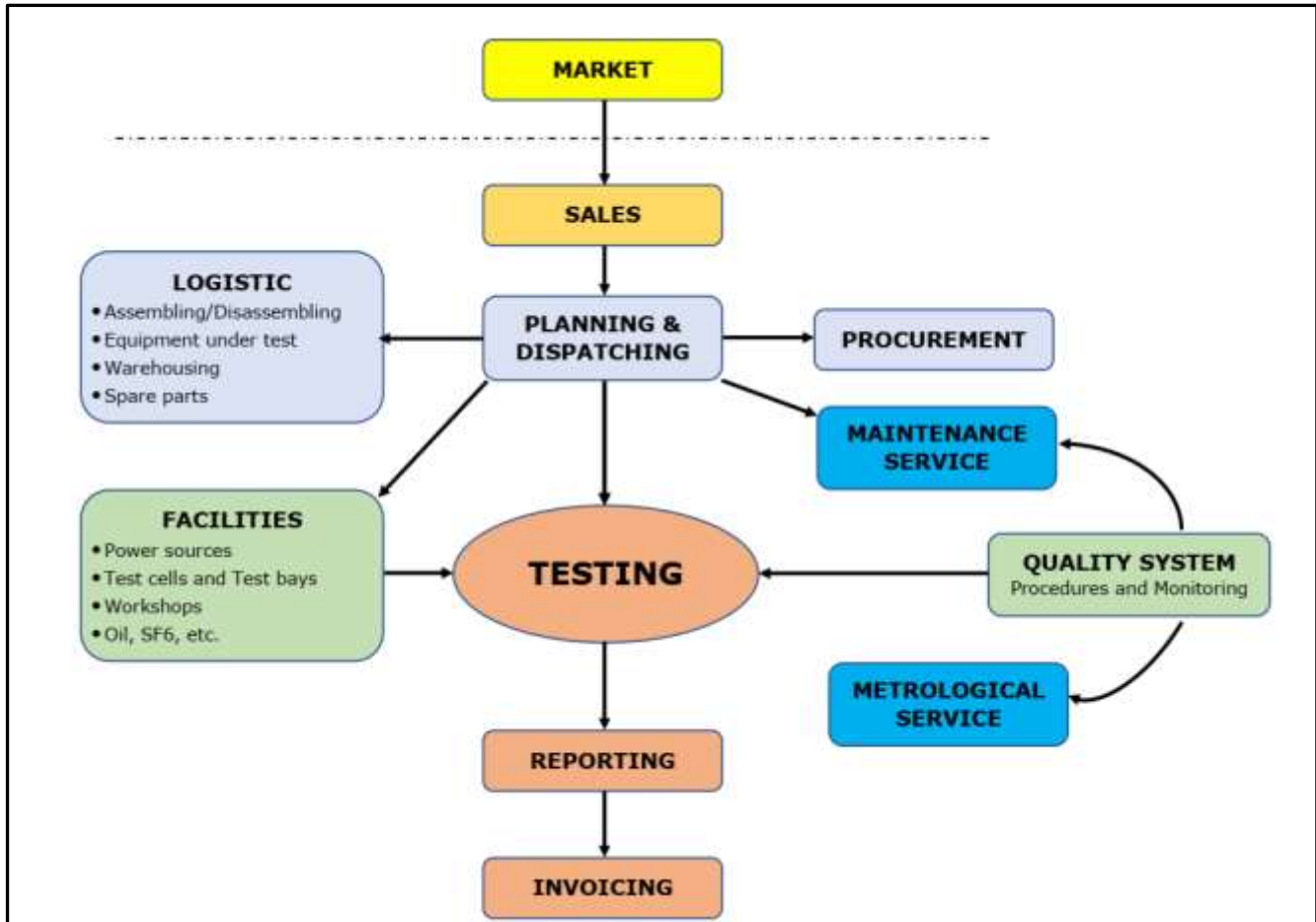


Fig. D3-2-1- Block diagram of processes involved in testing activities

- schedule the tests·
- identify additional needs, if any, in terms of testing equipment or instrumentation other than the one normally available in the identified testing facility,
- check the availability of each testing facility at the time of the scheduled date,
- check the logistics availability, if additionally requested, at the time of the scheduled date.

In case of High-Power tests shall be ensured the availability of power sources specifically conceived for this purpose. During the Stage 1 the Testing Laboratory is only powered by a 230 kV external line while during the Stage 2 the Laboratory is also equipped with a Short-circuit Generator.

Considering the different testing facilities of the Laboratory (High-Power LV and MV, Power Transformer Bay, High Voltage, Temperature Rise, Mechanical, HV power Cables) the more suitable power source has to be selected and its utilization has to be planned according to the type of test and to the related test parameters.



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DESIGN and MANAGEMENT of ELECTRICAL POWER ASSETS

Care must be taken in optimizing the dispatching of the power supply sources allowing the execution of as many tests as possible.

The impact of Power dispatching on the design of NTL is outlined in the following requirements:

- a) foresee a control room for the management of the Short-circuit Generator(s) and of the external line coming from the power grid;
- b) implement flexible and reliable connections of the power sources to the testing facility supply sections, in order to achieve a safe, fast and easy commutation among the different connections; all the operation must be automated and controlled by a proper supervision system;
- c) provide the supervision system with suitable automated functions for a fast and easy change of power supply settings from one test to the other, optimizing the commutation time and making parallel testing possible and efficient.

It is advisable that the management of Power dispatching, as part of the services carried out by the maintenance function that can promptly intervene in case of malfunctioning.

2.2.2 Logistic and material management processes

Logistics is the management of the goods and materials (the equipment to be tested but also the Laboratory equipment) in order to carry out the scheduled testing activities and to meet the requirements of maintenance service and auxiliary services (including calibration of instrumental devices).

With regard to the equipment to be tested, logistics involves the correct receipt, handling, storage, protection, retention and tracing of the testing materials, up to their disposal or return, according to the quality prescriptions and confidentiality.

The flow of materials must be optimized reducing the number and the time/effort needed for handlings. This implies that the buildings involved in the process must be located coherently with the process flow, without crossing or overlapping points. Assembly/disassembly halls and temporary storage areas must be located as near as possible to the testing facilities while long waiting period storage area can be placed conveniently far from the more congested ways of handling.

The dimensions of the equipment to be tested must be taken into consideration in designing roads, warehouses and assembly/disassembly halls.

With respect to maintenance, logistics involves the correct purchase, receipt, storage, protection, retention and tracing of spare parts and their delivery at place when needed for the execution of maintenance activities.

An essential requirement is that NTL must be equipped by with all the spare parts necessary to assure the higher possible level of business continuity. Stock availability of spare parts is crucial for the continuity of operation of the equipment and for a fast recovery of outages minimizing the idle periods. The process allowing the provision of spare parts assuring their availability on time and the delivery at place is defined Material Management process and it is managed by the Procurement function.



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The impact of Logistics and Material Management process on the design of the ETL is outlined in the following requirements:

- a) provide proper structures for the receipt of goods (equipment to be tested, spare parts, consumables), with an inbound/outbound area, loading and unloading equipment, long waiting period storage area, etc.
- b) conceive suitable dimensioned and equipped warehouses that must be differentiated in their destination, without mixing different type of contents (a warehouse for equipment to be tested, another warehouse for spare parts and consumable)
- c) foresee Assembly/Disassembly halls for the customers, equipped with auxiliary services (electrical power source, compressed air, etc.), cranes, lifting platforms, etc. and with optimized access to the laboratories;
- d) include an area for the disposal of equipment to be tested and waste materials.

2.2.3 Maintenance Service

Many of the tasks of the Maintenance service have been already specified in previous paragraphs, like the need of a spare parts warehouse, the implementation of material management system, the availability of a workshop and the power supply source dispatching service.

Other tasks falling within the scope of this function are:

- a) provide a workroom for the maintenance of electronic equipment and measuring instruments (including the software of control, monitoring and data acquisition systems),
- b) organize the maintenance areas and structures in order to minimize the time needed for the maintenance interventions;
- c) foresee suitable tools for the monitoring of the status of the laboratory equipment;
- d) prepare tools for the planning of maintenance activities, the tracing of maintenance interventions, the analysis of faults, the evaluation of maintenance statistics.

2.2.4 Metrological service

A Test Laboratory performs periodical calibration of the measuring instruments to achieve confidence in the measurement, assure that measurements are accurate within the specification limits and verify that they are consistent and, above all, repeatable.

The measurements of test parameters and quantities, such as currents and voltages, are the main results of a testing activity and determine the positive or negative outcome of the test itself.

A proper calibration process is then crucial for the quality of a laboratory and is therefore an important requirement of all the Standards on Quality.

The calibration process is assured by a metrological service that, using internal and external resources, complies with the prescriptions of the Standards assuring the full traceability of measuring instruments to national standards.



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The impact of Metrological Service process on the design of NTL is outlined in the following requirements:

- a) conceive a calibration laboratory, equipped with suitable sources of current and voltage and with an area controlled in temperature and humidity;
- b) consider that, where the capabilities of the calibration lab are not sufficient (high currents and voltages ratings), calibration activities must be foreseen in HV and/or HP testing facilities;
- c) envisage proper areas for the storage of measuring instruments before and after the calibration, of the measuring standards, of the instruments to be sent to external calibration service and of the non-conform instruments;
- d) provide suitable tools for the monitoring, tracing, management of measuring instruments of the Laboratory.

2.2.5 Test execution

All operations requested to carry out tests shall be performed by qualified and properly trained personnel, organized in testing teams.

In each testing team personnel having different skills will be present:

- Test Engineer (engineer responsible of the test performing and relevant results),
- Test Operators (for the set-up and operation of the equipment and of the measuring system),
- Workmen (to assembly/disassembly the test plant, power circuits and test circuits).

During the initial operating phase of NTL all the testing facilities will be most probably scheduled with one shift per day. An increase of request from the market, asking for a higher testing capacity, will be easily implemented adding a second shift per day and increasing the number of testing teams without any significant modification of Laboratory assets.

The impact of Test planning on the design of NTL is limited to the few following aspects:

- a) provide offices and spaces for the test engineers and test operators,
- b) provide dressing rooms and restrooms with showers for the workers;
- c) make the access to the necessary services by the testing personnel possible also out of normal working time (for instance during night shift).

2.2.6 Reporting and Editing process

It has to be outlined that the testing activity does not end upon completion of the test but with the issuance of the document (whether it is a Test Report or a Test Certificate) which is valid for the market as attesting the quality of the tested equipment. In other terms the issued document reporting the tests results is the final product of the testing activity and their level of quality is crucial for the excellence of the laboratory itself.

In fact, Reporting and Editing process shall be an important part of NTL Quality System and it must comply to the prescription of ISO/IEC 17025.



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Reporting and Editing process requires a relevant organizational structure and a consistent set of procedures and tools for an effective management of the Test document:

- a) conceive an Editing Office with suitable tools for the preparation, editing, printing, binding and filing of the test documents;
- a) include an area for the archive of drawings and documents delivered by the customer for the identification of their equipment to be tested;
- b) provide a reliable, powerful and safe IT network with connections with testing facilities measuring systems and with data loggers to have direct access to test results;
- c) foresee safe, redundant and large data storage areas for the registration of raw data coming from the testing activities.

2.2.7 Requirements for Customer Care and Confidentiality

Customers asking to test in NTL will deliver their equipment normally not assembled in the final configuration and not ready for tests.

The preparation of the equipment for the test is under responsibility of the Customer that usually send his personnel to support all the assembly and disassembly phases, to witness the tests and to perform maintenance on the EUT where applicable.

Privacy of Client's activities is needed, to assure service confidentiality in presence of multi-customer operations. IEC 17025 at Clause 4.2.4 states: "Personnel <...> shall keep confidential all information obtained or created during the performance of laboratory activities, except as required by law".

The impact of Customer Care and Confidentiality issues on the design of NTL is outlined in the following requirements:

- a) provide to the customer appropriate support for the assembly, maintenance and disassembly of the equipment to be tested, in terms of equipped areas, auxiliary services (electrical power source, compressed air, etc.), cranes, lifting platforms, etc.;
- b) provide to customer's people structures for their staying during the testing period (i.e. customer rooms, restrooms, showers, dressing rooms, meeting rooms) and for their witness of the test inside the laboratories;
- c) protect assembly/disassembly areas from the access and the sight of other customers, preventing the theft of confidential information; the same apply to customer rooms and areas where confidential documents are normally present;
- d) prevent access to laboratories and reserved areas, like warehouse for the equipment to be tested, by nonauthorized personnel, through proper controlled passages.

2.2.8 Requirements for Safety and Environmental issues

Maximum care to Safety and Environmental aspects have to be taken in every activity of the Laboratory. Typically, these issues are managed by the same organizational structure involved in the management of the Quality System and proper procedures and tools are implemented and integrated at this level.



The impact of Safety and Environmental issues on the design of NTL is outlined in the following requirements:

- a) implement proper fire prevention systems and firefighting measures according to the local laws and prescriptions – particular care must be devoted to the test area for power transformers;
- b) foresee suitable measures for the collection of transformer oil leakages;
- c) include an area for the temporary storage of equipment to be scrapped;
- d) include a waste area for the controlled and confined storing of waste materials, even dangerous substances (like products of exhausted SF6);
- e) organize the internal road network with restricted access to industrial areas, safe routes for pedestrians, yard for trucks manoeuvre, etc.

2.3 The operating functions of the National Testing Laboratory

The different functions that must be present in NTL, regardless of their hierarchical organization or the specific nomenclature used for the different functions (such as Department, Direction, Office, etc.), are below considered.

As shown in the paragraph 2.2, all the different functions are involved in the production processes of the Laboratory and all must contribute to providing competitive services in terms of quality, price and rapid response to customer requests.

The below Figure D3-2-2 shows all the considered functions of the National Testing Laboratory. The specific tasks and responsibility of each of them are described in the following.

2.3.1 Inspection

Inspection service must be present in NTL service portfolio because it is an **important lever for carrying out the testing activities**.

In fact, in a type test program of an equipment the Standards require that some tests (such as short-circuit tests) must be carried out in an independent testing laboratory while for other tests (e.g. dielectric and mechanical tests) allow that they can be carried out in accredited laboratories of manufacturers, with independent laboratory inspectors witnessing these tests.

NTL must be able to offer inspection services by entrusting the inspection activities of reputable bodies already existing and through their own inspectors.

It should be emphasized that the Stage 0 of the Laboratory (with the Test Facilities under construction) **the only activities that can be offered on the market are those made up by Inspectors** of the tests carried out at accredited laboratories in Bangladesh.

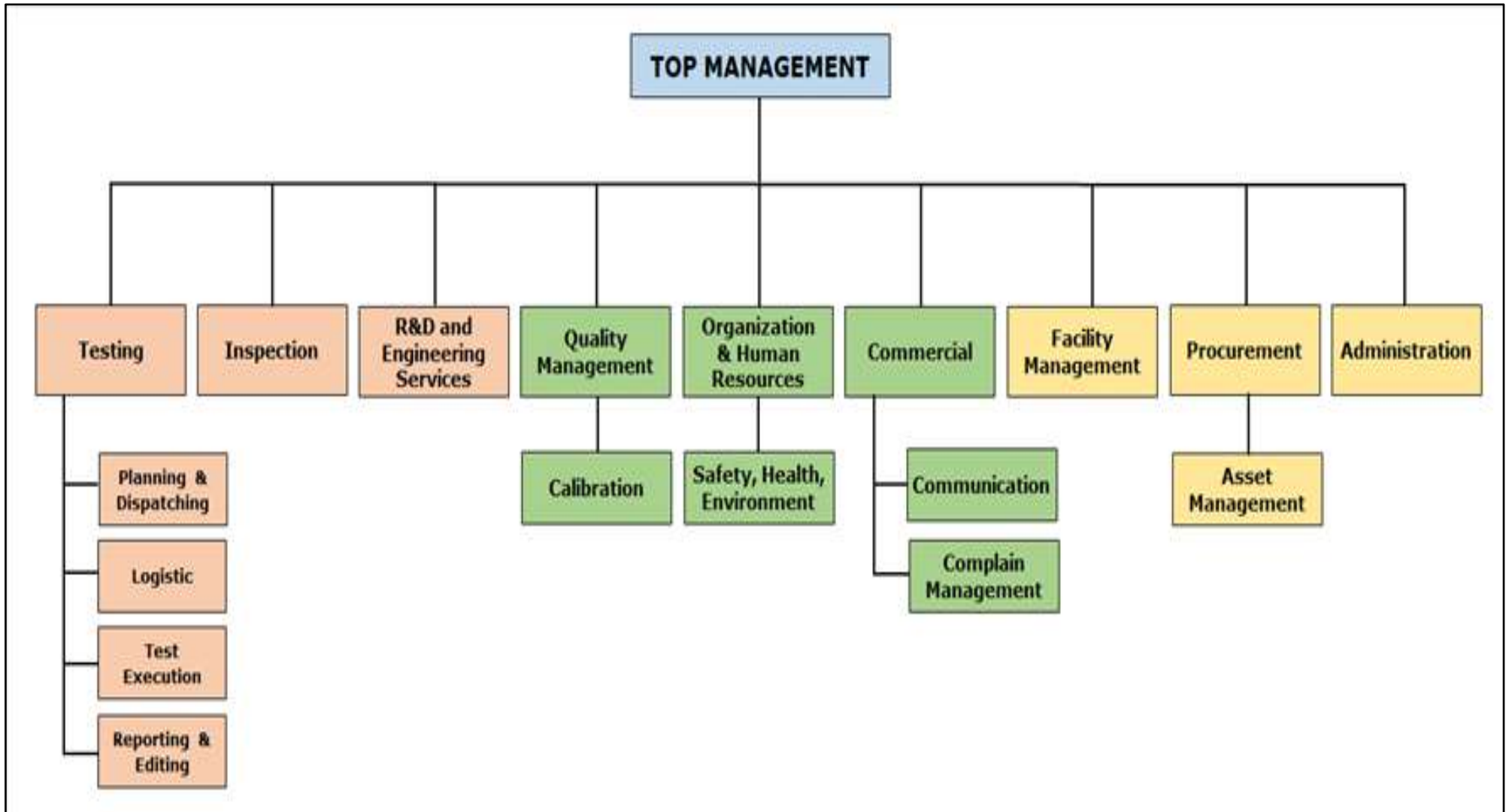


Fig. D3 – 2 – 2 - The operating functions of the National Testing Laboratory



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2.3.2 Testing

The different processes involved in testing activities has already been described in par. 2.2. Table D3-2-1 summarizes the main tasks and responsibilities of this operating function.

2.3.3 Commercial

The main tasks of this operating function are listed in Table D3–2–2, for each of which are described **the online activities** (carried out during the day-by-day operation) and **the offline or temporally programmable ones**.

Table D3 – 2 – 1: Tasks and main responsibility of the Commercial Function

Main Responsibility	On – line Activities	Out of line activities
Market monitoring	Info collections about • Customer, • Competitors, • new services required. <i>Activity carried out during all commercial and technical activities (Promotion, sale, delivery of the service)</i>	Elaboration of collected information with regards to: • Amount of the accessible market and trend, segmented by type of tests, • Rates and commercial conditions of competitors, • Service portfolio of the Competitors, • Preparation (in collaboration with the technical functions) of the Tariff and Price List.
Promotion of services	N.A.	• Preparation of Promotional Plan
Preparation of proposals and commercial follow-up	• Activity carried out daily according to market demands • Involvement of technicians for special test offers and for Consulting activities	• Preparation of the typical structure of the offer for the technical, commercial and contractual aspects.
• Periodic monitoring of sales activities • Participation in Budget definition and updating	• Continuous updating of information on requests for offers and orders	• Periodic preparation (quarterly or half-yearly) of the offer and order portfolio with respect to the budget

In the frame of the Commercial organization it has to be also considered a **Complain function**. NTL shall have a policy and related procedure for the **resolution of complaints received from customers or other parties**. Records shall be maintained of all received complaints, the subsequent investigations and corrective actions taken.

For reasons of potential conflict of interest, this function cannot be managed by the Testing function.



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Table D3 – 2 – 2 : Tasks and main responsibility of the Testing Function

Tasks	Main Responsibilities	Comments
Organization and dispatching of testing activities	- Booking of Testing dates according to the Laboratory availability, - Dispatching of tests among the various facilities with the aim of their full employment and responding to the client's delivery time request. - Management of the testing teams.	This activity must be carried out in collaboration with the Commercial Direction.
Tests planning and performing	- Organization and sizing of the test team, in order to be efficient but at the same time not to overload personnel costs, - Execution of the tests according to what is indicated in the test program agreed with the client, - Making available in real time (and possibly remotely) to the Customer the test data and the results, - Managing a test failure providing the customer with explanations and possibly suggestions of alternative solution for the equipment under tests, - Safety management of laboratory staff and testing equipment, - Sensors and measuring chains calibration plan, - Control of nonconforming testing and/or calibration: suitable procedures shall ensure that when a nonconforming work is identified appropriate corrective actions are taken, including halting of work and withholding of test reports and calibration certificates.	The Test Department has strong interactions with the Client in connection with: - Setting up of the Test Program, - Test results interpretation - Management of Test Failures. The effective management of this last aspect requires a strong collaboration with the Commercial function.
Reporting and Editing of Test documents	It is a critical activity, as it must be carried out immediately after the conclusion of the Tests, as without these documents the client will not be able to move on the market.	Modern Laboratories are equipped with automatic solutions.
Maintenance and improvement of the Laboratories	- Annual maintenance planning, - Managing of malfunction, - Laboratory performances improving in connection with: - New investment to remedy the natural obsolescence of the testing equipment.	Improvements are motivated by: - Marketing considerations (new tests to be performed or new equipment to be taken into consideration), - Standard evolution.



2.3.4 Communication

This function is responsible for **promoting the image of NTL**, making its Brand known on the market both among **potential Customers** (above all Manufacturers), but also among the various **Stakeholders who influence the Business**, in particular:

- Electrical Utilities that require testing services,
- Development Banks (such as World Bank, Asian Development Bank) and Investors who finance projects,
- Technical organizations (Standard, Certification, and Inspection Bodies of the country),
- Technical Universities of the country.

The main tasks to be performed by this function:

- Definition of the Branding Strategy,
- Preparation of Communication Program,
- Periodic updating of documentation and references,
- Preparation and periodic update of the WEB site,
- Participation in Congresses, Fairs and Work Shops

The communication activity is very important and not easy to carry out. In fact, it is not enough to organize events, develop high-performance websites or complete institutional brochures. The result to be achieved is that **the market considers NTL to be fully equivalent or even superior to the Competitors**.

Institutional communication not only must emphasize the technical excellence of NTL, its organization, its accreditations, competitiveness, etc., but must also focus on the fact that the **NTL services are fully equivalent to that of CPRI** and in perspective of CESI-Kema.

In the first phase of NTL operation the Communication activity could be part of the Commercial function.

2.3.5 Organization & Human Resource

Usually the organizational function and the Personnel Management are **managed by a single structure**. Below only the typical issues concerning a Testing Laboratory are concerned, leaving out all the usual aspects of any business structure.

Based on Top Management inputs, mainly consisting in the NTL strategical vision and the objectives (in the short and medium-long terms) to be achieved, **the organizational function** has to:

- to define and implement the NTL organization, specifying for each function the tasks and responsibility, the functional and hierarchical dependence, the assigned staff;
- supervise that the internal organization of each function is consistent with the overall organizational chart;



- update NTL organization in relation to its development over time and the need to conform to the market requests in order to seize at best all business opportunities.

The main tasks and responsibility of the **Human Resource management** concern:

- to define and implement an effective **salary policy** that must be such as to prevent the outflow of well-trained personnel towards private industries and manufacturers; an important issue to be considered is the linking between some part of the salary and the achieved results in respect of predefined goals;
- to define and implement an effective Career development policy;
- Personnel recruitment;
- Training.

Particular attention has to be paid to the last above issues, especially during the Stage 0 of NTL. As far as **recruitment**, it should not be overlooked that some experts, and especially those of the highest level in the testing function, can be engaged on the international market (from CPRI, for example).

Other qualified personnel may be recruited from private companies:

- Test Engineers from the testing laboratories of manufacturers,
- Inspectors from the measurement and testing services of electrical utilities,
- Engineers from engineering companies and universities,
- Sales staff from the Commercial Department of Manufacturers, especially those already operating on the international market.

The **training activities** has to be carried out in a substantial way during the Stage 0 and continuously over the time stated the need of high skills of the Laboratory personnel and the evolution of Standards and the new equipment on the market.

Most of the technical staff will have to be trained internally, starting from a solid technical base. The training activity can be entrusted - from the operating point of view - also to external subjects, for example Universities and Research Centers for the technical aspects and Consulting Society for the managerial aspects.

2.3.6 Quality Management

Paragraph 2.1 defines the reference Standard for the Quality System that concerns not only the testing operations but all the NTL functions which decisively influence the quality of the service of a Laboratory. The management of the Quality System involves a comprehensive framework of processes, procedures and practices implemented within the Laboratory to ensure overall quality and to comply with regulatory requirements, maintain reliable results, and enhance customer satisfaction.



Between this framework has to be mentioned:

- the handling and traceability of the equipment to be tested,
- calibration and maintenance of measuring equipment,
- validation and verification of the test method and relevant testing equipment,
- training and assessment of the personnel skills,
- safety of staff and customer's personnel witnessing the test execution,
- document control and record keeping.

Quality System also include procedures and protocols designed to maintain uniform and high quality and accuracy in tests, analyzes and reports. To this purpose **Internal audit** must be organized for all NTL functions and reports drawn up with any non-conformities to be investigated and solved.

A specific issue of the Quality System management in a Testing Laboratory concerns the **Nonconforming testing work**².

The Laboratory shall have a **policy and related procedures to be implemented when the results of work** do not conform to its own procedures or the agreed requirements with the customer. These policy and procedures shall ensure that:

- the responsibilities and authorities for the management of nonconforming work are designated and actions are defined and taken when nonconforming work is identified, including halting of work and withholding of test reports, as necessary.
- an evaluation of the significance of the nonconforming work is made;
- correction is taken immediately, together with any decision about the acceptability of the nonconforming work;
- where necessary, the customer is notified, and work is recalled;
- the responsibility for authorizing the resumption of work is defined.

2.3.7 Procurement and Asset Management

The **Procurement** function plays an important role in all the purchase processes, starting from the assignment of contracts for the building the Laboratory (civil works, testing equipment, auxiliary services and utilities) up to contracts concerning the operation of the

Laboratory, such as: the electricity supplying, the maintenance and the spare parts of the equipment.

During the Stage 0 of NTL this function **have to follow the procurement process of equipment, material and services for a value of several** tens of millions of USD.

²Nonconforming testing work.

As per the standard ISO 17025:2017, a Non-Conforming Work is a work do not conform to:

- its own procedure,
- Agreed requirements of the Customer.



This function will have to be set up right away once the decision has been made to build the Laboratory. An effective procurement strategy can save money by negotiating favorable terms and prices while ensuring the quality, efficiency, and timeliness of suppliers.

The main responsibilities of this function are:

- Sourcing activities for any needed equipment, energy, material or services,
- Establishing a Register of Suppliers,
- Approval of purchase requests,
- Negotiation with suppliers
- Receipt of goods and services.

In the framework of the Procurement function it may appropriate to consider a specific activity of **Asset Management** taking into consideration that the Laboratory is a capital-intensive structure. This activity has to be carried out in close cooperation with the Testing function in order to evaluate the profitable and the lower risk investment as well the refurbishment and maintenance plans of the existing testing equipment.

2.3.8 Safety, Health and Environmental

This function must establish a comprehensive framework of processes, procedures and implemented practices to ensure the health of the personnel, the security of personnel as well as the compliance of environmental issues with laws, bylaws and regulatory requirements.

Large part of these procedures and relevant tools are integrated in the Quality System. Examples of the activities to be carried out by this function is given in paragraph 2.2.9.

This function often resides under the **Organization and of Human Resources** structure.

2.3.9 Facility management

Facility management it has to be intended the efficient and effective delivery of the auxiliary services needed for NTL operation. This function has to coordinate the demand and the supply of the auxiliary services to ensure the correct operation of the testing equipment, the assembling/disassembling operations performed by the Customers as well as common services addressed to all the operating units of NTL.

The list of the auxiliary services managed by this function include:

- compressed air grid
- auxiliary power supplies
- hydraulic plants (tap water, drainage, sewer)
- SF6 gas treatment
- oil treatment
- workshop
- IT services (data, phone)



- lighting (even for outdoor areas)
- heating ventilation and air conditioning (HVAC)
- reception service
- common services (canteen, cleaning, internal transfer, etc.)

2.3.10 R&D and engineering services

Even NTL is not a Research Center, some **Research and Development activities** have to be carried out. These activities include:

- the development of new measurement techniques used in testing operation in connection with the evolution of Standards or of the equipment to be tested;
- the carry out studies and experimental evaluations to be proposed in the framework of international Working Group of National and International Technical Bodies; it has to be underlined that such participation to local and international initiatives is extremely important to strengthen the image and brand of NTL;
- a **Technological Window** on what is happening worldwide about testing activities (standards, new type of equipment, new competitors);

and they **contribute to the development of the NTC** and therefore to the strengthening of its business.

A cooperation with local and international University and Research Centres can be very convenient in performing such tasks.

Moreover, after some years of operation and related experience and skills of its staff acquired in testing several types of equipment, NTL will be able to offer to the market engineering services addressed to the following clients:

- **Manufacturers**, in supporting the development of equipment, especially in the event of **failure of the Tests** or **re-engineering of the existing ones**;
- **Electrical Utilities**, supporting them:
 - in the preparation of the **purchase specifications** of the Equipment, paying particular attention to the specifications of the tests (Type Tests and Acceptance Tests) that must be carried out on the purchased equipment,
 - in **Failure Analysis** activities and in **Network Integration Study of Components** (above all Transformers, GIS, and Switches) addressed to deep understand the behaviour of equipment once it is integrated into the network.

It has to be again outlined that these activities are very skill demanding and presuppose long-trained Engineers.

2.3.11 Administration

The Administrative function of NTL is not different from those managing other Businesses. This way, the Consultant does not make any particular suggestions for this Structure.



Power Cell
Ministry of Power, Energy & Mineral Resources
Govt. of the People's Republic of Bangladesh

**Consultancy Services for Setting Up Electrical Testing
Laboratory**
(Contract Package: S-10)



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1. Summary

This document is addressed to define the Conceptual Configuration of the Testing Laboratory on the basis of the information collected from the Stakeholders (electrical utilities, manufacturers, technical bodies) on the need of testing services to improve the quality and performances of electrical equipment used in the Bangladesh power system.

A proposal for developing the Testing Laboratory through subsequent stages is presented with the related advantages.

A detailed definition of the equipment to be tested per each of the two considered phases of the Laboratory implementation is reported.

Rev. 1 of this document have been taken into consideration all the comments and remarks received from Power Cell and the Stakeholder that are collected in Annex 4 together with the Consultant's replies.

Therefore, the Conceptual Configuration of the Testing Laboratory described in this document has to be understood as shared by the Client and the Stakeholders and as such will be taken as a reference for the development of the Feasibility Study of the Testing Laboratory.



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2. Foreword

The Conceptual Configuration is the first step in the design of the Testing Laboratory. It defines the equipment to be tested in the Laboratory and their main ratings (such as operating rated voltage and current) and the tests to be considered for each equipment with reference to an International Standard. The configuration of the testing laboratory can be directly derived from a list of test requirements defined by the Customer who is usually the owner of the laboratory to be built.

In this project "Consulting Services for Setting Up Electrical Testing Laboratory" the Client Power Cell, a Power Division of the Ministry of Energy and Mineral Resources of the Government of Bangladesh, required that the Testing Laboratory Configuration to be defined on the basis of the Consultant's experience and knowledge and verified through the evaluations of the Stakeholders of the future Laboratory.

The Consultant considered appropriate to submit to all Stakeholders (electrical utilities, manufacturers, certification and inspection bodies) dedicated questionnaires to collect the specific needs about a National Testing Laboratory able to improve the power quality and reliability of the national power system and at the same time to strengthen the local electromechanical industry.

The rev. 0 of this document describes the solution proposed by the Consultant for the Conceptual Configuration of the Bangladesh Testing Laboratory in the light of the experience gained in previous similar projects and the responses received from Stakeholders through the filled questionnaires.

On the basis of the remarks raised from Stakeholders the document has been reviewed in order to include, as much as possible and convenient, the received requests to extend the capability of the Testing Laboratory. So, this document in rev.1 defines the whole framework within which to proceed in the development of the Laboratory design.



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3. Basic information and criteria adopted for the configuration of the Bangladesh National Testing Laboratory

The project “Consultancy Services for Setting up Electrical Testing Laboratory” requires to assess the potential of a **world class testing laboratory** able:

- to perform a series of tests according to the International Standards (IEC, IEEE) on the main electromechanical equipment,
- to conduct research and development tests on new components and equipment developed by the domestic manufacturers,
- to constitute an open and fruitful environment for know-how development of the scientific & technical point of view and business development (market & technology evolution, Standard evolution).

In the following are clearly stated the collected information and data on the electromechanical sector and the power system of the country jointly with the Consultant evaluation on the main issues to be taken into consideration for an effective configuration of the Testing Laboratory.

3.1 Information and data provided by the Client and the Stakeholders

In order to define the Testing Laboratory configuration reference was made to:

- the survey, conducted through questionnaires presented by the Consultant during the 1st Stakeholders Meetings held on 18th June 2023 and sent by Power Cell through the letter No. 27.71.0000.002.12.002.21-759 21, dated 21th June 2013, to all Stakeholders;
- interviews made by the Consultant to some electrical utilities and manufacturers.

The following main elements emerged from the data and information collected¹:

- **the electrical utilities currently purchase:**
 - **about 80% of the Low Voltage equipment** (MCB, MCCB, RCD, RCCB, Assemblies, Cables) **from domestic manufacturers;**
 - **large portion** (ranging from 60% to 80% for the different products) **of the Medium and High Voltage equipment from international manufacturers** (ABB, Siemens, Schneider Electric, Toshiba, Hitachi, the Indian manufacturers CG Power and Genus, Hyosung-Korea, Shandong Taikai-China);
- **the totality of electrical utilities declare that type tests are mandatory in their purchase specifications of the equipment** impacting on the network’s reliability and performances (power

¹ All the questionnaires filled by the Stakeholders are collected in the document D2-Interim Report – 2 – Existing testing Laboratories and Certification & Inspection Bodies

transformers, circuit breakers, switchgears); this implies for national manufacturers the resorting of foreign testing laboratories resulting in very high cost for the performed tests.

- all national manufacturers who provided filled questionnaires **declare that they are able to carry out routine tests on their produced equipment**; only one of the manufacturers testing laboratories are accredited;
- from the filled questionnaires it emerges that the national manufacturers currently produce and plan to develop in the next 3÷10 years the equipment listed in Table D2-1-1;

Table D2-1-1 Equipment currently produced and planned to be developed by domestic manufacturers

Equipment and Rated Voltage		Lv Circuit Breakers, Switches, Assemblies	Distribution Transformers	Power Transformers	Current and Potential Transformers	MV Circuit Breakers and Switchgears	HV Circuit Breakers and Switchgears	Bus Bar Trunking	Insulators	Power Cables
High Voltage	400 kV			X	X		X		XX	
	245 kV			XX	X				XX	
	132 Kv			X	X		X		XX	X
Medium Voltage	33 ÷ 36 kV			XXXX		XXXX			X	
	28 kV					X				
	11 ÷ 12 kV		XXXX		XX	XXX				
Low Voltage	690 V	XXX						X		XX
	415 V	XXXX						XX		X
	220 V	XX								

X current production

X planned to be developed

- Large part of the products by the local electromechanical sector are Low and Medium Voltage equipment (distribution and power transformers, switchgears, cables, insulators, bus bar trunking). Only Energypac Engineering currently produces Power Transformers, Current and Potential Transformers up to 245 kV rated voltage. Two firms plan to develop in the medium-term equipment up to 400 kV and a company intend to develop power cable at 132 kV.



- It is widely believed among electricity utilities that **there are significant differences in quality and/or performance between equipment produced on the international market - specifically in the EU, North America, Japan, Korea - and those available from domestic manufacturers;** consequently, the quality of:
 - Distribution and Power Transformers
 - Current and Potential Transformers
 - Circuit Breakers
 - Switchgears (AIS, GIS)
 - Insulators
 - Cables

produced by the local electromechanical sector has to increased wanting to maintain high performances of the power system having to resort to the equipment locally manufactured.

In addition to the foregoing describing the current situation of the national electromechanical sector it is appropriate to take into consideration the envisaged evolution of country's power system.

The current Bangladesh electric system consists of²:

- a total generation capacity of 26,550 MW provided by 153 power generation plants,
- a transmission networks with 14,672 kilometres of lines at 132, 230 and 400 kV plus a 230 kV dc line for energy import from India,
- a distribution network with 628,562 kilometres of lines at 33, 11 and 0.4 kV.

A strong expansion of power generation is planned by the Perspective Plan of Bangladesh 2021-2041: 62 GW over a period of 20 years with the strategic goal to put the country on a sustained path for a high-income economy.

This huge growth of the power generation system necessarily induces reinforcement of the transmission and distribution networks (for which the Plan envisages an investment in the period of 1.4 billion USD per year) resulting in the need to install a considerable number of new lines and power stations, power and distribution transformers, circuit Breakers, switchgears and instrument (voltage and current) transformers and meters.

This favourable outlook will certainly **have the effect of strengthening and developing local production facilities both by existing producers and by new national operators.**

A National Testing Laboratory able to perform complete series of tests according to the International Standard **allows improve the quality of equipment produced by the national electromechanical sector so as to make them fully competitive with those of international manufacturers.**

² Source: Power Cell



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3.2 Considerations on the main issues related to Laboratory configuration

The National Testing Laboratory has to be mainly addressed to the performance of **type tests on the prototype of a new electromechanical equipment developed by the local manufacturers.**

The type tests:

- require the completion of many tests, using different techniques, to be carried out in sequence on the same object,
- must cover the whole range of Standards test requirements.

As an example, a high-power test program on switching equipment may include the performance of:

- ✓ Dimensional checks,
- ✓ Resistance measurements,
- ✓ Mechanical operation tests,
- ✓ High power tests,
- ✓ High voltage tests,
- ✓ Temperature rise tests.

The routine tests, covering a subset of the tests specified by the International Standards, are carried out on every production sample and are performed by the manufacturers at the factory as a necessary extension of the production process, as confirmed by manufacturers declaration in the above paragraph 3.1.

The laboratory must be able to carry out some routine tests, but be aware don't replicate the routine tests already carried out by utilities (such as tests on transformer oils or meter tests) or by other laboratories in the country.

In a testing laboratory special equipment are commonly used and several of them operate at non-standard conditions. For instance, the generators and transformers feeding the circuits for short-circuit tests operate in short-circuit condition at each test performed in the laboratory while usually this equipment experience such conditions only few times during their operational life in a power plant or in a power station, respectively.

This implies specific knowledge and skills requested to the technical staff of the testing laboratory addressed to mainly perform type tests.

In addition to a deep knowledge of the International Standards and the related testing technique, the laboratory staff must have:

- **a thorough knowledge of the functional characteristics and technical features of the testing equipment** for their appropriate use and to avoid inappropriate stress on the equipment under tests,
- **a capacity for interpretation the results of the tests carried out**, especially when the test result is partly or completely unsatisfactory in order to provide the customer with useful information on the causes that led to this outcome.



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As a matter of fact, **the learning process of the laboratory staff** (from the chief engineers up to the testing operators) **is likely to grow at a slow pace.**

The level of knowledge and experience of the technical staff also impacts on the efficiency in planning and performing a tests cycle on an equipment and then on the laboratory productivity (defined as the number of executed test programs per month or per year) that determines the turnover generated by the laboratory through the provided testing services.

Other important aspects to be considered in the design of a new test laboratory lies in **its testing facilities** and the highest test ratings of each facility.

A testing facility little used for lack (or very low) of testing services demand leads only to an increase of the required capital expenditure and operating cost of the laboratory without adequate returns in terms of turnover.

The required capital expenditure of a testing facility is highly dependent on the maximum ratings of tests to be performed. So, high test ratings of a testing facility that are rarely used have a negative impact on the economic and financial items of the Laboratory.

Based on the above and referring to Table 1, it may not be convenient for the first phase of the National Testing Laboratory to build facilities capable to perform HV tests up to 400 kV being only two manufacturers intends to develop new equipment with this rated voltage.

An effective solution would seem to be to build at first a Laboratory able to meet the request of testing the Low and Medium Voltage equipment that are largely manufactured in the country and accepting that the (few) tests on High Voltage equipment continue to be carried out at foreign laboratories. Subsequently, **the Laboratory test capability can be extended in response to an increasing demand for testing not covered by its first configuration.**

As already stated in the Inception Report, the **development of the Laboratory through subsequent steps** allows:

- **to minimize the initial capital outlay,**
- **a gradual growth of the technical competences and skills of the Laboratory staff** which is to be recruited and trained,
- **to check in real conditions the actual achievable testing market and to fine-tune the pricing policy for the laboratory services** which must be such to generate revenues covering the laboratory operating costs (salaries and wages, electricity and other consumables costs, maintenance costs) but at the same time highly competitive with foreign laboratories.

It has to be outlined that the development through subsequent stages can be found in the evolution of all the largest and worldwide known testing laboratory: Kema (Netherlands), CESI (Italy), CPRI (India) and Keri (Korea) along paths lasting several years.



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4. A comprehensive proposal for the National Testing Laboratory

In the light of the considerations set out in Cap. 3 and based on the Consultant deep knowledge of the testing market and his experience gained in similar projects, the establishment of the National Independent Testing Laboratory is proposed through two successive stages.

- **Stage 1:** consisting in the setting up of an On-line Medium Voltage Laboratory supplied by an external power line at 230 kV coming from a nearby 230/132 kV Station and having not less than 5000 MVA short-circuit power.

Assuming the **availability for the laboratory of a short-circuit power of 250 MVA**, even in the event of the most power demanding tests the corresponding voltage drop into the grid supplied by the concerned Station can be estimated, in the first approximation, in not more than 5% for a duration not greater than 0,3 s. Such condition has to be verified with the Power Grid Company of Bangladesh.

This Laboratory is able to perform all the type tests on the LV equipment below listed with the relevant maximum operating ratings:

- **Circuit Breakers for industrial uses** having rated voltage 220 V, 415 V, 690 V, up to 5000 A rated current, short-time current up to 200 kA, 1 s and 200 kA max short-circuit current;
- **Switches, Disconnectors, Switch-disconnectors and fuse combination** with rated voltage 220 V, 415 V, 690 V, up to 5000 A rated current, short-time current up to 80 kA, 3 s and up to 80 kA short-circuit current;
- **Electromechanical Contactors and Motor-starters** with rated voltage 220 V, 415 V, 690 V, up to 5000 A rated current and up to 50 kA short-circuit current;
- **Fuses** with rated voltage 220 V, 415 V, 690 V, up to 800 A rated current and up to 80 kA short-circuit current;
- **LV Switchgears and Controlgears Assemblies** with rated voltage 220 V, 415 V, 690 V, up to 5000 A rated current, short-time current up to 200 kA, 1 s and 200 MVA max short-circuit power;
- **LV Busbar Trunking** with rated voltage 220 V, 415 V, 690 V, up to 5000 A rated current, short-time current up to 200 kA, 1 s, 200 MVA max short-circuit power and max 6 meters long;
- **Distribution Transformers** with a maximum power of 4 MVA, primary windings up to 12 kV, any secondary voltage and short-circuit impedance not lower than 10%;
- **Power Transformers** with a maximum power of 20 MVA, primary windings up to 36 kV, any secondary voltage and short-circuit impedance not lower than 10%;
- **Dry-type Transformers** with a maximum power of 12 MVA, primary windings up to 36 kV, any secondary voltage and short-circuit impedance not lower than 10%;
- **Power Cables with extruded insulation** with rated voltage from 1.2 up to 3.6 kV;

- Power Cables with extruded insulation with rated voltage from 7.2 up to 36 kV.

On the following **MV equipment** the Laboratory is able to perform all the type tests with the exclusion of the short-circuit making and breaking tests.

Table D2-1-2: MV Switching equipment considered for Stage 1

Equipment	Rated voltage	Rated Short-time current
MV Circuit Breakers	up to 36 kV	up to 63 kA for 1s
MV Disconnectors and Earthing Switches	from 15 up to 17.5 kV	up to 50 kA for 1s
MV Switches	up to 24 kV	up to 35 kA for 1s
MV Switchgears and Controlgears	up to 33 kV	up to 25 kA for 1s

- **Stage 2:** the power source of the Testing Laboratory is increased by adding a Short-Circuit Generator, with a short circuit power of about 2000 MVA. The Laboratory in this configuration is able to perform in addition to the Low Voltage equipment considered for Stage 1, all the type test on the below listed equipment with the relevant maximum operating ratings.

Table D2-1-3: Distribution Transformers

Primary voltage [kV]	Secondary Voltage [kV]	Short-circuit impedance	Rated power [MVA]
11 kV or 13,8 kV	0.4	2.5% ÷ 4 %	up to 2.5
33 kV	0.4	4 ÷ 7 %	up to 5

Table D2-1-4: Power Transformers

Primary voltage [kV]	Secondary Voltage [kV]	Short-circuit impedance	Rated power [MVA]
33	11	4 ÷ 8 %	up to 16
66	11	7 ÷ 10 %	up to 25
132	11	15 ÷ 22 %	up to 50
132	33	15 ÷ 22 %	up to 50

Table D2-1-5: MV Switching equipment considered for Stage 2

Equipment	Rated Voltage	Rated Current
Circuit Breakers	from 3.6 kV up to 36 kV	up to 6.3 kA
Disconnectors and Earthing Switches		up to 6.3 kA
Switches		from 400 A up to 800 A
Switch-Fuse Combination		from 400 A up to 800 A
Current limiting Fuses		up to 6.3 kA
Expulsion Fuses	up to 36 kV	up to 6.3 kA
Gas insulated Metal enclosed Switchgears and Controlgears	from 3.6 kV up to 36 kV	up to 3.15 kA
Metal enclosed Switchgears and Controlgears (Ring Main Unit included)		up to 3.15 kA
Solid insulated-enclosed Switchgears and Controlgears		up to 3.15 kA

- **MV Busducts** with rated voltage above 1 kV and up to 36 kV, up to 5000 A rated current, short-time current up to 63 kA, 3 s, 1260 MVA max short-circuit power and max 10 meters long;
- **Current Transformers and Inductive Voltage Transformers** with rated voltage up to 400 kV, up to 5000 A rated current, short-time current up to 63 kA, 3 s, 1260 MVA max short-circuit power;
- **Ceramic and glass insulators** with rated voltage up to 400 kV;
- **Polimeric insulators** with rated voltage up to 400 kV;
- **Power Cables with extruded insulation** with rated voltage from 1.2 up to 3.6 kV;
- **Power Cables with extruded insulation** with rated voltage from 7.2 up to 36 kV;
- **Power Cables with extruded insulation** with rated voltage above 36 kV and up to 170 kV.

It should be noted that the availability of a 2000 MVA Short-circuit Generator allows to perform tests not only on equipment with higher rated voltage but also a greater number of tests not feasible in the On-line Medium Voltage Laboratory of Stage 1, such as the short- circuit making and breaking tests on the switching equipment.



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5. Review of the Testing Laboratory configuration following the remarks by the Stakeholders

The Testing Laboratory configuration defined in Chapter 4 of this document was related to the questionnaires filled by the Stakeholders downstream of the 1st Stakeholders Meeting. The comments received from the Stakeholders on the rev. 0 of this document and based on the manufacturer's development programs of new equipment with more high operating ratings and the evolution of the networks expected by the electrical utilities have led to a significant revision of the Testing Laboratory Configuration.

All the received Stakeholders remarks on the rev. 0 of this document are collected in Annex 4 together with the Consultant's reply for each of them.

The following defines the changes made to the previously described configuration of the Testing Laboratory.

5.1 Different organization of the Stage 1 and Stage 2 of the Testing Laboratory

The building of Testing Laboratory in the two considered configurations, identified as Stage 1 and Stage 2, was foreseen in Chapter 4 in sequential time terms: after some time of operation of the Laboratory in the Stage 1 configuration it should have to undertake the construction of Stage 2.

The stringent requirements to run tests with high ratings by both manufacturers and electrical utilities **make it necessary to equip the Laboratory with a Short-circuit Generator in the shortest time**. Therefore:

- the Stage 1 of the laboratory, that can be built within about three years, will be fed through a power line with a maximum short-circuit power of 250 MVA,
- **The building of the Laboratory in configuration of the Stage 2**, requiring a lead time between 5 and 6 years, **must be started at the same time as Stage 1**, taking care not to hinder the operation of the laboratory in Stage 1 configuration.

In this way **the lead time of all the testing facilities afferent both Stage 1 and Stage are minimized**, maintaining the advantages of starting the Laboratory operation in a configuration with reduced testing capacity but allowing:

- the improving of the Staff skills and experience in organizational, commercial and technical terms,
- to verify in real conditions the actual achievable testing market by the new Testing Laboratory and thus to fine-tuning the commercial strategy (marketing, service pricing, communication) for the provided services.

5.2 Increasing of the short circuit power of the Short-circuit Generator used in the Stage 2 configuration

The request to extend the Laboratory testing capacity for both switching equipment and power transformers requires to increase from 2000 MVA previously foreseen to 2500 MVA the short-circuit power of the Generator feeding the test circuits in the Stage 2 of the Laboratory.



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This allows to meet a large part of the requests advanced from the Stakeholders with a moderate increase in capital expenditure.

5.3 Possible OPTIONS for the Laboratory in Stage 2 configuration

During the 2nd Stakeholders Meeting and taking into consideration the developmental perspectives of some local manufacturers it emerged the need to tests in the next 3-5 years Power Transformers having rated power of 350 MVA and 230 kV as a primary voltage.

According to the rev. 0 of this document, the Laboratory in the configuration of the Stage 2 is equipped with a Short-circuit Transformer bank with secondary voltages in the range 11 kV ÷ 40 kV suitable for short-circuit tests on all MV equipment. This bank allows also to make short-circuit tests also on Power Transformers having voltage ratio 132/11 kV and 132/33 kV.

The short-circuit tests of a 230 kV Power Transformers entails to equip the laboratory with an additional bank of Short-circuit Transformers having secondary voltages in the range 65-230 kV. When fed with a 2500 MVA Short-circuit Generator such additional bank allows to perform short-circuit tests on power transformers having a power up to:

- 160 MVA when the short-circuit test **is carried out only on one phase of the transformer,**
- 120 MVA when **the 'single-phase equivalent' scheme for the short-circuit test is adopted.**

The second Laboratory Short-circuit transformer bank involves supplementary capital expenditure around USD 15 million (taking into consideration also the involved bus-bar connections and a dedicated testing facility with the relevant control and management systems).

Therefore, for the configuration of the Testing Laboratory in Stage 2 two options are considered in the following:

- **Option A** with a single bank of Short-circuit Transformers addressed to perform short-circuit tests on MV equipment and Power Transformers having secondary voltage in the range 11 kV ÷ 40 kV;
- **Option B** equipped with two Short-circuit Transformer Banks, the former one equal to that of Option A and the latter with secondary voltages in the range 65-230 kV.



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6. The revised configuration of the National Testing Laboratory

6.1 The Testing Laboratory in the Stage 1 configuration

Through a letter dated 09/08/2023 (see Annex 3) the Power Grid Company of Bangladesh (PGCB) confirmed the substantial capacity to provide the Laboratory from one of the twelve 220/132 Power Stations around Dhaka the requested 250 MVA short-circuit power.

Taking into consideration the request by Stakeholder to extend the testing capability of this configuration, the power of the Laboratory Short-circuit Transformers has been increased to 1500 MVA.

In this Stage 1 configuration the Laboratory **is able to perform all the type tests on the LV equipment** below listed with the relevant maximum operating ratings that, if modified with respect to the Laboratory configuration described in Chapter 4, they are written in red colour.

- **LV Circuit Breakers for industrial uses** having rated voltage 220 V, 415 V, 690 V, up to **6300 A** rated current, short-time current up to 200 kA, 1 s and 200 kA max short-circuit current;
- **LV Switches, Disconnectors, Switch-disconnectors and fuse combination** with rated voltage 220 V, 415 V, 690 V, up to **6300 A** rated current, short-time current up to 80 kA, 3 s and up to 80 kA short-circuit current;
- **Electromechanical Contactors and Motor-starters** with rated voltage 220 V, 415 V, 690 V, up to 5000 A rated current and up to 50 kA short-circuit current;
- **LV Fuses** with rated voltage 220 V, 415 V, 690 V, up to 800 A rated current and up to 80 kA short-circuit current;
- **LV Switchgears and Controlgears Assemblies** with rated voltage 220 V, 415 V, 690 V, up to **6300 A** rated current, short-time current up to 200 kA, 1 s and 200 MVA max short-circuit power;
- **LV Busbar Trunking** with rated voltage 220 V, 415 V, 690 V, up to **6300 A** rated current, short-time current up to 200 kA, 1 s, 200 MVA max short-circuit power and max 6 meters long.

The Testing Laboratory in the Stage 1 configuration allows also to perform the type tests of the following equipment (in red colour the equipment operating ratings modified with respect to the Laboratory configuration described in Chapter 4)

- **Distribution Transformers** with a maximum power of 4 MVA, primary windings up to 12 kV, any secondary voltage and short-circuit impedance not lower than 10%;
- **Power Transformers** with a maximum power of **28 MVA**, primary windings up to 36 kV, any secondary voltage and short-circuit impedance not less than **8%**;
- **Dry-type Transformers** with a maximum power of 12 MVA, primary windings up to 12 kV, any secondary voltage and short-circuit impedance not lower than 10%;
- **Power Cables with extruded insulation** with rated voltage from 1.2 up to 3.6 kV;

- Power Cables with extruded insulation with rated voltage from 7.2 up to 36 kV.

On the MV equipment listed in Table D2-1-7 the Laboratory is able to perform all the type tests with the exclusion of the short-circuit making and breaking tests.

Table D2-1-6: MV Switching equipment considered for Stage 1 revised configuration

Equipment	Rated voltage	Rated Short-time current
MV Circuit Breakers	up to 36 kV	up to 63 kA for 1s
MV Disconnectors and Earthing Switches	from 15 up to 17.5 kV	up to 50 kA for 1s
MV Switches	up to 24 kV	up to 35 kA for 1s
MV Switchgears and Controlgears	up to 33 kV	up to 25 kA for 1s

A detailed list of the performed tests by the Laboratory in the configuration of the Stage 1 are specified in Annex 1.

6.2 The Testing Laboratory in Option A of the Stage 2 configuration

In this configuration the Laboratory is equipped with a 2500 MVA Short-circuit Transformers having secondary voltage in the range 11 kV ÷ 40 kV and fed by a 2500 MVA Short-circuit Generator.

In addition to the Low Voltage equipment considered for Stage 1, in this Stage 2 configuration the Laboratory is able to perform all the type test on the below listed equipment with the relevant maximum operating ratings (in red colour the equipment operating ratings modified with respect to the Laboratory configuration described in Chapter 4).

Table D2-1-7: Distribution Transformers considered for the revised Stage 2 configuration

Primary voltage [kV]	Secondary Voltage [kV]	Short-circuit impedance	Rated power [MVA]
11 kV or 13,8 kV	0.4	2.5% ÷ 4 %	up to 2.5
33 kV	0.4	4 ÷ 7 %	up to 5

Table D2-1-8: Power Transformers considered for the revised Stage 2 configuration - Option A

Primary voltage [kV]	Secondary Voltage [kV]	Short-circuit impedance	Rated power [MVA]
33	11	4 ÷ 8 %	up to 16
66	11	7 ÷ 10 %	up to 25
132	11	15 ÷ 22 %	up to 50
132	33	15 ÷ 22 %	up to 50

Table D2-1-9: MV Switching equipment considered for the revised Stage 2 configuration

Equipment	Rated Voltage	Rated Current
Circuit Breakers	from 3.6 kV up to 36 kV	up to 6.3 kA
Disconnectors and Earthing Switches		up to 6.3 kA
Switches		from 400 A up to 800 A
Switch-Fuse Combination		from 400 A up to 800 A
Current limiting Fuses		up to 6.3 kA
Expulsion Fuses	up to 36 kV	up to 6.3 kA
Gas insulated Metal enclosed Switchgears and Controlgears	from 3.6 kV up to 36 kV	up to 3.15 kA
Metal enclosed Switchgears and Controlgears (Ring Main Unit included)		up to 3.15 kA
Solid insulated-enclosed Switchgears and Controlgears		up to 3.15 kA

- **MV Busducts** with rated voltage above 1 kV and up to 36 kV, up to **6300 A** rated current, short-time current up to 63 kA, 3 s, **1500 MVA** max short-circuit power and max 10 meters long;
- **Current Transformers and Inductive Voltage Transformers** with rated voltage up to **400 kV**, up to **6300 A** rated current, short-time current up to 63 kA, 3 s, **1500 MVA** max short-circuit power;
- **Ceramic and glass insulators** with rated voltage up to 400 kV;
- **Polimeric insulators** with rated voltage up to 400 kV;
- **Power Cables with extruded insulation** with rated voltage above 36 kV and up to 170 kV;
- **Power Cables with extruded insulation** with rated voltage above **170 kV and up to 400 kV**.

A detailed list of the performed tests by the Laboratory in the configuration of the Stage 2, Option A are specified in Annex 2.

It should be noted that the availability of a 2500 MVA Short-circuit Generator allows to perform tests not only on equipment with higher rated voltage but also a greater number of tests not feasible in the On-line Medium Voltage Laboratory of Stage 1, such as the short- circuit making and breaking tests on the switching equipment.

However, there are still limits to the applicable test ratings. The below Table D2-1-6 lists the maximum short-circuit current that can be applied during making and breaking tests on circuit breakers.



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Table D2-1-10: Max short-circuit current test ratings for Circuit Breakers in Stage 2 configuration

Circuit breakers rated voltage	Max short-circuit current test rating
from 3.6 up to 12 kV	up to 90 kA
24 kV	up to 45 kA
36 kV	up to 31,5 kA

6.3 The Option B of the Stage 2 configuration

In the Option B of the Testing Laboratory in configuration Stage 2 an additional 2500 MVA Short-circuit Transformer bank having secondary voltages in the range 65-230 kV is used. This Short-circuit Transformer bank fed by the 2500 MVA Short-circuit Generator allow to perform short-circuit tests on Power Transformers having a power up to 160 MVA being the short-circuit test carried out only on one phase of the transformer.

This means the possibility to execute short circuit tests on one phase of a Power transformers having 230 kV primary voltage and up to 160 MVA 3-phase power.



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7. Final considerations on the Testing Laboratory configuration

The **lead time for the setting up of the Testing Laboratory in the Stage 1 configuration** (including detailed design, equipment procurement, laboratory erection and equipment installation, commissioning) may be evaluated in **around 3 years**. During this period the complete staff of the Laboratory may be recruited and adequately trained on the testing technique and also on technical features and performances of the testing equipment installed in the Laboratory (assuming the technical staff is fully involved in all the phases of laboratory erection, testing equipment installation and commissioning).

The lead time for the setting up of the Testing Laboratory in the configuration described as Stage 2 would take no less than 5 years from the decision of its building, considering the time needed to procure the Short Circuit Generator, its installation and commissioning.

Instead, the Testing Laboratory in the Stage 1 configuration can start operation in three years and it will be able to supply testing services on all the main equipment of a MV/LV Station (circuit breakers, distribution and power transformers, switches, switchgears and controlgears, bus bar trunking) with the only limitation of the impossibility to perform short-circuit tests on the switching equipment with rated voltage above 1 kV.

During the operation of the Laboratory in the Stage 1 configuration **the Laboratory staff:**

- **will acquire skills and experience** in organizational, commercial and technical terms,
- **will verify in real conditions the actual achievable testing market** by the new Testing Laboratory and **thus can fine-tuning the commercial strategy** (marketing, service pricing, communication) for the provided services.

It should also be noted that the configuration of the Laboratory according to the Stage 1 has the following advantages in terms of management and operations compared to that obtainable upon completion of the 2° Stage where the power source of the testing circuit is the Short-circuit Generator:

- **simpler test execution and control,**
- **minimum risk of failure of the Laboratory power source,**
- **reduced operating and maintenance costs.**

In the suggested approach of the development of the Laboratory through successive stages, the Laboratory staff will feel the need for further development on the basis of the acquired technical competence acquired and a growing demand for testing services that cannot be satisfied by the operational limits of the existing test facilities.

Concerning the Testing Laboratory in the Stage 2 configuration, it has the maximum test capability allowed by a single Short Circuit Generator. These capabilities can only be improved by using more Short Circuit Generators and/or synthetic tests.

Table D2- 1- 8 offers an overview of the maximum operating ratings of the equipment that can be tested in the two configurations Stage 1 and Stage 2 of the Laboratory.



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Table D2-1-11: Max operating ratings of the equipment that can be tested in the in the two considered configurations of the Laboratory

LV Circuit Breakers	up to 6300 A ; up to 200 kA short circuit current	
LV Switches, Disconnectors, Switch-disconnectors, Fuse combination	up to 6300 A ; up to 80 kA short circuit current	
LV Fuses	up to 800 A ; up to 80 kA short circuit current	
LV Switchgears and Controlgears	up to 6300 A ; up to 200 MVA short circuit power	
LV Busbar Trunking	up to 6300 A ; up to 200 MVA short circuit power	
Distribution Transformers	12/0.4 kV; up to 4 MVA	33/0.4 kV; up to 5 MVA
Power Transformers	up to 36 kV; up to 28 MVA	up to 132 kV; up to 50 MVA
Power cables with extruded insulation	from 1.2 kV up to 36 kV	up to 400 kV
MV Circuit Breakers	up to 36 kV; no short circuit test	up to 36 kV; up to 2000 MVA short circuit power
MV Disconnectors and Earthing Switches	up to 17.5 kV; no short circuit test	up to 36 kV; up to 1500 MVA short circuit power
MV Switches	up to 24 kV; no short circuit test	up to 36 kV; up to 2000 MVA short circuit power
Gas insulated Metal enclosed Switchgears and Controlgears	up to 36 kV; up to 1500 MVA short circuit power	
Metal enclosed Switchgears and Controlgears	up to 33 kV; no short circuit test	up to 36 kV; up to 1500 MVA short circuit power
Solid insulated -enclosure Switchgears and Controlgears	up to 36 kV; up to 1500 MVA short circuit power	
MV Busduct	up to 36 kV; up to 1500 MVA short circuit power	
Current Transformers and Potential Transformers	up to 400 kV; up to 1500 MVA short circuit power	
Ceramic, glass and polimeric insulators	up to 400 kV	

STAGE 1

STAGE 2



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ANNEX 1

Performed Test by the On-Line MV Testing Laboratory (Stage 1)

A1.1 LV Circuit Breakers for industrial uses

Rated voltage	Rated current	Rated Short-time current	Rated Short-circuit current
220 V	from 25 A up to 6300 A	100 kA for 3 s 200 kA for 1 s	from 25 kA up to 120 kA
415 V			from 25 kA up to 140 kA
690 V			from 25 kA up to 200 kA

Test on LV Circuit Breakers for industrial uses	IEC Standard	Clause
Dielectric tests	60947-2	8.3.3.2
Service short-circuit breaking capacity		8.3.4.1
Ultimate short-circuit breaking capacity		8.3.5.2
Short-time withstand current		8.3.6.2
Temperature-rise		8.3.2.5
Short-circuit breaking capacity test at maximum short-time withstand current		8.3.6.4
Overload performance		8.3.3.4
Mechanical operation		8.4.1

A1.2 LV Switches, Disconnectors, Switch-disconnectors and fuse combination units

Rated voltage	Rated current	Rated Short-time current	Rated Short-circuit current
220 V	from 25 A up to 6300 A	80 kA for 3 s	from 25 kA up to 80 kA
415 V			
690 V			

Test on LV switches, disconnectors, switch-disconnectors and fuse combination units	IEC Standard	Clause
Dielectric tests	60947-3	8.3.3.2
Short-time withstand current		8.3.5.1
Short circuit making capacity		8.3.5.2
Fuse protected short circuit withstand and making		8.3.6.2.1(a) & (b)
Temperature-rise		8.3.3.1
Making and breaking capacities		8.3.3.3
Overload		8.3.7.1



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A1.3 Electromechanical Contactors and Motor-starters

Rated voltage	Rated current	Rated Short-circuit current
220 V	from 25 A up to 5000 A	from 6 kA up to 50 kA
415 V		
690 V		

Test on Electromechanical Contactors and Motor-starters	IEC Standard	Clause
Dielectric test	60947-4-1	9.3.3.4
Short-circuit		9.3.4.1.2
Temperature-rise		9.3.3.3
Making and breaking capacities		9.3.3.5
Overload		9.3.5

A1.4 LV Fuses

Rated voltage	Rated current	Rated Short-circuit current
220 V	from 10 A up to 800 A	up to 80 kA
415 V		
690 V		

Tests on LV fuses	IEC Standard	Clause
Verification of the insulating properties	60269-1	8.2.2
Temperature-rise and power dissipation		8.3
Verification of conventional non-fusing and fusing-current		8.4.3.1
Verification of time-current characteristics and gates		8.4.3.3
Overload		8.4.3.4
Verification of the breaking capacity		8.5
Verification of the cut-off current characteristics		8.6
Verification of I^2t characteristics and overcurrent discrimination		8.7



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DESIGN and MANAGEMENT of ELECTRICAL POWER ASSETS

A1.5 LV Switchgears and Controlgears Assemblies

Rated voltage	Rated current	Rated Short-time current	Short-circuit power
220 V	from 400 up to 6300 A	up to 100 kA ,3 s up to 200 kA, 1 s	Not higher than 200 MVA
415 V			
690 V			

Tests on LV Switchgears and Controlgears Assemblies	IEC Standard	Clause
Power frequency withstand voltage	61439-2	10
Impulse voltage		10.9.3.2
Temperature-rise		10
Short-circuit withstand strength		10.11
Mechanical operation		10.13

A1.6 LV Busbar Trunking (max 6 meters long)

Rated voltage	Rated current	Rated Short-time current	Max Short-circuit power
220 V	from 400 A up to 6300 A	up to 160 kA for 1 s up to 120 kA for 3 s	not higher than 200 MVA
415 V			
690 V			

Tests on LV Busbar Trunking	IEC Standard	Clause
Power-frequency withstand voltage	61439-6	10
Impulse withstand voltage test		10
Temperature- rise		10.10
Short-time withstand current and peak withstand current		10.11
Short-circuit withstand strength		10.11



A1.7 Distribution and Power Transformers

Equipment	Power	Primary Voltage	Secondary Voltage	Vector Group
Distribution Transformer	up to 4 MVA	from 3.3 up to 12 kV	any	any
Power Transformer	up to 28 MVA	up to 33 kV	any	any

Tests performed on Distribution and Power Transformers	IEC Standard	Clause
Measurement of winding resistance	60076-1	11.2
Measurement of voltage ratio and check of phase displacement		11.3
Measurement of short-circuit impedance and load loss		11.4
Measurement of no-load loss and current		11.5
Measurement of no-load loss and current at 90 % and 110 % of rated voltage		
Measurement of zero-sequence impedance(s) on three-phase transformers		11.6
Determination of capacitances windings-to-earth, and between windings		11.1.4 point c)
Measurement of dissipation factor ($\tan \delta$)		11.1.4 point d)
Measurement of d.c. insulation resistance each winding to earth and between windings		11.1.4 point h)
Temperature rise test	60076-2	7
Applied voltage test (AV)	60076-3	10
Induced voltage withstands test (IVW)		11.2
Induced voltage test with partial discharge measurement (IVPD)		11.3
Line Terminal AC withstand voltage test		12
Lightning impulse tests (LI)		13
Ability to withstand short circuit	60076-5	4.2
Measurement of frequency response (Frequency Response Analysis)	60076-18	4



A1.8 Dry-type Transformers

Power	Primary Voltage	Secondary Voltage	Short-circuit Impedance	Vector Group
up to 4 MVA	from 3.3 up to 12 kV	any	not lower than 10%	any

Tests performed on Dry-type Transformers	IEC Standard	Clause
AC withstand voltage	60076-11	19
Induced AC withstand voltage		20
Lighting Impulse		21
Partial discharge measurement		22
Temperature rise		23
Ability to withstand short-circuit	60076-5	4.2

A1.9 Power Cables with extruded insulations with rated voltage from 1.2 kV up to 3.6 kV

Electrical type tests	IEC Standard	Clause
Insulation resistance measurement at ambient temperature	60502.1	17.1
Insulation resistance measurement at maximum conductor temperature in normal operation		17.2
Voltage tests for 4 h		17.3
Impulse voltage tests		17.4

A1.10 Power Cables with extruded insulations with rated voltage from 7.2 kV up to 36 kV

Electrical type tests		IEC Standard	Clause
Cables having conductor screen and insulation screens	Bending	60502.1	18.2.4
	Partial discharge		18.2.5
	Tan δ measurement		18.2.6
	Heating cycle		18.2.7
	Impulse voltage followed by a voltage test		18.2.8
	Voltage test 4 h		18.2.9
Cables having unscreened insulation	Insulation resistance measurement		18.3.2
	Insulation resistance measurement at maximum conductor temperature		18.3.3
	Voltage test 4 h		18.3.4
	Impulse test		18.3.5



A1.11 MV Switching Equipment

Equipment	Rated voltage	Rated current	Rated Short-time current
Circuit Breakers	up to 36 kV	from 630 A up to 3150 A	up to 63 kA for 1s
Disconnectors and Earthing Switches	from 15 up to 17,5 kV		up to 50 kA for 1s
Switches	24 kV		up to 35 kA for 1s
Switchgears and Controlgears	33 kV		up to 25 kA for 1s

On the above listed equipment with their relevant ratings the Laboratory is able to perform the following tests.

Test on MV Circuit Breakers	IEC Standard	Clause
Power-frequency voltage test	62271-100	6.2.6.1
Lightning impulse voltage test		6.2.6.2
Partial Discharge		6.2.9
Tests on auxiliary and control circuits		6.2.10
Voltage test as a condition check		6.2.11
Measurement of the resistance of the main circuit		6.4
Temperature-rise tests		6.5
Mechanical operation test at ambient air temperature		6.101.2
Short-time withstand current and peak withstand current tests		6.6

Tests on MV Disconnectors and Earthing Switches	IEC Standard	Clause
Dielectric tests	62271-102	7.2
Voltage test as a condition check		7.2.12
Continuous current test (for Disconnectors only)		7.5
Short-time withstand current and peak withstand current tests		7.6
Tests on auxiliary and control circuits		7.10
Measurement of the main circuit resistance (for Disconnectors only)		7.44
High-temperature test		7.104.4
Continuous current test (for Disconnectors only)		7.5



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Test on MV Switches	IEC Standard	Clause
Power-frequency voltage test	62271-103	6.2
Lightning impulse voltage test		
Tests on auxiliary and control circuits		
Voltage test as a condition check		
Measurement of the resistance of the main circuit		6.4
Temperature-rise tests		6.5
Short-time withstand current and peak withstand current tests		6.6
Mechanical operation test at ambient air temperature		6.102.2

Tests on MV Switchgears and Controgears	IEC Standard	Clause
Power-frequency voltage test	62271-200	6.2.6.1
Lightning impulse voltage test		6.2.6.2
Voltage test as a condition check		6.2.11
Temperature-rise tests		6.5
Mechanical operation test		6.102
Short-time withstand current and peak withstand current tests		6.6



Power Cell



ANNEX 2

Performed Test by the Testing Laboratory supplied by
a Short-circuit Generator (Stage 2)

A2.1 Distribution and Power Transformers

Equipment	Primary Voltage	Secondary Voltage	Short-circuit impedance	Rated Power
Distribution Transformer	11 kV or 13.8 kV	0.4 kV	2.5 ÷ 4 %	up to 2.5 MVA
	33 kV	0.4 kV	4 ÷ 7 %	up to 5 MVA
Power Transformer	33 kV	11 kV	4÷8%	up to 16 MVA
	66 kV	11 kV	7÷10%	up to 25 MVA
	132 kV	11 kV	15÷22%	up to 50 MVA
	132 kV	33 kV	15÷22%	up to 50 MVA

Tests performed on Distribution and Power Transformers	IEC Standard	Clause
Measurement of winding resistance	60076-1	11.2
Measurement of voltage ratio and check of phase displacement		11.3
Measurement of short-circuit impedance and load loss		11.4
Measurement of no-load loss and current		11.5
Measurement of no-load loss and current at 90 % and 110 % of rated voltage		
Measurement of zero-sequence impedance(s) on three-phase transformers		11.6
Determination of capacitances windings-to-earth, and between windings		11.1.4 point c)
Measurement of dissipation factor (tan δ)		11.1.4 point d)
Measurement of d.c. insulation resistance each winding to earth and between windings		11.1.4 point h)
Temperature rise test	60076-2	7
Applied voltage test (AV)	60076-3	10
Induced voltage withstands test (IVW)		11.2
Induced voltage test with partial discharge measurement (IVPD)		11.3
Line Terminal AC withstand voltage test		12
Lightning impulse tests (LI)		13
Ability to withstand short circuit	60076-5	4.2
Measurement of frequency response (Frequency Response Analysis)	60076-18	4



A2.2 MV Switching Equipment

Equipment	Rated Voltage	Rated Current
Circuit Breakers	from 3.6 kV up to 36 kV	up to 6.3 kA
Disconnectors and Earthing Switches		up to 6.3 kA
Switches		from 400 A up to 800 A
Switch-Fuse Combination		from 400 A up to 800 A
Current limiting Fuses		up to 6.3 kA
Expulsion Fuses	up to 36 kV	up to 6.3 kA
Gas insulated metal enclosed Switchgears and Controlgears	from 3.6 kV up to 36 kV	up to 3.15 kA
Metal enclosed Switchgears and Controlgears (Ring Main Unit included)		up to 3.15 kA
Solid insulated-enclosed Switchgears and Controlgears		up to 3.15 kA

Test on MV Circuit Breakers	IEC Standard	Clause
Mechanical operation test at ambient air temperature	62271-100	6.101.2
Short-circuit making and breaking		6.106
Critical current tests		6.107
Single phase and double earth fault		6.108
Out-of-phase making and breaking tests		6.110
Capacitive current switching		6.111
Power-frequency voltage		6.2.6.1
Lightning impulse voltage		6.2.6.2
Partial Discharge		6.2.9
Tests on auxiliary and control circuits		6.2.10
Voltage test as a condition check		6.2.11
Measurement of the resistance of the main circuit		6.4
Temperature-rise tests		6.5
Short-time withstand current and peak withstand current		6.6



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Tests on MV Disconnectors and Earthing Switches	IEC Standard	Clause
Power-frequency voltage test	62271-102	7.2.6
Lightning impulse voltage test		7.2.7
Partial Discharge		7.2.10
Voltage test as a condition check		7.2.12
Measurement of the main circuit resistance (for Disconnectors only)		7.4.4
Continuous current test (on Disconnectors only)		7.5
Short-time withstand current and peak withstand current tests		7.6
Tests on auxiliary and control circuits		7.10
Test to prove the short-circuit making performance (on Earthing Switch only)		7.101
High-temperature test		7.104.4

Test on MV Switches	IEC Standard	Clause
Power-frequency voltage test	62271-103	6.2
Lightning impulse voltage test		
Tests on auxiliary and control circuits		
Voltage test as a condition check		
Measurement of the resistance of the main circuit		6.4
Temperature-rise tests		6.5
Short-time withstand current and peak withstand current tests		6.6
Making and breaking tests- Switching test		6.101, Table 4
Making and breaking tests- Single capacitor bank switching current		6.101, Table 5
Mechanical operation test at ambient air temperature		6.102.2

Test on Expulsion Fuses	IEC Standard	Clause
Power-frequency voltage test	60682-2	8.4.4
Lightning impulse voltage test		8.4.5
Temperature-rise test and power-dissipation measurement		8.5
Breaking tests (Test Duty 1, 2, 3)		8.6
Tests for time-current characteristics		8.7



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Test on Switch-Fuse Combination	IEC Standard	Clause
Power-frequency voltage test	62271-105	6.2
Lightning impulse voltage test		
Tests on auxiliary and control circuits		
Voltage test as a condition check		
Temperature-rise tests		6.5
Short-time withstand current and peak withstand current tests		6.6
Making and breaking tests at the rated short-circuit current		6.101
Making and breaking tests at the maximum breaking I _{2t}		
Breaking tests at the rated transfer current		
Breaking tests at the rated take-over current		
Mechanical operation test		6.102
Mechanical shock tests on fuses		6.103
Thermal test with long pre-arcing time on fuse		6.104

Test on Current limiting Fuses	IEC Standard	Clause
Power-frequency voltage test	60682-1	6.4.4
Lightning impulse voltage test		6.4.5
Temperature-rise test and power-dissipation measurement		6.5
Breaking tests (Test Duty 1, 2, 3)		6.6
Tests for time-current characteristics		6.7
Tests of strikers		6.8

Tests on Gas Insulated metal enclosed Switchgears and Controlgears	IEC Standard	Clause
Power-frequency voltage	62271-203	6.2.6.1
Lightning impulse voltage		6.2.6.2
Partial Discharge		6.2.9
Voltage test as a condition check		6.2.11
Radio interference voltage test		6.3
Temperature-rise tests		6.5
Mechanical operation test		6.102.2
Short-time withstand current and peak withstand current tests		6.6
Verification of making and breaking capacities		6.101



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Tests on Metal enclosed Switchgears and Controlgears (Ring Main Unit included)	IEC Standard	Clause
Power-frequency voltage test	62271-200	6.2.6.1
Lightning impulse voltage test		6.2.6.2
Partial Discharge		6.2.9
Voltage test as a condition check		6.2.11
Temperature-rise tests		6.5
Mechanical operation test		6.102
Short-time withstand current and peak withstand current tests		6.6
Verification of making and breaking capacities		6.101
Mechanical operation test		6.102
Tests to verify the protection of persons against dangerous electrical effects		6.104
Internal arc test		6.106; Annex AA

Tests on Solid insulated-enclosed Switchgears and Controlgears	IEC Standard	Clause
Power-frequency voltage test	62271-201	6.2.6.1
Lightning impulse voltage test		6.2.6.2
Partial Discharge		6.2.9
Voltage test as a condition check		6.2.11
Temperature-rise tests		6.5
Mechanical operation test		6.102
Short-time withstand current and peak withstand current tests		6.6
Verification of making and breaking capacities		6.101
Mechanical operation test		6.102
Tests to verify the protection of persons against dangerous electrical effects		6.104
Internal arc test		6.105
Thermal stability test		6.106



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A2.3 MV Busducts (max 10 meters long)

Rated voltage	Rated current	Rated Short-time current	Max Short-circuit power
from 1 kV up to 36 kV	up to 6300 A	up 63 kA, 3 s	1500 MVA

Tests on MV Busduct	IEC Standard	Clause
Power-frequency voltage test	62271-200	6.2.6.1
Lightning impulse voltage test		6.2.6.2
Partial Discharge		6.2.9
Voltage test as a condition check		6.2.11
Temperature-rise tests		6.5
Short-time withstand current and peak withstand current tests		6.6

A2.4 Current Transformers and Inductive Voltage Transformers

Equipment	Rated Voltage	Rated Short-time current	Max Short-circuit power
Current Transformers	up to 400 kV	up to 6.3 kA	1500 MVA
Inductive Voltage Transformers			

Test on Current Transformers	IEC Standard	Clause
Wet test for outdoor type transformers	61869-1	7.2.4
Partial discharge measurement		7.3.2
Power-frequency voltage withstand tests between sections		7.3.3
Power-frequency voltage withstand tests on secondary terminals		7.3.4
Chopped impulse voltage withstand test on primary terminals		7.4.1
Mechanical tests		7.4.5
Temperature rise test	61869-2	7.2.2
Impulse voltage withstand test on primary terminals		7.2.3
Short-time current tests		7.2.201
Test for accuracy		7.2.6
Power-frequency voltage withstand tests on primary terminals		7.3.1
Inter-turn over voltage test		7.3.204



Power Cell

Test on Inductive Voltage Transformers	IEC Standard	Clause
Wet test for outdoor type transformers	61869-1	7.2.4
Power-frequency voltage withstand tests between sections		7.3.3
Power-frequency voltage withstand tests on secondary terminals		7.3.4
Chopped impulse voltage withstand test on primary terminals		7.4.1
Mechanical tests		7.4.5
Temperature rise test	61869-3	7.2.2
Short-circuit withstand capability		7.2.301
Lightning impulse voltage test on primary terminals		7.2.3.2
Short-circuit withstand capability		7.2.301
Power-frequency voltage withstand tests on primary terminals		7.3.1
Partial discharge measurement		7.3.2

A2.5 Ceramic and glass insulators with rated voltage up to 400 kV

Test on Ceramic and glass insulators	IEC Standard	Clause
Lightning impulse voltage	61869-1	13
Wet power-frequency voltage		14
Puncture withstand tests		15
Radio interference voltage	60437	13

A2.6 Polymeric insulators with rated voltage up to 400 kV

Test on Polymeric insulators	IEC Standard	Clause
Reference dry power frequency	62217	9.2.3
Step-front impulse voltage		9.2.6.2
Dry power frequency voltagePuncture withstand tests		9.2.6.3
Radio interference voltage	60437	13



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A2.7 Power Cables with extruded insulations with rated voltage above 36 kV and up to 170 kV

Type tests on complete cable		IEC Standard	Clause
Electrical tests	Bending	60840	12.4.3
	Partial discharge		12.4.4
	Tan δ measurement		12.4.5
	Heating cycle		12.4.6
	Lightning impulse voltage test followed by a power frequency voltage		12.4.7
Prequalification test	Heating cycle voltage		13.2.4
	Lightning impulse voltage		13.2.5

A2.8 Power Cables with extruded insulations with rated voltage above 170 kV and up to 400 kV

Type tests on complete cable		IEC Standard	Clause
Electrical tests	Bending	62067	12.4.3
	Partial discharge		12.4.4
	Tan δ measurement		12.4.5
	Heating cycle voltage tests		12.4.6
	Switching impulse voltage test		12.4.7.1
	Lightning impulse voltage test followed by a power frequency voltage		12.4.7.2
Prequalification test	Heating cycle voltage		13.2.4
	Lightning impulse voltage		13.2.5



Power Cell

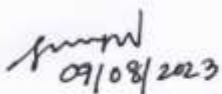


ANNEX 3

Statement of PBCB about the supply of short-circuit power
to the On-line MV Testing Laboratory (Stage 1)

PGCB's observations on Interim Report of Consultancy Services for Setting Up Electrical Testing Laboratory

- I. A substantial capacity to provide a short-circuit power of 5000 MVA exists in most of the 230 kV grid substations operated by PGCB. Consequently, the establishment of an On-line Medium Voltage Laboratory, which requires a short-circuit power of 250 MVA, is technically feasible within the existing transmission infrastructure.
- II. The impact of voltage flicker introduced during repeated testing of equipment must be considered. To prevent the degradation of power quality, it is recommended that the testing facility should not be located near the grid substation from which sensitive loads are being served. The probable location of the testing facility shall be in Chattogram, Khulna, or Barishal zone. This choice of location considers the potential consequences of voltage fluctuations on the grid while ensuring optimal conditions for testing without adversely affecting the broader power supply.
- III. The standard voltage variation range defined in the grid code for the 230 kV level is $\pm 6\%$. As per the report the testing facility will draw 250 MVA of short-circuit power for a duration of 300 ms, it is likely that this will cause a maximum 5% temporary dip in the grid voltage along with other connected loads with the system. This may lead to a distortion of power quality at the grid level. Therefore, a highly recommended comprehensive technical impact analysis of the testing laboratory's effect on the grid's performance. This analysis should delve into the specifics of how the short-term voltage dip might impact power quality, reliability, and the overall stability of the grid.
- IV. After receiving the detailed grid impact study of the testing facility, further observations from PGCB could be provided.


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ANNEX 4

Remarks raised by the Stakeholders together
with the Consultant's replies



Power Cell



Remarks by the Manufacturers

1. ADEX Corporation Limited
2. Energypac Engineering
3. Reverie Power & Automation Engineering Limited



ADEX Corporation Limited

Remarks

The prime requirement of the national testing laboratory are as follows:

1. Dynamic short circuit test for a voltage level up to 36kV & short circuit current up to 31.5kA.
2. Low voltage rated current capacity of circuit breakers, switchgears & bus bar trunking should be up to 6300A, 150kA.

Above mentioned testing requirements are the severely required for the local manufacturers as those tests are not possible to arrange by the local manufacturers. Other tests & calibration can be done by the local manufacturers.

Without above two test facilities the testing lab will be of no use to the local manufactures. **Setting up the testing laboratory without above testing facilities will be wastage of money.**

Consultant's reply

1. The short-circuit tests on MV equipment having rated voltage up to 36 kV and short-circuit current up to 31.5 kA can be carried out by the Laboratory in the Stage 2 configuration.
2. The test ratings defined at par. 6.1 and Annex 1 of this document are such to allow testing on LV equipment with rated current up to 6300 A and short-circuit current up to 200 kA.



Power Cell



Energypac Engineering

Remarks

I like to include following comments:

- 1) We manufacture 80/120 MVA power transformer with voltage ratio 132/33 kV. PGCB is using this transformer. So, max. operating rating of power transformer should be 120 MVA.
- 2) The laboratory is connected 2500 MVA short circuit generator.

Consultant's reply

The revision of the Laboratory Stage 2 configuration defined as Option B at par. 6.3 allows the execution of short-circuit tests on Power transformers with 132/33 kV ratio voltage and a rated power up to 120 MVA.



Power Cell



Reverie Power & Automation Engineering Limited

Remarks

Reverie Power & Automation Engineering Ltd currently produces power transformers with a primary voltage of 132 kV and plans to develop:

- in the next three years power transformers with a power of 350 MVA and 230 kV primary voltage,
- to extend its production capability within the next 10 years up to 500 MVA and 400 kV of primary voltage.

Consultant's reply

The revision of the Laboratory Stage 2 configuration defined as Option B at par. 6.3 allows the execution of short-circuit tests on one phase of the Power transformers having 230 kV primary voltage and 350 MVA 3-phase power.



Power Cell



Remarks by Electrical Utilities

1. Ashugany Power Station Company Limited
2. B-R Powergen Limited
3. Bangladesh Rural Electrification Board
4. Coal Power Generation Company Bangladesh Limited
5. Dhaka Electricity Supply Company
6. Dhaka Power Distribution Company Limited



Power Cell

Ashugany Power Station Company Limited

Remark

Generator circuit breaker voltage rating is about 12kv/15.75kv/22kv and short circuit rating 80kA to 120KA. Higher short circuit MVA equipment testing facilities need consider.

Consultant's reply

The availability of a 2500 MVA Short Circuit Generators allows, in principle, to perform the short circuit tests on the considered Generator Circuit Breakers according the above table:

Rated Voltage	80 kA rated current	120 kA rated current
12 kV	yes	no
15.75 kV	yes	no
22 kV	no	no

It has to be outlined that the tests of Generator Circuit Breakers are among the most demanding ones in terms of short circuit power and the feasibility of each specific test program is related to the detailed ratings of the equipment to be tested.

Clearly short-circuit tests on Generator Circuit Breakers having 22 kV rated voltage and 120 kA short-circuit current require two 2500 MVA Short Circuit Generators and a corresponding Laboratory Short-circuit Transformer Banks. To evaluate the opportunity of the large investment required for such testing equipment must be taken into consideration how many prototypes of such Circuit Breakers Generator will be produced by the local industry in the coming years (since only the new prototypes locally developed can give the request for testing services at the Laboratory being the equipment purchased by international manufacturers are already qualified by foreign testing laboratories).



B-R Powergen Limited

Remarks

1. The calibration with specific time interval of various equipment's used in the Electrical Testing Laboratory can be discussed in the report.
2. If the Electrical Testing Laboratory power is supplied by an external source i.e. from 230 kV and a short circuit power of 250 MVA then considering testing interval Bangladesh Electricity Grid Code compliance must be ensured.

Consultant's reply

1. The Testing Laboratory surely must carry out periodic calibrations of its measuring instruments through appropriate records and procedures allowing to monitor the calibration status of each instrument throughout its operating life and to exclude from service those having an invalid calibration. This activity has to be carried out by a dedicated office of the Testing Laboratory and will be described in the document Testing Laboratory organization in the frame of the Deliverable D3-First Informative Report.
2. The selection of which of the twelve 230 kV Power Station around Dhaka will have to make available to the Laboratory the power line capable of 250 MVA short circuit power will be defined by Power Grid Company of Bangladesh in close cooperation with Power Cell and certainly all issues concerning the Electricity Grid Code will be considered in this regard.

Bangladesh Rural Electrification Board

Remarks

1. Proposal of the configuration of proposed testing Laboratory for stage 1 and Stage 2, the Short Circuit generator rating have to be higher rating (41kA). As a result, it will be more adequate to do the type test that material/equipment is used in REB distribution system.
2. REB Uses IEC, IEEE and ANSI standard materials/equipment in electrical distribution system. In interim report, IEC Standard testing facility is shown only. It is necessary to have ANSI standard in proposed testing laboratory. It is needed to create testing facilities for following material/equipment which will be Performed Test by the Testing Laboratory:

The following material/equipment Type Tests as per ANSI Standard described in below;

Equipment: Fuse Cut-out

Type Test of Fuse Cut-out	Standard	Remarks
Dielectric Tests	ANSI C 37.41 & ANSI C 37.42	
Impulse Withstand voltage Tests		
Interrupting Rating & performance Tests		
Short time Current Tests		
Temperature Rise Tests		
Time Current Tests		

Equipment: 1-phase Distribution Transformer (5, 10, 15, 25, 37.5, 50, 75, 100 & 167 KVA)

Type Test of 1-phase Distribution Transformer	Standard	Remarks
Lightning Impulse Test	ANSI C 57.12.90	
Temperature Rise Test		
Short Circuit Test		

Equipment: Instrument Transformer (Dry Type Current transformer & Potential Transformer)

Type Test of Instrument Transformer (Current transformer & Potential Transformer)	Standard	Remarks
Lightning Impulse Voltage Test	ANSI C 57.13	
Temperature Rise Test		
Short time Current Test		
Wet withstand test		
Determination of error & Polarity test		
Power frequency withstand test		
Partial Discharge Measurement		
Inter-turn over voltage test		

Equipment: Lightning Arrester

Type Test of Lightning Arrester	Standard	Remarks
Arrester insulation withstand test	ANSI C 62.11 & ANSI C 62.22	
Power frequency spark over test		
Discharge voltage Characteristic test		
Impulse Protective level Voltage time Characteristic test		
Contamination test		
Distribution Arrester seal Integrity design test		
PD Test		
High Current Short Duration Withstand Test		
Duty Cycle Test		
Temporary Over Voltage Test		
Pressure Relief test for station intermediate arresters		
Short Circuit test for Porcelain house distribution arresters		
Ultimate Mechanical Strength Static Test for Porcelain house arresters		

Equipment: Three Phase CT/PT rated Electronic Meter (Socket Type)

Type Test of Three Phase CT/PT rated Electronic Meter (Socket Type)	Standard	Remarks
Insulation test	ANSI C 12.20	
Voltage Interruptions Test		
Effect of high voltage line surges		
Effect of high external magnetic field		
Effect of variation of ambient temperature		
Effect of temporary overloads		
Effect of current surge in ground conductor		
Effect of Super imposed signals		
Effect of Electrical fast transient/Burst Test		
Effect of SWC Test		
Effect of Radio frequency interference		
Effect of Electro static Discharge		
Effect of Storage Temperature		
Rain tightness & Salt spray Test		
Effect of Non Sinusoidal Test		



Power Cell

Consultant's reply

1. Short circuit tests on MV equipment with 41 kA short circuit current may be performed by the Laboratory in the Stage 2 configuration only if the equipment rated voltage is equal to 12 kV or 24 kV. An equipment with 36 kV rated voltage and 41 kA short circuit current requires a short circuit power exceeding the 2500 MVA Short circuit power of the Generator.
2. Every single test on equipment has to be necessarily referred to a Standard (the only name of the tests does not identify the test procedure and parameters as well as the conditions for which the test was passed positively). The Consultant refers to IEC Standard. As known the tests specified by IEC Standard are quite similar to those of ANSI Standard in terms of required capacity of the testing equipment. Then all the tests above listed above can be performed by the test equipment proposed in this document. In particular:
 - a) tests on Fuse Cut-out according to ANSI C 3741 and ANSI C 3742 are similar to those of IEC Standard 60682 series mentioned in this document for the Expulsion Fuses and the Limiting Current Fuse;
 - b) concerning the 1-phase Distribution Transformers having 11/0.4 kV voltage ratio and rated power from 5 kVA to 167 kVA can be performed in the Stage 1 configuration of the Testing Laboratory;
 - c) Tests on 3-phase Current and Potential Transformers to be performed according to ANSI C 12.20 are similar to those of IEC Standard 61869 series mentioned in this document for instrument equipment with rated voltage up to 400 kV and rated short-time current up to 6300 A taking into consideration the expected development of such equipment by local manufacturers;
 - d) concerning the Lighting Arresters to be tested according to ANSI C 62.11 and ANSI C 62.22 Standard, the required tests are similar to that listed by IEC 60099/4 Standard for the Surge Arresters. Both Standards requires to carried out dielectric tests different from the usual LI (1.25 μ S- 50 μ S) or SI (250 μ S- 2500 μ S) test; this entails the provision of special test circuits (not less than 3 different testing circuits, used only for the tests on Lighting Arresters or Surge arresters). The Laboratory in the Stage 2 configuration allows to carry out short-circuit tests on this equipment having rated voltage up to 400 kV and rated short-circuit current up to 63 kA.



Power Cell

Coal Power Generation Company Bangladesh Limited

Remarks

Sl.	Clause No	Page No	Content of the Report	Comment of CPGCBL
1	Table D2-1-8: Max operating ratings of the equipment that can be tested in the two considered configurations of the Laboratory	16	-	Lightning arrester, Motor, Solar inverter, Energy Meter and Smart meter could be included in the proposed equipment list.

Consultant's reply

- Concerning the Lightning Arresters, please see the previous page 51 on the matter.
- The testing of electrical motors requires a dedicated test facility and dedicated test equipment. Are there in Bangladesh local manufacturers producing electrical motor and that are not able to test them in its factory so as to determine a request for tests to the Laboratory? The decision to build such testing facilities must be thoroughly investigated in order to avoid an increase in capital expenditure without the possibility of an acceptable return on the additional investment.
- The National Testing Laboratory aims to make available the High Voltages and High-Power testing facilities not feasible by the local manufacturers being the high the required capital expenditure and that do not exist currently in Bangladesh. Surely Energy meters can be tested with simple tools measuring voltage, current, power factor and frequency; several existing laboratories existing in Bangladesh (Iconic Engineering Ltd, for instance) supply services for testing such equipment.

Dhaka Electricity Supply Company Limited

Remarks

DESCO's comments on D2-Interim Report, under "Consultancy Services for Setting Up Electrical Testing Laboratory" project.

Sl. No.	Reference	Information given in the report	DESCO's Comment
1.	Table D2-1-8, page 16	Power Transformers: Stage 1 - up to 36 kV; up to 12 MVA. Stage 2 - up to 132 kV; up to 50 kV.(MVA)	a) DESCO uses 132/33 KV 80/120 MVA transformers and hence, those power transformers cannot be tested even in stage 2.
2.	Annex-2, Table A2.1, page 26	Power Transformers: a) Short Circuit Impedance of 33/11 KV power transformer is 4-8% for rated power up to 16 MVA. b) Short Circuit Impedance of 132/33 KV power transformer is 15-22% for rated power up to 50 MVA.	a) 33/11 KV power transformer used in DESCO has a maximum MVA rating of 28 MVA and 35 MVA rating transformers will be installed in the upcoming project. Hence this type of transformer cannot be tested in stage 2. b) 132/33 KV Power Transformers used in DESCO has a maximum MVA rating of 120 MVA having short circuit impedance as less as 13%. Hence this type of transformer cannot be tested even in stage 2.
3.	Article:4 (Comprehensive proposal) page 11 and Table D2-1-4: Distribution Transformers Annex-2, Table A2.1, page 26	Distribution Transformers: a) Distribution Transformers with a maximum power of 4 MVA short circuit impedance not lower than 10%. b) 11 or 13.8 kV/0.4 kV Distribution Transformers: Short circuit impedance 4-6% c) Short Circuit Impedance of 11/0.4 KV power transformer is 4-6% for rated power up to 2 MVA.	a) According to page-11 of D2-INTERIM REPORT, Short Circuit Impedance of 11/0.4KV distribution transformers should not be lower than 10% whereas that value is 4-6% mentioned in table D2-1-4 at page 12. Correction may be required. b) Now-a-days, DESCO is getting 11/0.4KV distribution transformer with 2.5 to 4% Short Circuit Impedance. Hence, facilities should be kept to test distribution transformers having short circuit impedance lower than the value stipulated in the report.
4.	Additional Comment: Facilities for Non-Electrical type tests should be kept in the laboratory especially for power cables, insulators, surge arresters, etc. as per IEC and equivalent International Standards.		



Consultant's reply

1. The revision of the Stage 2 Laboratory configuration defined as Option B at par. xx of the Chapter z allows to execution of short-circuit tests on only one phase of the Power transformers with 132/33 kV ratio voltage, rated power up to 120 MVA and 13% short-circuit impedance adopting pre-set short-circuit scheme.
2. a) Making use in Stage 1 configuration of the Testing Laboratory of Short-circuit Transformers Bank (fed by the external power line) having a short-circuit power of 1500 MVA, the Power Transformer with 33/11 kV voltage ratio, 28 MVA rated power and short-circuit impedance not less than 8% can be tested when supplied from 11 kV side and short-circuit pre-set on the 33 kV side.

b) The revision of the Stage 2 Laboratory configuration defined as Option B at par. xx of the Chapter z allows to execution of short-circuit tests on one phase of the Power transformers with 132/33 kV ratio voltage, rated power up to 120 MVA and Short-circuit impedance not lower than 13 %.
3. a) & b) In the rev. 0 of the document the page 11 refers to Testing Laboratory in Stage 1 configuration (the allowed short-circuit tests on 4 MVA Distribution Transformers are allowed for short-circuit impedance not lower than 10%) while the Table D2 1.4 refers to short-circuit tests on Distribution Transformers Bank (having short-circuit impedance between 4% and 6%) performed in Stage 2 configuration of the Laboratory. So, any correction has to be done on this item.

c) The short-circuit tests on Distribution Transformers having rated power up to 2 MVA, voltage ratio 11/0,4 kV or 13,8/0,4 kV, short-circuit impedance from 2.5% up to 4%, can be performed by the Testing Laboratory in Stage 2 configuration.
4. The National Testing Laboratory aims to make available the High Voltages and High-Power testing facilities needed to perform type tests (including the non-electrical ones) not feasible by the local manufacturers being the high the required capital expenditure and that do not exist currently in Bangladesh. As resulting from the filled questionnaires, the local manufacturers are able to perform all the electrical routine tests and the non-electrical tests not classified as type tests. Therefore, it seems not effective to replicate in the National Testing Laboratory what can already be done in existing laboratories.



Power Cell

Dhaka Power Distribution Company Limited

Remarks

Section	Sub-Section	Observation of DPDC
Document 1- Conceptual Configuration of the Testing Laboratory	3. Basic information and criteria adopted for the configuration of the Bangladesh National Testing Laboratory, Page No. 6	➤ The detail step-by-step procedure to achieve international accreditation needs to be included. ➤ Physical infrastructure required for the testing laboratory set up, size, layout, and location constraints (If any) needs to be specified.
	3.2 Considerations on the main issues related to Laboratory configuration, Page No. 9	➤ The proposal should include a robust quality assurance plan, including internal audits and external certifications to ensure the accuracy and credibility of testing results. ➤ Brief description on expected turnaround time for completing different types of tests, mechanism to expedite urgent requests, quality assurance program to monitor and maintain the accuracy and reliability of testing processes can be included. ➤ Assessment regarding the environmental impact of laboratory operations, including waste management and energy consumption should be specified more clearly. ➤ It is also important to specify how will the laboratory ensure the calibration and accuracy of testing equipment and whether there will be any plans for regular maintenance and calibration checks. ➤ The qualifications and expertise of the laboratory staff are crucial for accurate testing and reliable results. The qualifications and training are required for laboratory personnel to perform tests accurately and safely should be mentioned clearly. Moreover, the safety protocols to protect personnel and equipment during testing and potential hazards (if any) need to be addressed.

	4. A comprehensive proposal for the National Testing Laboratory, Page No. 11	➤ It is important to mention the detail procedure how the event of the most power demanding tests (sort circuit test) and how corresponding voltage drop of the grid, if any, will be handled.
	Table D2-1-8, Page No. 16	➤ The maximum operating ratings of the equipment considered for testing and configuration of the laboratory in stage 1 and stage 2 need to be modified. It is observed that for stage 1, the testing capacity of power transformer is up to 12MVA at 36 kV. In DPDC and other power utilities of Bangladesh, the capacity of 33/11kV power transformer is generally 20/28MVA. It is to be noted that in some substations of DPDC, 33/11kV power transformers having capacity of 28/35MVA are also used. Moreover, in a recent mega project of DPDC, 33/11kV power transformers having capacity of 35/50 MVA are being used. As such, the capacity of 33/11kV power transformer that can be tested in the proposed testing laboratory in stage 1 should be increased up to 28MVA, otherwise utility in Bangladesh who require 20/28 MVA or higher rating transformer at 33 kV can't get any benefit from proposed testing laboratory of stage 1. ➤ The proposed operating ratings of power cable for stage 2 is 132kV. But according the statement of the some reputed local UG cable manufacturers of Bangladesh, they have already procured machinery which have capacity to produce power cable up to 230kV level. The voltage level of UG power cable that can be tested in the proposed testing laboratory should be increased up to 230kV, which shall be beneficial for both power utilities and local manufacturers of Bangladesh.
	ANNEX 1 Performed Test by the ON Line Medium Testing Laboratory (Stage 1), Page No. 17	➤ List of Type Tests to be performed on the equipment need to listed separately for better understanding.



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Consultant's reply

1. Concerning several issued taken into consideration:

- a) how to obtain the international accreditation of the Testing Laboratory
- b) layout, organization in testing facilities, buildings of the Testing Laboratory
- c) the need of Quality Assurance Plan ensuring the accuracy of the tests results
- d) calibration of the testing equipment of the Testing Laboratory
- e) how to the dispatching of tests in the framework of Testing Laboratory operation
- f) the assessment of the environmental impact of the Testing Laboratory
- g) the recruitment, qualification and training of the Testing Laboratory staff

they will be the subject of following documents:

- Laboratory Organisation (within the Deliverable D3-First Informative Report)
- Feasibility Study of Testing Laboratory (within the Deliverable D3-First Informative Report) and Conceptual electric, civil, architectural engineering (within the Deliverable D4-Second Informative Report)
- Capacity Building (within the Deliverable D5-Draft Final Report).

2. About the operation of Testing Laboratory in the Stage 1 configuration where the testing circuit will be supplied by an external power line coming from 230/132 Power Station it has to considered the position of Power Grid Company of Bangladesh (see Annex 3) that may be summarized as follows:

- A substantial capacity the provide the required short-circuit power of 250 MVA by the On-line Medium Voltage Laboratory is technically feasible within the existing transmission infrastructure,
- The standard voltage variation range defined in the grid code for the 230 kV level is $\pm 6\%$. As per the report the testing facility will draw 250 MVA of short-circuit power for a duration of 300 ms, it is likely that this will cause a maximum 5 % temporary dip in the grid voltage along with other connected loads with the system. This may lead to a distortion of power quality at the grid level. Therefore, a highly recommended comprehensive technical impact analysis of the testing laboratory's effect on the grid's performance. This analysis should delve into the specifics of how the short-term voltage dip might impact power quality, reliability, and the overall stability of the grid.



Power Cell



3. Making use of Short-circuit Transformers Bank (fed by the external power line) having a short-circuit power of 1500 MVA the requested short-circuit tests on Power Transformer with 33/11 kV voltage ratio and 28 MVA rated power can be performed by the Testing Laboratory in Stage 1 configuration.
4. Considering the expected production from a local manufacturer of 230 kV underground cable, for the Testing Laboratory in Stage 2 configuration the testing capability of cables was increased to 400 KV.
5. The allowed tests by the Testing laboratory in Stage 1 configuration are clearly defined in Annex 1: for each equipment the related operating rates (rated voltage, rated current, etc.) are listed as well the tests that can be carried with the clause of the reference IEC Standard.



Power Cell
Ministry of Power, Energy & Mineral Resources
Govt. of the People's Republic of Bangladesh

**Consultancy Services for Setting Up Electrical Testing
Laboratory**
(Contract Package: S-10)



Deliverable	D2
Document	2 – Existing Testing laboratories and Certification & Inspection Bodies
Revision	1
Date	11/08/2023
Client	Power Cell
Consultant	DeMEPA in JV with ECBL



Power Cell

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Power Cell



1. Summary

In order to provide an overview of the current characteristics of the electrical equipment market in Bangladesh and the expectations of the different players of this market towards an electrical Testing Laboratory in Bangladesh and the National Independent Authority, the Consultant prepared questionnaires which were distributed by Power Cell to all the Stakeholders.

In the rev. 0 of this document all the filled questionnaires have been collected in Annex 1, dividing them among those compiled by:

- the electrical utilities,
- the manufacturers,
- the Certification and Inspection Bodies, including the public agencies having a role on the matter.

In this rev.1 of the document the filled questionnaire by the Bangladesh Standard and Testing Institution (BSTI) is included (the rev.0 did not include it because of a mistake) as well as additional comments received from BSTI following the 2nd Stakeholders Meeting.

A first analysis of the filled questionnaires is carried out in Chapters 3 and 4 while in Chapter 5 explanations are given to the remarks raised by some Stakeholders on the rev. 0 of the document.



Power Cell

2. Foreword

The two main objective of the project "**Consulting Services for Setting Up Electrical Testing Laboratory**":

- to assess the potential of a **Testing Laboratory** able to perform a series of tests according to the International Standards on the main electromechanical equipment of the Bangladesh power system,
- the design of a **National Independent Authority** providing testing and certification services to the domestic electromechanical sector,

will surely impact on the existing national context aimed to ensure the quality of equipment that are used in the power system and related energy intensive sector.

Hence the need to **carry out a survey on**:

- **the electrical utilities**, mainly concerning their request for higher quality/performances on the equipment produced by the local manufacturers, the current penetration of the international players on the Bangladeshi market, the type tests currently required and performed on the purchased equipment;
- **the manufacturers**, addressed to define the equipment locally produced and sold in the domestic and international market, the planned development of new equipment in the short- and medium terms and the quality of the equipment currently manufactured in comparison with the ones available from international market;
- **the certification and inspection bodies**, considering the existing public and private bodies in the country and their current role over the quality processes of the electrical equipment, the accreditation of the testing laboratories and of the Certification bodies, the reference International Standard in the certification and inspection activities.

The questionnaires prepared by the Consultant have been distributed by Power Cell to all the potential Stakeholders.



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3. The existing electrical testing laboratories

Filled questionnaires show that **all manufacturers have a testing laboratory able to perform the routine tests** (or a large part thereof) **on each sample of their products**.

Based on information provided by the Bangladesh Accreditation Board, the government agency responsible for providing accreditations to Bangladeshi laboratories, testing centres and certification bodies, only two manufacturers' testing laboratories are accredited:

- the High Voltage Test Laboratory of Energypac Engineering, accredited according to ISO 17025:2017 by the Indian Institute NABL;
- the Calibration laboratory of Reverie Power & Automation Engineering Ltd, accredited by the Bangladesh Accreditation Board.

Some testing laboratories operate within BSTI, the Bangladesh Standards and Testing Institution, performing tests on power transformers, switching equipment, insulators and power cables: some of them has got accreditation from the Bangladesh Accreditation Board.

Iconic Engineering & Trading Company supplied testing and measuring services on power cables.

The laboratory of the Department of Electrical Engineering and Electronics of the University of Engineering and Technology performs some tests on Distribution Transformers, Cables, Instrument Transformers (CT and Pt), Switchboard and Overhead Conductor, not always fully complying with International Standards. The complete list of tests carried out by this Laboratory is listed in Annex 1.

Most of the electrical utilities (including Ashuganj Power Station, Dhaka Power Distribution Company, CERS of Bangladesh Power Development Board) have internal laboratories that perform tests on some equipment (such as meters, switchboards, overhead conductors, distribution transformers). Power Grid Company of Bangladesh has a wide range of laboratories also used for the purpose of predictive and corrective maintenance.

There also different calibration laboratories:

- Seven laboratories are operating under National Metrology Laboratory of BSTI; they are accredited by a Norwegian accreditation body and provide calibration services as per the guideline of ISO/IEC 17025 concerning DC current and voltage, AC current and voltage, capacitance, resistance and power;
- Summit Testing & Calibration Laboratory, accredited by the Bangladesh Accreditation Board for AC and DC measurement equipment;
- ION Engineering Pvt. Ltd, accredited by the Bangladesh Accreditation Board for AC Voltage up to 1000 V, AC current up to 10 A, Resistance and Insulation Resistance measurement;
- Pico Labs Ltd, accredited according ISO 17025: 2017 by the Indian Institute NABL and providing service calibration.



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DeMEPA
DESIGN and MANAGEMENT of ELECTRICAL POWER ASSETS

With the sole exception of Energypac Engineering, **no laboratory is able to perform type tests**, that is a complete set of tests according to the International Standard and performed in accredited testing facility.

For this reason, the execution of type tests on the purchased equipment are required by the electrical utilities to be carried out by independent foreign testing laboratories. This results into considerable costs in the case of a national manufacturer (and indirectly also for utilities) to which must also be added transport costs and the outlay of foreign currency.

From the above framework it can be deduced:

- **the establishment of National Testing Laboratory, mainly addressed to perform type tests, is fully motivated:**
 - to ensuring more stringent quality criteria for the equipment supplied to utilities by the local manufacturers,
 - to strengthen the local electromechanical sector pushed to become more competitive in terms of product quality with the international manufacturers.

A step forward, that can be implemented right away, to improve the quality of the equipment locally manufactured **would be the requirement for the manufacturers' testing laboratories addressed to perform routine tests be accredited** (taking advantage of the Bangladesh Accreditation Board) so that the competence to assess the conformity of the produced equipment to the requirements established by the customer and by the International Standards is attested.



Power Cell

4. The Certification and Inspection Bodies

4.1 Certification Bodies

A prominent role in the country in this area is played by the Bangladesh Standards and Testing Institution (BSTI). Under the Ministry of Industries this Institution provides the control of the standard of services and goods in the country, issues a certification mark on a series of products, including electrical equipment. A number of 276 commodities, including 38 electrical and electronic equipment, are forbidden to sell and distribute in the market without BSTI license and clearance.

BSTI is a member of ISO - International Organization for Standardization, associated member of IEC - International Electrotechnical Commission and his National Metrology Laboratory is a member of BIPM - Bureau International des Poids and Measures.

According to his institutional role, BSTI:

- performs testing activities as per National & International (ISO, IEC, IEEE) standard and supplies calibration services in his facilities, as already mentioned in Chapter 3,
- issues quality certificate after testing the commodities being accredited by the Bangladesh Accreditation Board according to ISO/IEC 17021-1:2015,
- carries out Inspection activities for conformity assessment under the Standard ISO 17065 Standard.

BSTI has skilled manpower for operating the activity of certification and inspection body as well as for performing test on electrical equipment.

The filled questionnaires have shown the following other Certification Bodies:

- the Bangladesh Association of Certification Bodies groups all operators in the sector; regarding the electrical equipment the Certification services mainly concerns the guarantee of conformity of consumer products;
- some members of the Bangladesh Association of Certification Bodies, belonging to International Groups (such as TUF and SGS), offers certification services in the field of low voltage network and substations but no utilities make use of these services;
- Pico Labs Ltd company, that in addition of certification activities provide also calibration and inspection services of electrical equipment.

4.2 Inspection services

The Office of the Chief Electrical Inspector (OCEI), a government agency responsible for the supervision of electrical systems in order to ensure the aspects of electrical safety, plays an essential role in the field of inspection services through his staff of experienced electrical inspectors that also review the plans for all new electrical installations.



All electrical utilities have internal inspectors who usually attend the acceptance tests in the factory and on site and in some cases even the execution of routine tests at the manufacturer's laboratories.

Among the private operators carrying out inspection activities, it has to be mentioned:

- IISPL Bangladesh, which also performs some calibration and testing activities,
- International Inspection Service Limited.

The collected information allows for the possibility that the National Independent Authority for its inspection services could rely on internal inspectors (some of which recruited from public electrical utilities) and external inspectors through collaboration agreements with private companies. This would allow, especially during the years when the new test laboratory is under construction, to carry out inspection activities in existing test laboratories during tests on equipment deemed of particular importance, thus starting the path to improve the quality of equipment produced by the local electromechanical sector.



Power Cell

5. Reply to the remarks raised by Stakeholders

As reported in the previous Chapters, the **Bangladesh Standards and Testing Institution (BSTI)** has facilities and skilled manpower able to perform testing activities on several electrical equipment (power transformers, switching equipment, insulators and power cables). The questionnaires received and the provided institutional information¹ do not show the availability in BSTI of testing equipment operating at High Voltages and High-Power ratings as required for the execution of all type tests defined by International Standards (IEC, ANSI, IEEE) on MV and HV equipment. The National Testing Laboratory aims to make available the High Voltages and High-Power testing facilities not feasible by the local manufacturers being the high required capital expenditure and that do not exist currently in Bangladesh. This lack of test capability limits the possibility of carrying out tests that fully qualify the new equipment developed by the local industry. With only few exceptions, the MV and HV equipment necessary to the Bangladesh electrical utilities is supplied by international manufacturers who can use suitable testing laboratories. The local manufacturers producing MV and HV equipment must use foreign laboratories to qualify and then market new products, with obvious higher costs to be incurred in addition to the disbursement of foreign currency. The National Testing Laboratory intends to fill this gap for the benefit of national manufacturers and also of the national utilities which can buy equipment produced in the country and competitive, both in terms of quality and price, with those offered by the international market.

The above also responds to the observation made by **Rural Power Company Ltd** which call into questions the opportunity of a National Testing Laboratory when currently 80% of the MV and HV equipment are supplied from foreign manufacturers. The Laboratory aims to change this situation, clearly disadvantageous for the country, by making available to local industry (and local utilities) testing facility with capabilities similar to those of international testing laboratories and therefore able to support them in the execution of the development tests during the development of prototypes and type tests for the qualification of the new products.

Iconic Engineering Ltd has described in an accurate and complete manner the importance of calibration and traceability for a world class testing laboratory. The National Testing Laboratory surely must carry out periodic calibrations of its measuring instruments through appropriate records and procedures allowing to monitor the calibration status of each instrument throughout its operating life and to exclude from service those having an invalid calibration. The measurements made during the tests must be linked to recognized national and international standards through a documented chain of comparison. To this purpose the National testing Laboratory through its dedicated operating structure will be **able to make use of the calibration services offered by the various national operators mentioned in this document.**

¹ BSTI Annual Reports 2020-2021 and 2021-2022



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ANNEX 1

Filled Questionnaires by the Stakeholders



Power Cell



Electrical Utilities and Power Generation Company

1. APSCL- Ashugany Power Station Company Ltd
2. BREB – Bangladesh Rural Electrification Board
3. CPGCBL- Coal Power Generation Company Bangladesh Ltd
4. EGCB – Electricity Generation Company of Bangladesh Ltd
5. DESCO- Dhaka Electricity Supply Company Ltd
6. DPDC- Dhaka Power Distribution Company Ltd
7. PGCB- Power Grid Company of Bangladesh Ltd

Ashuganj Power Station Company Limited

Questionnaire to be submitted to Power Generation Companies

Scope of the questionnaire

The questionnaire is addressed to understand the current characteristics of the electrical equipment market and the expectation of the Power Generation Institution and Companies towards a Bangladesh Independent Electrical Testing Laboratory.

The questionnaire is organized in four sections:

Sections	Comments/Remarks
1.the requests for higher quality/performance on the equipment to be used on generation plants	The higher quality equipment is used for generation plant.
2.the penetration of the international manufacturers on the Bangladesh market,	The penetration of the international manufacturers on the Bangladesh market is very high.
3.Type Test currently performed on the purchased equipment,	The type certificate should be provided for every equipment.
4.Need for new testing facilities.	Yes, it is very essential.

Higher quality/performance requests on the equipment to be installed on networks

Stated that according to a precise project guidance, the Independent Testing Laboratory has to be addressed to electrical equipment:

Questions	Questions
1.What are the electrical equipment manufactured on the domestic market that you feel the need for a higher quality or performance?	The most of electrical equipment Transformer up to 230 kv voltage level and CT, PT, upto 230 kv Voltage level. CB upto 33kv voltage level.
2.Which of the above electrical equipment should be given priority for a better operation of your generation plants?	Every equipment is important for better operation.



Penetration of the international manufacturers on the Bangladesh market

Questions	Questions
1. Are there important differences in quality and/or performances between the equipment produced on the international market and those available from domestic manufacturers?	Of Course there is difference between foreign good manufacturer and local manufacturer and manufacturing process for assuring quality.
2. What is the share of purchases on the international market? and mainly for which equipment?	Almost 98%

Type Test currently performed on the purchased equipment

Questions	Comments/Remarks
1. Are type tests currently required in all purchase specifications? And if not, how do you verify the adequacy of the quality and performances?	Yes, Type test is required in all purchase equipment.
2. Are some Tests carried out in the local Manufacturers' Laboratories? And if so, for which components?	Some high voltage test is done in local manufacturers Laboratories.
3. Do you have internal Laboratories in your organization? And to carry out which tests? Are your Laboratories accredited?	CT, PT, Transformer, CB and oil test field test facilities is available in our company.
4. Referring to the electrical equipment used in your plants, which Type Tests are carried out on them in International Laboratories? In which laboratories (CPRI, CESI/Kema, KERI, others)	It depend on country of origin of the equipment. But most of the test done by CESI/Kema etc.

Need for new testing facilities

Questions	Comments/Remarks
1. Considering the establishment of an Independent Testing Laboratory in Bangladesh, which test facilities for electrical equipment do you consider to be priority?	Power Transformer CT, PT, LA, CB etc voltage level upto 420 kv.
2. Do your inspectors participate (or witness) in tests performed in others laboratories, or in factory acceptance tests or on-site acceptance test?	Factory acceptance test is witnessed by our engineers.

26/6/2017
Noor Mohammad
Superintending Engineer
(Electrical Maintenance)
Ashuganj Power Station Co. Ltd.
Ashuganj, Brahmanbaria.

Page 2 | 2



Power Cell

Bangladesh Rural Electrification Board

Questionnaires for Electrical Utilities

The questionnaire is addressed to understand the current characteristics of the electrical equipment market and the expectation of the electrical companies towards a Bangladesh Independent Testing Laboratory.

The questionnaire is organized in **four sections**:

Sections	Comments/Remarks
1. The requests for higher quality/performance on the equipment to be installed on networks,	-Given below-
2. The penetration of the international manufacturers on the Bangladesh market,	-Given below-
3. Type Test currently performed on the purchased equipment,	-Given below-
4. Need for new testing facilities.	-Given below-

Higher quality/performance requests on the equipment to be installed on networks

Questions	Comments/Remarks
1. To achieve the objectives of the Company Development Plan do you feel the need for higher quality for the equipment manufactured on the national market? And/or greater performances?	1. To achieve the objectives of the Company Development Plan, it is needed for higher quality for the equipment manufactured on the national market. And/or greater performances, it is mandatory .
2. If so, which areas of the network should be given priority (HV, or MV or LV, including rural distribution) and which equipment (Transformers, Switchgears, Breakers, Insulators, Power cables)?	2. For this reason, MV network should be given priority and the following equipment such as Transformers, Insulators, Fuse Cut-outs, Lightning Arresters, Meters (1-Phase & 3-Phase), Switchgears, Breakers, and Power cables.

Penetration of the international manufacturers on the Bangladesh market

Questions	Comments/Remarks
1. Are there important differences in quality and/or performances between the equipment produced on the international market and those available from domestic manufacturers?	1. No, there are not important differences in quality and/or performances between the equipment produced on the international market and those available from domestic manufacturers. Some of cases, it is shows that domestics manufacturers equipment are better quality than international market material.
2. What is the share of purchases on the international market? and mainly for which equipment?	2. The share of purchases on the international market about 70% or above and mainly for the following equipment's: Insulators, Fuse Cut-outs, Lightning Arresters etc.

Type Test currently performed on the purchased equipment

Questions	Comments/Remarks
1. Are type tests currently required in all purchase specifications? And if not, how do you verify the adequacy of the quality and performances?	1. Type tests are currently required in all purchase specifications.
2. Are some Tests carried out in the local Manufacturers' Laboratories? And if so, for which components?	2. Yes, Some of routine Tests carried out in the local Manufacturers' Laboratories which has type test certificate for that material from an International Laboratories.
3. Does the compliance required only towards International standards (e.g. IEC or IEEE or Indian Standard) or also with local standards? and if so, which ones?	3. Compliance required not only International standards (e.g. IEC or IEEE or Indian Standard) but also with local standards.
4. Do you have internal Laboratories in your organization? And to carry out which tests? Are your Laboratories accredited?	4. BREB has an internal Laboratory. This laboratory carried out routine tests of electrical equipment's. No, this laboratory is not accredited.
5. Which Type Tests are carried out in International Laboratories? In which laboratories (CPRI, CESI/Kema, KERI, others)	5. All equipment's which are purchased by BREB must have the Type Tests which are carried out in International Laboratories such as CPRI, CESI/Kema, KERI and others.

Need for new testing facilities

Questions	Comments/Remarks
1. Considering the establishment of an Independent Testing Laboratory in Bangladesh, which test facilities do you consider to be priority?	1. Considering the establishment of an Independent Testing Laboratory in Bangladesh, Transformers, Insulators, Fuse Cut-outs, Lightning Arresters, Meters (1-Phase & 3-Phase), Switchgears, Breakers, and Power cables test facilities should to be considered as in priority basis.
2. Do your inspectors participate (or witness) in tests performed in others laboratories, or in factory acceptance tests or on-site acceptance test?	2. Our inspectors participate (or witness) in tests performed in others laboratories, or in factory acceptance tests or on-site acceptance test.

Coal Power Generation Company Bangladesh Limited

Questionnaire to be submitted to Power Generation Companies

Scope of the questionnaire

The questionnaire is addressed to understand the current characteristics of the electrical equipment market and the expectation of the Power Generation Institution and Companies towards a Bangladesh Independent **Electrical Testing Laboratory**.

The questionnaire is organized in **four sections**:

Sections	Comments/Remarks
1.the requests for higher quality/performance on the equipment to be used on generation plants	-
2.the penetration of the international manufacturers on the Bangladesh market,	-
3.Type Test currently performed on the purchased equipment,	-
4.Need for new testing facilities.	-

Higher quality/performance requests on the equipment to be installed on networks

Stated that according to a precise project guidance, the Independent Testing Laboratory has to be addressed to electrical equipment:

Questions	Comments/Remarks
1.What are the electrical equipment manufactured on the domestic market that you feel the need for a higher quality or performance?	Transformer, Cable
2.Which of the above electrical equipment should be given priority for a better operation of your generation plants?	Transformer, Cable

Dep

[Signature]
10/07/2023

Penetration of the international manufacturers on the Bangladesh market

Questions	Comments/Remarks
1. Are there important differences in quality and/or performances between the equipment produced on the international market and those available from domestic manufacturers ?	Durability is one of the major points of concern. Equipment produced on the international market has longer life span than locally manufactured. Better quality equipment could be manufactured.
2. What is the share of purchases on the international market? and mainly for which equipment?	All projects of CPGCBL are under planning / construction stage. Currently, all equipment are supplied by EPC contractor as per the contract. Therefore, this question is not applicable for CPGCBL at this moment.

Type Test currently performed on the purchased equipment

Questions	Comments/Remarks
1. Are type tests currently required in all purchase specifications? And if not, how do you verify the adequacy of the quality and performances?	Yes. Contractors need to submit type test report of major equipment like, Generator, Transformer, Switchgear, Circuit breaker, CT/PT, Isolator, Motor, Cables, etc.
2. Are some Tests carried out in the local Manufacturers' Laboratories? And if so, for which components?	No
3. Do you have internal Laboratories in your organization? And to carry out which tests? Are your Laboratories accredited?	No
4. Referring to the electrical equipment used in your plants, which Type Tests are carried out on them in International Laboratories? In which laboratories (CPRI, CESI/Kema, KERI, others)	Supplier need to submit type test certificates from an independent testing authority as specified in the tender document. Selection of testing laboratories is depended on suppliers.

Need for new testing facilities

Questions	Comments/Remarks
1. Considering the establishment of an Independent Testing Laboratory in Bangladesh, which test facilities for electrical equipment do you consider to be priority?	Transformer, Cable
2. Do your inspectors participate (or witness) in tests performed in others laboratories, or in factory acceptance tests or on-site acceptance test?	We participated in factory acceptance tests and on-site acceptance test.

Depayan Paul
10.07.2023
Depayan Paul
Executive Engineer-2 (Planning)
Coal Power Generation Company
Bangladesh Limited (CPGCBL)

SM Abdul Mannaf
10/07/2023
SM Abdul Mannaf
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EGCB-Electricity Generation Company of Bangladesh Limited

Questionnaire submitted to Power Generation Companies

Scope of the questionnaire

The questionnaire is addressed to understand the current characteristics of the electrical equipment market and the expectation of the Power Generation Institution and Companies towards a Bangladesh Independent **Electrical Testing Laboratory**.

Higher quality/performance requests on the equipment to be installed on networks

Stated that according to a precise project guidance, the Independent Testing Laboratory has to be addressed to electrical equipment:

Questions	Comments/Remarks
1.What are the electrical equipment manufactured on the domestic market that you feel the need for a higher quality or performance?	1. Multimeter 2. Current Injector 3. CT & PT 4. Motor (MV/LV) 5. Circuit Breaker (SF6/VCB/ACB) 6. Energy Meter 7.Cable (HV/MV/LV) 8. Emergency Diesel Generator 9. UPS 10. Battery 11.Relay & Timer 12. Surge Arrester 13. Fire Protection equipment
2.Which of the above electrical equipment should be given priority for a better operation of your generation plants?	1. CT & PT 2. Motor (MV/LV) 3. Circuit Breaker (SF6/VCB/ACB) 4. Energy Meter 5.Cable (HV/MV/LV) 6. Emergency Diesel Generator 7. Battery 8.Relay & Timer 9. Surge Arrester 10. UPS



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Questions	Comments/Remarks
1. Are there important differences in quality and/or performances between the equipment produced on the international market and those available from domestic manufacturers?	1. High Reliability (Failure rate is very low) 2. No rust in the equipment 3. Long lifetime 4. Low noise 5. Low Maintenance
2. What is the share of purchases on the international market? and mainly for which equipment?	EGCB always try to avoid purchase from international market. If the product is only in foreign OEM then EGCB is compelled to buy the product. 1.Spare & Consumables of Generator, 2.Spare & Consumables of Excitation System, AVR, DC/AC system, SFC (Static Frequency Converter) 3. Generator Rotor 4. Transformer OLTC & Spare items

Type Test currently performed on the purchased equipment

Questions	Comments/Remarks
1. Are type tests currently required in all purchase specifications? And if not, how do you verify the adequacy of the quality and performances?	EGCB may call for Type tests to be carried out at the Manufacturer's works and witnessed by the representative. (For critical equipment i.e., Transformer, MV Cable, MV Terminating Kits).
2. Are some Tests carried out in the local Manufacturers' Laboratories? And if so, for which components?	Yes. 1. Transformer Oil test 2. Different equipment Calibration test (Example: Multimeter, Vibration meter etc.)
3. Do you have internal Laboratories in your organization? And to carry out which tests? Are your Laboratories accredited?	No.
4. Referring to the electrical equipment used in your plants, which Type Tests are carried out on them in International Laboratories? In which laboratories (CPRI, CESI/Kema, KERI, others)	EGCB may call for type tests to be carried out at the <u>Manufacturer's works</u> in accordance of IEC standards and witnessed by the representative. For <u>Transformer</u> : Temperature rise test, Zero Sequence impedance, Noise Level, Examination of harmonics, Test on brushings For <u>MV Cable & MV Terminating Kits</u> : AC voltage withstand test, Loading cycle tests, Partial discharge test, Impulse voltage withstand test, Thermal short circuit test, DC voltage withstand test, Humidity test (only for terminations), Non-tracking tests.

Need for new testing facilities

Questions	Comments/Remarks
1. Considering the establishment of an Independent Testing Laboratory in Bangladesh, which test facilities for electrical equipment do you consider to be priority?	1. Transformer Oil Test 2. Transformer bushing Tan delta test 3. Different equipment Calibration test (Example: Multimeter, Vibration meter etc.)
2. Do your inspectors participate (or witness) in tests performed in others laboratories, or in factory acceptance tests or on-site acceptance test?	Yes. Transformer FAT.



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DESCO- Dhaka Electricity Supply Company Limited

Questionnaires for Electrical Utilities

The questionnaire is addressed to understand the current characteristics of the electrical equipment market and the expectation of the electrical companies towards a Bangladesh Independent Testing Laboratory.

Higher quality/performance requests on the equipment to be installed on networks

Questions	Replies
1. To achieve the objectives of the Company Development Plan do you feel the need for higher quality for the equipment manufactured on the national market? And/or greater performances?	It's very important to increase the quality of our domestically manufactured product for better service.
2. If so, which areas of the network should be given priority (HV, or MV or LV, including rural distribution) and which equipment (Transformers, Switchgears, Breakers, Insulators, Power cables)?	At primary stage, distribution line equipments such as distribution transformers, Insulators, DOFC (Fuse), Capacitor Bank, etc should be given priority to maintain international standard and minimize interruptions.

Penetration of the international manufacturers on the Bangladesh market

Questions	Questions
1. Are there important differences in quality and/or performances between the equipment produced on the international market and those available from domestic manufacturers?	The quality of a product of about similar price manufactured in abroad and in domestic market does not differ significantly where the manufacturers comply the tender requirement (supply experience, type tests, etc).
2. What is the share of purchases on the international market? and mainly for which equipment?	About 90% products are supplied from abroad in terms of cost, especially all HV products and most MV products. Distribution transformers, MV and LV power cables, insulators are often supplied from domestic manufacturers.

Type Test currently performed on the purchased equipment

Questions	Comments/Remarks
1. Are type tests currently required in all purchase specifications? And if not, how do you verify the adequacy of the quality and performances?	Type tests are mandatory for all electrical goods such as transformers, switchgears, cables, conductors and accessories, capacitor bank, DOFC, CT, PT, etc.
2. Are some Tests carried out in the local Manufacturers' Laboratories? And if so, for which components?	For HV and MV equipment, only routine tests are carried out in the local manufacturers' laboratories.
3. Does the compliance required only towards International standards (e.g. IEC or IEEE or Indian Standard) or also with local standards? and if so, which ones?	In most cases only IEC standard is mentioned.
4. Do you have internal Laboratories in your organization? And to carry out which tests? Are your Laboratories accredited?	DESCO has centralized and distributed meter testing labs with test benches for revenue energy meter functional tests. None of the laboratories are accredited.
5. Which Type Tests are carried out in International Laboratories? In which laboratories (CPRI, CESI/Kema, KERI, others)	Almost all type tests as per relevant IEC standards are required for HV, MV and LV equipment and cables with accessories procurement. In most cases, type tests are only accepted from STL member laboratories.

Need for new testing facilities

Questions	Comments/Remarks
1. Considering the establishment of an Independent Testing Laboratory in Bangladesh, which test facilities do you consider to be priority?	Primarily, all type tests on Insulators, DOFC (Fuse), Capacitor Bank, distribution transformers, LV and MV power cables, etc. as the quality of those is difficult to ensure through open tender process and those affects the service mostly.
2. Do your inspectors participate (or witness) in tests performed in others laboratories, or in factory acceptance tests or on-site acceptance test?	DESCO nominated personnel witness the routine tests at manufacturer's laboratory prior shipment. Type tests are not witnessed, only type test reports are submitted along with tenders.

DPDC - Dhaka Power Distribution Company Limited

Questionnaires for Electrical Utilities

Sections	Comments/Remarks
1. The requests for higher quality/performance on the equipment to be installed on networks,	Yes, higher quality/performance on the equipment to be installed on networks is always given utmost priority
2. The penetration of the international manufacturers on the Bangladesh market,	Name of some international manufacturers whose product are being used in DPDC: ABB, Siemens, Schneider Electric, Toshiba Japan, REPL UK, Raychem RPG, Pfisterer, Phelps Dodge, Hitachi, Fortune Electric, Landis+Gyr and so on
3. Type Test currently performed on the purchased equipment,	<u>Power Transformer:</u> - Temperature Rise Test - Lightning Impulse Test - Noise level Test - Vacuum Test <u>Distribution Transformer:</u> - Lightning Impulse test - Temperature Rise test - Short Circuit withstand test <u>GIS:</u> - Dielectric tests - Measurement of the resistance of circuits - Temperature-rise tests - Short-time withstand current and peak withstand current tests - Pressure withstand test for gas-filled compartments <u>AIS:</u> - Lightning Impulse Voltage Withstand tests. - Power frequency withstands tests. - Measurement of resistance of the main circuit. - Short circuit performance tests (including short-time and peak withstand current tests, Verification of making & breaking capacities tests). - Mechanical operation tests.

	vi. Arcing due to internal fault current tests for fault current specified for the 11KV Switchgear Cubicle. <u>UG Cable:</u> i. Bending test followed by partial discharge test ii. Tan Delta measurement iii. Heating cycle voltage test iv. Impulse withstand test <u>DOFC</u> i. Dielectric Tests. ii. Mechanical Test iii. Breaking Test iv. Test for time/current characteristics v. Temperature Rise Tests. <u>Lightning Arrester:</u> i. Insulation withstand test on the arrester housing. ii. Residual voltage test. a) Step current impulse residual voltage test. b) Lightning impulse residual voltage test. c) Switching impulse residual voltage test. iii. Long duration current impulse withstand test. iv. Operation duty test. a) High-current impulse operating duty test. b) Switching surge operating duty test. v. Short-circuit test. vi. Internal partial discharge test. vii. Bending moment test. viii. Environmental test. ix. Seal leak rate test. x. Radio interference voltage (RIV) test.
4. Need for new testing facilities.	Yes, it is needed.

Higher quality/performance requests on equipment to be installed on networks

Questions	Questions
1. To achieve the objectives of the Company Development Plan do you feel the need for	Higher quality and greater performance equipment improves the competitiveness of

higher quality for the equipment manufactured on the national market? And/or greater performances?	local manufacturers in both domestic and international markets. When locally manufactured equipment meets or exceeds international quality standards, it can enhance the national reputation.
2. If so, which areas of the network should be given priority (HV, or MV or LV, including rural distribution) and which equipment (Transformers, Switchgears, Breakers, Insulators, Power cables)?	To ensure power system reliability and customer satisfaction each HV, MV and LV network has equal importance. As distribution utility Transformers, Switchgears, Breakers, Insulators, Power cables, cable termination, conductor, conductor accessories, hardware materials etc have significant importance.

Penetration of the international manufacturers on the Bangladesh market

Questions	Questions
1. Are there important differences in quality and/or performances between the equipment produced on the international market and those available from domestic manufacturers?	There can be differences in quality and performance between equipment produced on the international market and those available from Bangladeshi manufacturers, but it's important to note that these differences can vary depending on the specific products and manufacturers involved. Equipment produced for the international market often needs to meet stringent quality standards and certifications, depending on the industry and target market. International manufacturers may invest in research and development, quality control measures, and use high-quality materials, resulting in better overall product quality. International manufacturers often have access to the latest technologies and innovations due to their research and development capabilities and collaborations with leading institutions.
2. What is the share of purchases on the international market? and mainly for which equipment?	For DPDC, the share of purchases on the international market is about 100% for Gas Insulated Switchgear(GIS), Air Insulated Switchgear(AIS), 132kV XLPE Cable, Cable Termination, GIS Termination, Test Equipment, Energy Meter, SAS, Protection Relay etc



Power Cell

Type Test currently performed on the purchased equipment

Questions	Comments/Remarks
2. Are some Tests carried out in the local Manufacturers' Laboratories? And if so, for which components?	Yes Distribution transformer, overhead conductor, hardware material, Metering Panel etc
3. Does the compliance required only towards International standards (e.g. IEC or IEEE or Indian Standard) or also with local standards? and if so, which ones?	IEC or equivalent international standards
4. Do you have internal Laboratories in your organization? And to carry out which tests? Are your Laboratories accredited?	No currently we do not have internal Laboratory in DPDC
5. Which Type Tests are carried out in International Laboratories? In which laboratories (CPRI, CESI/Kema, KERI, others)	Which Type Tests are carried out in International Laboratories? Ans: please refer to the answer section given for <i>"Type Test currently performed on the purchased equipment"</i> In which laboratories (CPRI, CESI/Kema, KERI, others)? Ans.: Type test and some special tests as per IEC or equivalent international standards in STL member laboratories or STL member accredited laboratory or Tests witnessed by authorized representative of STL member laboratory is also accepted in some cases

Need for new testing facilities

Questions	Comments/Remarks
1. Considering the establishment of an Independent Testing Laboratory in Bangladesh, which test facilities do you consider to be priority?	Testing facility development for the following products can be given priority: Power and distribution Transformers, Energy meters, protection IED, Switchgears, Breakers, Insulators, Power cables, cable termination, conductor, conductor accessories, Pole and Pole fittings etc
2. Do your inspectors participate (or witness) in tests performed in others laboratories, or in factory acceptance tests or on-site acceptance test?	yes

NESCO- Northern Electricity Supply Company Limited

Questions	Comments/Remarks from NESCO
1. The requests for higher quality/performance on the equipment to be installed on networks.	1. In recent years the number of failure of essential equipment like power transformer, current transformer, switchgear panels etc. has been remarkably high to be concerned with the quality of equipment. Definitely there is a high demand on the performance of equipment to be installed on networks.
2. The penetration of the international manufacturers on the Bangladesh market	2. Ensuring the quality of products through necessary steps like as test from independent testing laboratories rather than penetration of the international manufacturers will be better for the economy of the country. Bangladesh has the opportunity to build its own expertise to produce quality products in the factory of local manufacturers. We think local manufacturers can make quality products if they get necessary support from the government.
3. Type test currently performed on the purchased equipment	3. In most of the cases type test is demanded for the qualification to bid. For important equipment like power transformer, circuit breakers, switchgear panels type test certificates from STL member testing laboratories is required to participate in the bid as a manufacturer.
4. Need for new testing facilities	4. Introduction of new testing facilities like short circuit test and other type test of equipment will obviously ease the way of purchasing quality product. A new independent testing laboratory having the facilities of type test as per IEC, IEEE and other relevant standards will create a new horizon for the local manufacturer

Section 1: Higher quality/ performance requests on the equipment to be installed on networks

Questions	Comments/Remarks from NESCO
1. To achieve the objectives of the Company development Plan do you feel the need for higher quality for the equipment manufactured on the national market? And/or greater performance	1. Higher quality of equipment will accelerate the achievement of the objectives of the Company development Plan. We feel that local manufacturer should put more emphasis on the quality of their products.
2. If so, which areas of the network should be given priority (HV, or MV or LV, including rural distribution) and which equipment (Transformers, switchgears, breakers, insulator, Power cables).	2. As a distribution utility we are putting comments only on MV and LV. Quality of equipment in the MV network should be prioritized for higher quality. Performance of power cable produced in the local market is satisfactorily high. Power transformer available in the local market must be designed better for satisfactory performance. Few local manufacturer has the ability to make MV switchgear although quality might be better. Following equipment should be given priority when quality is concern- ➤ Power Transformer (33/11 KV or above). ➤ HV or MV circuit breaker ➤ AIS & GIS switchgear panels ➤ Power Cables ➤ Current Transformer ➤ Insulator ➤ Lightning arrester

Section 2: Penetration of the international manufacturers on the Bangladesh market

Questions	Comments/Remarks from NESCO
1. Are there important differences in the quality and/or performances between the equipment produced on the international market and those available from domestic manufacturers?	1. Our experience says that quality and/or performance of the equipment depends on the manufacturer be it local or international. Products from international manufacturer doesn't always show better performance compared to the products from the domestic manufacturer.
2. What is the share of purchases on the international market? And mainly for which equipment?	2. A large portion of the equipment purchased are from international market. Power transformer, Vacuum circuit breaker, GIS switchgear, numerical relay, energy meter, surge arrester, AIS switchgear panel, battery are among the most common items purchased from international market.

Section 3: Type test currently performed on the purchased equipment

Questions	Comments/Remarks from NESCO
1. Are type tests currently required in all purchase specifications? And if not, how do you verify the adequacy of the quality and performances	1. Type tests are demanded in purchase specifications for all most every type of equipment.
2. Are some type tests carried out in the local Manufacturer's laboratories? And if so, for which components?	2. Type tests are required to be performed in independent testing laboratories.
3. Does the compliance required only towards international standards (e.g. IEC or IEEE or Indian standard) or also with local standard? And if so, which ones?	3. Compliance with international standards is sufficient.
4. Do you have internal laboratories in your organization? And to carry out which tests? Are your laboratory accredited?	4. We don't have internal laboratory in our organization.

5. Which type tests are carried out in international laboratories? In which laboratories (CPRI, CESI/Kema, KERI, others)	5. Type tests are demanded as per international standard. Short circuit test, lightning impulse voltage test etc, are few of them to be mentioned. For important equipment like power transformer, circuit breakers, switchgear panels type test certificates from STL member testing laboratories is required to participate in the bid as a manufacturer.

Section 4: Need for new testing facilities

Questions	Comments/Remarks from NESCO
1. Considering the establishment of an independent testing laboratory in Bangladesh, which test facilities do you consider to be priority?	1. Short circuit testing facilities with other type test facilities may get the highest priority for the proposed new independent testing laboratory.
2. Do your inspectors participate (or witness) in tests performed in others laboratories, or in factory acceptance tests or in-site acceptance test?	2. Usually for tests in others laboratories, inspectors don't participate. But in factory acceptance tests and in-site acceptance test inspector participation is a must.



PGCB – Power Grid Company of Bangladesh

Questionnaires for Electrical Utilities

The questionnaire is addressed to understand the current characteristics of the electrical equipment market and the expectation of the electrical companies towards a Bangladesh Independent Testing Laboratory.

The questionnaire is organized in **four sections**:

Sections	Comments/Remarks
1. The requests for higher quality/performance on the equipment to be installed on networks,	Yes. The higher quality/performance equipment are required to be installed on networks for reliable & un-interrupted power system.
2. The penetration of the international manufacturers on the Bangladesh market,	Yes. Most of the high voltage equipment on the Bangladesh power system are from international manufacturer. There is only one manufacturer who supplied type tested 132/33KV Transformer to PGCB.
3. Type Test currently performed on the purchased equipment,	Type Test performed only on new designed high voltage equipment by manufacturer. They submit type test report with the bid submission as per requirement of PGCB.
4. Need for new testing facilities.	Yes

Higher quality/performance requests on the equipment to be installed on networks

Questions	Answer
1. To achieve the objectives of the Company Development Plan do you feel the need for higher quality for the equipment manufactured on the national market? And/or greater performances?	Yes. The higher quality/performance equipment are required to be manufactured on the national market for trouble free/reliable operation of the equipment.
2. If so, which areas of the network should be given priority (HV, or MV or LV, including rural distribution) and which equipment (Transformers, Switchgears, Breakers, Insulators, Power cables)?	There is one manufacturer who manufactures type tested 132/33KV transformer and one manufacturer who manufactures 132KV type tested power cables. PGCB purchases some 132/33KV Transformer (up to 120MVA), CT/PT, DS & Power Cables from domestic market. To achieve the objectives of the power sector development plan, the quality of the LV, MV & HV equipment e.g. Transformer, Switchgear, CT/PT, LA, DS, Insulators, Power Cables, Conductor/Earth wire etc should be increased.

Penetration of the international manufacturers on the Bangladesh market

Questions	Questions
1. Are there important differences in quality and/or performances between the equipment produced on the international market and those available from domestic manufacturers?	Yes. There are significant differences in quality and/or performances between the equipment produced on the international market specially in EU/UK/America/Japan/Korea etc. and those available from domestic manufacturers?
2. What is the share of purchases on the international market? and mainly for which equipment?	(a) For 132KV equipment: About 80% equipment type come from international market & 20% from domestic. (b) For 230KV & above voltage level equipment: 99% equipment type come from international market.

Type Test currently performed on the purchased equipment

Questions	Comments/Remarks
1. Are type tests currently required in all purchase specifications? And if not, how do you verify the adequacy of the quality and performances?	Type Test required only on new designed high voltage equipment and that is done by manufacturer from STL approved laboratories like KEMA, CESI, CPRI, CERI, VEIKI-VNL etc. In PGCB, the adequacy of the quality is verified on the basis of submitted type test report with the bid document as per requirement of PGCB.
2. Are some Tests carried out in the local Manufacturers' Laboratories? And if so, for which components?	Yes. Routine Test/ Factory Acceptance Tests are carried out in the local manufacturer's laboratories. Some Type Test e.g. Induced Over Voltage Test, Lightning Impulse Voltage Withstand Test, Separate Source Voltage Withstand/Applied Voltage Test, Partial Discharge Test, Temperature Rise Test, Switching Impulse Test, Measurement of Sound Level etc. are carried out in the local market (one manufacturer's lab) too.
3. Does the compliance required only towards International standards (e.g. IEC or IEEE or Indian Standard) or also with local standards? and if so, which ones?	The compliance required towards International Standards e.g. IEC & IEEE.
4. Do you have internal Laboratories in your organization? And to carry out which tests? Are your Laboratories accredited?	We have one oil testing laboratory where oil DGA, Acidity, Tan-delta, Moisture & BDV are tested. Furthermore, we have some other test equipment for testing Transformer, Switchgear, CT/PT, LA, Power Cable etc. The equipment are: TESTRANO (for different type of low voltage testing of transformer), CIBANO (Circuit Breaker

	Analyzer), CPC 100 + TD1, SFRA Test set, DIRANA (Di-electric Response Analyzer), LA Leakage current Test Set (Isa, Italy), CT Analyzer (Omicron), Handheld Partial Discharge Test Set (PMDT, USA), SF6 Purity Test Set, Power Cable Fault Locator, DC Battery Load Testing Set (ISA, Italy), Line Impedance Test Set (Omicron) etc.
5. Which Type Tests are carried out in International Laboratories? In which laboratories (CPRI, CESI/KEMA, KERI, others)	Power Transformer : - Induced over voltage test - Lightning impulse voltage withstand test - Separate Source voltage Withstand/Applied Voltage test - Temperature-rise tests - Partial Discharge test - Measurement of Sound-Level - Short Circuit Withstand test Circuit Breaker : - Lightning impulse voltage withstand test - Power-frequency voltage withstand tests - Temperature-rise tests - Short-time withstand and peak withstand current tests - Short Circuit Current Making & Breaking Test - Capacitive current switching tests - Reactor Switching test - Mechanical operation test - Out-of-phase making and breaking tests Disconnecter : - Lightning impulse voltage withstand test - Power-frequency voltage withstand tests - Short-time withstand and peak withstand current tests - Temperature-rise tests Current Transformer: - Short Time Current test - Power-frequency voltage withstand tests - Impulse Voltage withstand Test - Temperature-rise tests - Measurement of Errors Capacitive Voltage Transformer: - Power-frequency voltage withstand tests - Impulse Voltage (Lightning Impulse) withstand Tests for service in exposed installation. - Temperature-rise tests - Capacitance & Temperature Measurement at Power Frequency - Short circuit test

	f. Accuracy test g. Transient Response Test Lightning Arrester: a. Power frequency voltage withstand test & Lightning impulse voltage test on complete arrester housing. b. Operating duty test c. Long duration current impulse withstand test d. Residual voltage test e. Pressure relief test f. Artificial pollution test Power Cable: g. PQ test h. Bending test i. Tan-delta test j. Heating cycle test k. Partial discharge test at ambient temperature and higher temperature l. Switching impulse test m. Lightning impulse voltage test followed by a power frequency voltage test Conductor: a. Mechanical load test b. DC Resistance test c. Heat cycle test d. Corona test Bolt torque test e. Conductor damage test Insulator: a. Power Arc Test b. Impulse voltage puncture test c. Dry lightning impulse voltage withstand test d. Wet switching impulse withstand voltage and the power frequency voltage withstand test e. Electromechanical failing load test f. Thermal mechanical performance test g. Radio Interference Voltage (RIV) & Corona Test

Need for new testing facilities

Questions	Comments/Remarks
1. Considering the establishment of an Independent Testing Laboratory in Bangladesh, which test facilities do you consider to be priority?	Bangladesh doesn't have any Independent Testing Laboratory who are able to perform third party testing and certification. So, it is required to establish an Independent Testing Laboratory for Routine Tests & Type Tests facility for LV, MV & HV (up to 230KV). Transformer Capacity: 450MVA, 230/132/33KV
2. Do your inspectors participate (or witness) in tests performed in others laboratories, or in factory acceptance tests or on-site acceptance test?	Yes. Our engineers participate in Routine Tests/Factory Acceptance Tests before delivery of the purchased equipment and on-site acceptance test before commissioning. Furthermore, we have some other test equipment for testing Transformer, Switchgear, CT/PT, LA, Power Cable etc. The equipment are: TESTRANO (for different type of low voltage testing of transformer), CIBANO (Circuit Breaker Analyzer), CPC 100 + TD1, SFRA Test set, DIRANA (Di-electric Response Analyzer), LA Leakage current Test Set (Isa, Italy), CT Analyzer (Omicron), Handheld Partial Discharge Test Set (PMDT, USA), SF6 Purity Test Set, Power Cable Fault Locator, DC Battery Load Testing Set (ISA, Italy), Line Impedance Test Set (Omicron) etc. Our engineers perform above mentioned test during schedule & emergency maintenance.



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Manufacturers

1. ADEX Corporation Ltd
2. Energypac Engineering
3. POLY CABLE Industry Ltd
4. PROTEC ELECTRONICS Ltd
5. Reverie Power & Automation Engineering Ltd

ADEX Corporation Limited

Questionnaire for Manufacturers

Type of electrical equipment manufactured in Bangladesh

Main Manufactured Equipment(°)	Rated Voltage
a)Transformer(oil type) max up to 35MVA	Max. up to 36kV,BIL=70/170kV
b)Transformer(oil type) max up to 3150kVA	Max. up to 12kV,BIL=28/75kV
c) Cast Resin Dry Type Transformer max up to 3150kVA	Max. up to 12kV,BIL=28/75kV
d) Current Transformer max up to 1000A	Max. up to 36kV,BIL=70/170kV
d) Current Transformer max up to 3000A	Max. up to 12kV,BIL=28/75kV
e) Low Voltage Current Transformer max up to 6300A	Max. up to 12kV,BIL=28/75kV
f) Potential Transformer 33/0.110kV	Max. up to 36kV,BIL=70/170kV
g) Potential Transformer 11/0.110kV	Max. up to 12kV,BIL=28/75kV
h) Miniature Circuit Breaker (SP,DP,TP & 4P) 2-63A	240/415/690V up to 10kA
i) Molded Case Circuit Breaker max up to 1600A, 65kA	415/690V
j) Air Circuit Breaker max up to 6300A, 100kA	415/690V
k) Bus Bar Trunking System(BBT)max up to 6300A	415/690V
l) Low Voltage Switchgear max up to 6300A	415/690V
m) Power Factor Improvement Plant	415/690V

(°) representing not less than 80% of the yearly turnover 2022

Questionnaire for Manufacturers

Current and expected total sales volume

	Year 2021	Year 2026	Year 2031
Total Sales(°)			
% of sales on the international market			

(°) Specify the reference currency (BDT, USD...)

Questionnaire for Manufacturers

Development of new equipment

In progress and in the next 3 years		In progress the next 5-10 years	
Equipment	Rated Voltage	Equipment	Rated Voltage
a) VCB up to max 2500A, 25kA	12kV, 28/75kV	a) Digital protection relay	415/690V
b) Stepped Voltage Regulator up to max. 500A	12kV, 28/75kV	b) Magnetic contactors Up to max. 630A	415/690V
c) Indoor panel light(LED)	415/230 V	c) Spot light	415/230 V
d) Indoor Down light(LED)	415/230 V	d) Tube light	415/230 V
e) outdoor street light	415/230 V	e) High bay light	415/230 V
f) Flood light	415/230 V		

Questionnaire for Manufacturers

Technical characteristics of the manufactured equipment

- According to which standard (IEC, IEEE, Local standard, etc.) the equipment are developed?
 - All equipment are manufactured as per IEC & BDS
- Main international competitors present in Bangladesh for their manufactured equipment
 - Schneider electric, Siemens & ABB
- Main differences between the manufactured equipment and the international ones (price, quality, etc.)
 - As like as international brands
- Are the new products are type tested in Independent Testing Laboratory? And what percentage of new products are type tested?
 - Not all products but only a few products are type tested

Energypac Engineering

Questionnaires for Manufacturers

Scope of the questionnaires

The questionnaire is addressed to understand the current characteristics of the electrical equipment market and the expectation of the manufacturers towards a Bangladesh Independent Testing Laboratory.

The questionnaire is organized in **four sections**:

Sections	Comments/Remarks
1. the type of electrical equipment manufactured in Bangladesh and sold in the domestic and international market,	Power transformer, Distribution (oil and dry type) transformer, Instrument transformer, VCB, Switchgear, Isolator, AVR, SVR & BBT
2. the development of new equipment in progress and the challenges to be taken up in order to increase the role in the national market,	33 kV GIS; 11 kV SF6 LBS; 500 MVA, 400 kV power transformer; 400 kV CT-PT. The challenge is that we need to compete with other manufacturers of different countries.
3. technical characteristics of the manufactured equipment also in comparison with the ones available from the international market,	Transformer: 300 MVA, 230 kV, CT-PT: 230 kV, VCB:33 kV, Isolator: 132 kV. From international market: Transformer: 520 MVA, 400 kV, CT-PT: 400 kV, Breaker: 400 kV, Isolator: 400 kV.
4. The existing testing facilities and the need for new testing facilities.	All routine test facility up to 300 MVA, 230 kV transformer. Temperature rise test facility up to 300 MVA power transformer. All routine test facility up to 230 kV CT-PT, 33 kV VCB, 132 kV isolator. Need to increase testing facility for 500 MVA, 400 kV transformer, 400 kV CT-PT.



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Type of electrical equipment manufactured in Bangladesh

Main Manufactured equipment (°)	Rated Voltage
a) Power transformer	230 kV
b) Distribution transformer	33 kV
c) CT-PT	230 kV
d) Outdoor VCB	33 kV
e) Switchgear	400 kV
f) Switch & Isolator	132 kV
g) SVR	6.35 kV

(°) representing not less than 80% of the yearly turnover

Current and expected total sales volume

	Year 2021	Year 2026	Year 2031
Total sales (°)	BDT 1000 crore	BDT 1500 crore	BDT 2000 crore
% of sales on the international market	BDT 600 crore	BDT 1125 crore	BDT 1500 crore

(°) Specify the reference currency (BTD,USD, ...)

Development of new equipment

in progress and in the next 3 years		in the next 5-10 years	
Equipment	Rated Voltage	Equipment	Rated Voltage
a) Power Transformer	400 kV	a. GIS	132 kV
b) CT-PT	400 kV	b. Isolator	400 kV
c) GIS	33 V	c.	
d) Isolator	245 kV	d.	
e) SF6 RMU	11kV	e.	

Technical characteristics of the manufactured equipment

Question	Comments/Remarks
1. According to which Standard (IEC, IEEE, Local Standard, etc.) the equipment are developed?	Transformer: IEC 60076 CT-PT: IEC 61869-1, 2, 3 Switchgear: IEC 62271-100 & 200 IEC 61439
2. Main international competitors present in Bangladesh for their manufactured equipment,	Siemens, ABB, CGL, Schneider, GE, L&T, Sangdom Taikai, Hyosung
3. Main differences between the manufactured equipment and the international ones (price, quality, etc.)	We ensure export quality with international standard and offer competitive price compared to international companies. Besides, we are capable of doing any type of customization as per client requirement.
4. Are the new products type tested in Independent Testing Laboratory? And what percentage of new products are type tested?	New products are type tested from independent testing laboratories such as CPRI, India, CESI, Italy, KEMA Labs, Netherlands, LOVAG, Italy. Almost 80% of new products are type tested.
5. What is the evaluation of the services offered by the Independent Testing Laboratory? And what about the incurred costs for these services (also considering the transportation costs)?	The service was good. But time consuming and very expensive. 132/33 kV, 80/120 MVA= BDT 6 crore (apprx.)



Power Cell

DeMEPA
DESIGN and MANAGEMENT of ELECTRICAL POWER ASSETS

The existing testing facilities and the need for new ones

Questions	Comments/Remarks
1. Which testing laboratories (dielectric, mechanical operation, etc.) are there in your organization? Are they accredited?	We have the country's only high voltage testing laboratory that complies with ISO 17025: 2017. It is NABL accredited.
2. In addition to routine tests these laboratory are also able to perform some type tests?	Yes, we can perform almost all type tests such as Lightning Impulse Voltage test, Temperature Rise test, and Mechanical Endurance test. Only Short Circuit test is not performed by Energypac.
3. Considering the establishment of an Independent Testing Laboratory in Bangladesh, which test facilities do you consider to be priorities for the development of your business?	Short circuit tests up to 132/230 kV system voltage.

POLY CABLE Industry Limited

Scope of the questionnaires

The questionnaire is addressed to understand the current characteristics of the electrical equipment market and the expectation of the manufacturers towards a Bangladesh Independent Testing Laboratory.

The questionnaire is organized in **four sections**:

Sections	Comments/Remarks
1. the type of electrical equipment manufactured in Bangladesh and sold in the domestic and international market,	All type of electrical Machine we sold international Market
2. the development of new equipment in progress and the challenges to be taken up in order to increase the role in the national market,	Now a days we develop our goals and we have taken challenges order to increase the role in the national market
3. technical characteristics of the manufactured equipment also in comparison with the ones available from the international market,	Technical characteristics between manufacturer and international Market are Same
4. The existing testing facilities and the need for new testing facilities.	We need some new test facilities like Impulse test facilities , Short circuit withstand test etc.

Type of electrical equipment manufactured in Bangladesh

Main Manufactured equipment (°)	Rated Voltage
a) Catenary Continuous Vulcanization (CCV)	Up to 132 kV
b) 150 mm Extruder Machine	Up to 33 kV
c) 120 mm Extruder Machine	Up to 33 kV
d) 80+45 mm Extruder Machine	Up to 1 kV
e) Rod Break down Machine (R.B.D)	The draw Wire up to 1000 mm ²
f) 91/67 Wire Stranding Machine	The Twisted Conductor up to 1000 mm ²
g) Drum Twister laying Machine	Laidup up to 3x300 mm ²

(°) representing not less than 80% of the yearly turnover

Current and expected total sales volume

	Year 2021	Year 2026	Year 2031
Total sales (°)			
% of sales on the international market			

(°) Specify the reference currency (BTD,USD, ...)

Development of new equipment

in progress and in the next 3 years		in the next 5-10 years	
Equipment	Rated Voltage	Equipment	Rated Voltage
a) 50 mm Portable Horizontal strip machine	Up to 1 kV	a)	
b) Catenary Continuous Vulcanization (CCV)	Up to 132 kV	b)	
c) PVC Compoundig machine SJW-100-180	All PVC Compound	c)	
d)		d)	
e)		e)	

Technical characteristics of the manufactured equipment

Question	Comments/Remarks
1. According to which Standard (IEC, IEEE, Local Standard, etc.) the equipment are developed?	We developed all Equipment Accordng to IEC, IEEE, Local Standerd, etc.
2. Main international competitors present in Bangladesh for their manufactured equipment,	We have no Competitors.



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3. Main differences between the manufactured equipment and the international ones (price, quality, etc.)	There are no differences between the manufactured equipment and the international ones (price, quality, etc.) all are same.
4. Are the new products type tested in Independent Testing Laboratory? And what percentage of new products are type tested?	We would like to Routine test, Acceptance Test and Type Test hundred Percent of new products type test.
5. What is the evaluation of the services offered by the Independent Testing Laboratory? And what about the incurred costs for these services (also considering the transportation costs)?	Our Evaluation experience is very good, In case of Service offered by Independent Test Laboratory like, BUET, CPRI, SRIRAM, etc.

The existing testing facilities and the need for new ones

Questions	Comments/Remarks
1. Which testing laboratories (dielectric, mechanical operation, etc.) are there in your organization? Are they accredited?	We have a Excellent Test laboratories Where all kind of Test facilities like Dielectric, Mechanical test etc.
2. In addition to routine tests these laboratory are also able to perform some type tests?	We are also able to perform Routine Test, Acceptance test, Type test
3. Considering the establishment of an Independent Testing Laboratory in Bangladesh, which test facilities do you consider to be priorities for the development of your business?	We Consider to be Priorities Short Circuit withstand test for development our business an Independent testing laboratories in Bangladesh.



Power Cell

PROTEC ELECTRONICS Limited

Questionnaires for Manufacturers

Scope of the questionnaires

The questionnaire is addressed to understand the current characteristics of the electrical equipment market and the expectation of the manufacturers towards a Bangladesh Independent Testing Laboratory.

The questionnaire is organized in **four sections**:

Sections	Comments/Remarks
1. the type of electrical equipment manufactured in Bangladesh and sold in the domestic and international market,	Cable, Transformer (Power & Distribution, Instrument), CT-PT, MCB, MCCB, AVR, IVS, Panel (LV, MV) BBT, Meter(1Ph)
2. the development of new equipment in progress and the challenges to be taken up in order to increase the role in the national market,	In order to explore export diversification, we can expect government support in the local manufacturing industry. Our policy does not support local ind. electro-mechanical ind.
3. technical characteristics of the manufactured equipment also in comparison with the ones available from the international market,	A few electrical products like CRT, Cable, and Transformer are better than Indian and Chinese products.
4. The existing testing facilities and the need for new testing facilities.	Short Circuit lab is not in our country



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Type of electrical equipment manufactured in Bangladesh

Main Manufactured equipment (°)	Rated Voltage
a) Single and Three Phase Distribution Transformer	11KV/0.415V
b) Power Transformer	33KV
c) CT-PT	11KV, 33kV, 132KV, Low Voltage
d) LV, MV Panels and Control Panels	415V, 11KV, 33KV, 132KV
e) Meters Single and Three	220V, 315V
f) Cust Resin Transformer	11KV, 33KV
g) Bus Bar Trunking	415
h) Cable	415, 11KV, 33KV

(°) representing not less than 80% of the yearly turnover

Current and expected total sales volume

	Year 2021	Year 2026	Year 2031
Total sales (°)			
% of sales on the international market			

(°) Specify the reference currency (BTD,USD, ...)

Development of new equipment

in progress and in the next 3 years		in the next 5-10 years	
Equipment	Rated Voltage	Equipment	Rated Voltage
a) MCB,	415	a)	
b) MCCB	415	b)	
c) MC	415, 220 V	c)	
d) VCB	11KV, 33KV	d)	
e)		e)	

Technical characteristics of the manufactured equipment

Question	Comments/Remarks
1. According to which Standard (IEC, IEEE, Local Standard, etc.) the equipment are developed?	IEC
2. Main international competitors present in Bangladesh for their manufactured equipment,	schneider electric, ABB, Siemens, Danish, Genus, CG Power
3. Main differences between the manufactured equipment and the international ones (price, quality, etc.)	Price
4. Are the new products type tested in Independent Testing Laboratory? And what percentage of new products are type tested?	
5. What is the evaluation of the services offered by the Independent Testing Laboratory? And what about the incurred costs for these services (also considering the transportation costs)?	



Power Cell

The existing testing facilities and the need for new ones

Questions	Comments/Remarks
1. Which testing laboratories (dielectric, mechanical operation, etc.) are there in your organization? Are they accredited?	CPRI
2. In addition to routine tests these laboratory are also able to perform some type tests?	YES
3. Considering the establishment of an Independent Testing Laboratory in Bangladesh, which test facilities do you consider to be priorities for the development of your business?	Short Circuit, Temperature Rise, impulse

01.All mnc must have manufacturing unit to do business in Bangladesh.

02. All foreign companies must have local partners

Reverie Power & Automation Engineering Limited

Questionnaires for Manufacturers

Scope of the questionnaires

The questionnaire is addressed to understand the current characteristics of the electrical equipment market and the expectation of the manufacturers towards a Bangladesh Independent Testing Laboratory.

The questionnaire is organized in **four sections**:

Sections	Comments/Remarks
1. the type of electrical equipment manufactured in Bangladesh and sold in the domestic and international market,	Up to 315MVA, 230kV Oil Type Power, Up to 4MVA Distribution Transformer, Cast Resin Transformer, MV/LV Switchgear Panel, Isolator, Cables, Meter, Control Panel etc.
2. the development of new equipment in progress and the challenges to be taken up in order to increase the role in the national market,	No third party authority for testing as per requirements from clients. VAT/TAX Policy should be changed for the manufacturer.
3. technical characteristics of the manufactured equipment also in comparison with the ones available from the international market,	Technically there is no difference between Bangladeshi and International products that has to comply with relevant IEC standards.
4. The existing testing facilities and the need for new testing facilities.	The existing facility is not enough for doing all type of test in right manner. And there is no international accreditation of any laboratories in Bangladesh.

Type of electrical equipment manufactured in Bangladesh (For Revert)

Main Manufactured equipment (°)	Rated Voltage
a) Transformer (Up to 50MVA)	Up to 132 kV
b) MV Switchgear (Up to 2500A)	Up to 33kV
c) LV Switchgear (Up to 6300A)	Up to 0.415kV
d) CT/PT (Up to 2000-1000)	Up to 33kV
e) Isolator (Up to 2000A)	Up to 33kV
f) Control Relay & Protection Panel (PCM)	Up to 400kV
g)	

(°) representing not less than 80% of the yearly turnover

Current and expected total sales volume

	Year 2021	Year 2026	Year 2031
Total sales (°)	USD 50 Million	USD 150 Million	USD 200 Million
% of sales on the international market	3%	10%	25%

(°) Specify the reference currency (BTD,USD, ...)

Development of new equipment

in progress and in the next 3 years		in the next 5-10 years	
Equipment	Rated Voltage	Equipment	Rated Voltage
a) Transformer (350MVA)	Upto 230kV	a) Transformer (500 MVA)	Upto 400kV
b) MV panel	Upto 33kV	b) Isolator (4000 A)	Upto 400kV
c) Isolator (2500 A)	Upto 33kV	c) CT/PT (4000-2000 A)	Upto 400kV
d) CT/PT (2000-1000 A)	Upto 33kV	d) LA	Upto 400kV
e) LA	Upto 33kV	e) Shunt Reactor	Upto 400kV

Technical characteristics of the manufactured equipment

Question	Comments/Remarks
1. According to which Standard (IEC, IEEE, Local Standard, etc.) the equipment are developed?	For Transformer IEC 60076, For MV Switchgear IEC 62771-100 & 200, For LV panel IEC 61439-1 & 2, For CT/PT IEC 60044-1, For Isolator IEC 60747, For LA IEC 62561
2. Main international competitors present in Bangladesh for their manufactured equipment,	ABB, Siemens, Mitsubishi Electric, Hyundai Electric, Hitachi Energy, Schneider, Legrand, LS, CGL, BTW, Shanghai Electric, Shangdong taikai, Xian Electric, Chint, Aditya Biddyt, Danish Pvt. Limited, Tesla Pvt. Ltd., Marson Electric, L&T, S&S etc.
3. Main differences between the manufactured equipment and the international ones (price, quality, etc.)	Price is higher than the local manufacture product. Quality than international product.
4. Are the new products type tested in Independent Testing Laboratory? And what percentage of new products are type tested?	There is no such facility in Bangladesh for type test.
5. What is the evaluation of the services offered by the Independent Testing Laboratory? And what about the incurred	Various testing along with short circuit test. The transport cost of this equipment will depend on size of the equipments.

The existing testing facilities and the need for new ones

Questions	Comments/Remarks
1. Which testing laboratories (dielectric, mechanical operation, etc.) are there in your organization? Are they accredited?	We have testing laboratories for performing any type of routine test of transformer and switchgear panel. Along with that we have the facility of 400kV Lightning Impulse and Double Voltage Double Frequency (DVDF) facility. Not yet accredited, however we are taking preparation for NABL accreditation.
2. In addition to routine tests these laboratory are also able to perform some type tests?	Yes except Short Circuit, Internal Arc & Partial Discharge.
3. Considering the establishment of an Independent Testing Laboratory in Bangladesh, which test facilities do you consider to be priorities for the development of your business?	Short Circuit, Internal arc, Partial Discharge and all other routine test, so that manufactured equipment's in Bangladesh can easily be exported to other countries.



Certification and Inspection Bodies

1. BDP - Bangladesh Power Development Board
(as Government Agency consulted on the matter)
2. BSTI – Bangladesh Standards and Testing Institution
3. Iconic Engineering & Trading Company
4. Office of the Chief Electric Inspector
5. Pico Labs Ltd
6. Bangladesh University of Engineering and Technology, Department of
Electrical and Electronics Engineering



BPD - Bangladesh Power Development Board

Questionnaires for Certification and Inspection Bodies

Scope of the questionnaire

The aim of this questionnaire is to make an overview on the **existing Certification and Inspection Bodies in Bangladesh, their organization and the services provided** in the framework of quality verification of the electrical equipment.

Organization of the Certification and Inspection Bodies

Questions	Comments/Remarks
1. Are there Certification Bodies in Bangladesh? If so are they owned by the Ministry of Energy & Power & Mineral Resources or by electricity companies or are they independent organizations?	Yes OCEI MoPER
2. Are there Inspection Bodies in Bangladesh? Are they connected with the Certification Bodies	Yes BSTI Not directly connected
3. Who carries out the accreditation of the laboratories ? And according to what standards?	BAB IEC and IEEE
4. To which standards do the electrical utilities mainly refer for Certification and Inspection activities ? Are they different for different equipment and their rated voltage (HV, MV and LV)?	IEC and IEEE No
5. What role do the Technical Universities play?	As per request they do some test up to Medium voltage



Power Cell

Service portfolio of Certification and Inspection Bodies

Question	Comments/Remarks
1. For which electrical equipment are more required the services of the Certification Bodies? And who are the customers? Electrical companies, Manufacturers, Energy Intensive Industries	All kind of sub-station equipments mandatory All of them
2. From the point of view of Certification and Inspection Bodies what are the existing weakness in the verification of the quality of electrical equipment? - What are the suggested interventions? On which equipment and relevant rated voltage (LV, MV, and HV) are these interventions to be considered as priority?	All testing facilities (Especially type test) are not available. All type tests should be incorporated. All of them

Comments: In CERS, BPDB, we are doing the all tests of sub-station equipments, Energy meters, Transformer oil up to Medium Voltage (MV)



Bangladesh Standards and Testing Institution

Questionnaires for Certification and Inspection Bodies

Scope of the questionnaire

The aim of this questionnaire is to make an overview on the **existing Certification and Inspection Bodies in Bangladesh, their organization and the services provided** in the framework of quality verification of the electrical equipment.

Organization of the Certification and Inspection Bodies

Questions	Comments/Remarks
1. Are there Certification Bodies in Bangladesh? If so are they owned by the Ministry of Energy & Power & Mineral Resources or by electricity companies or are they independent organizations?	Bangladesh Standards and Testing Institution (BSTI) is one of the Certification Bodies in Bangladesh. Under Ministry of Industries, Bangladesh Standards and Testing Institution (BSTI) was established as an autonomous body by promulgating Ordinance of 1985.
2. Are there Inspection Bodies in Bangladesh? Are they connected with the Certification Bodies	Bangladesh Standards and Testing Institution (BSTI) is also one of the Inspection Bodies in Bangladesh.
3. Who carries out the accreditation of the laboratories ? And according to what standards?	Bangladesh Accreditation Board (BAB) carries out the accreditation of the laboratories according to the Standard ISO 17025 . It may be mentioned here that some laboratories of BSTI has got accreditation from BAB . Again it is a routine work of BSTI to increase the scope of accreditation day by day.
4. To which standards do the electrical utilities mainly refer for Certification and Inspection activities ? Are they different for different equipment and their rated voltage (HV, MV and LV)?	Bangladesh standards (BDS) are referred for certification of different products. Inspection activities of Bangladesh Standards and Testing Institution (BSTI) go through under the Standard ISO 17065 . Certification Marks department has also got accreditation on ISO 17065.
5. What role do the Technical Universities play?	Technical Universities has some small scale laboratories. But they are not carried out the tests following Standard Test Method

Service portfolio of Certification and Inspection Bodies

Question	Comments/Remarks
1. For which electrical equipment are more required the services of the Certification Bodies? And who are the customers? Electrical companies, Manufacturers, Energy Intensive Industries	239nos. of different products are mandatory for BSTI Certification. Among this 38 nos. of products are electrical. BSTI has the facilities test these 38 nos of LV electrical product. HV & MV electrical equipment are required the services of the Certification Bodies. Customers are Manufacturers, Importers etc.
2. For which electrical equipment are more required the services of the Inspection Bodies? And who are the customers? Electrical companies, Manufacturers, Energy Intensive Industries	HV & MV electrical equipment are required the services of the Certification Bodies. Customers are Manufacturers, Importers etc.
3. From the point of view of Certification and Inspection Bodies what are the existing weakness in the verification of the quality of electrical equipment? ○ What are the suggested interventions? ○ On which equipment and relevant rated voltage (LV, MV, HV) are these interventions to be considered as priority?	Certification and Inspection Bodies has some capacities but they are not fully capable to carry out the test. Especially Type test of HV & MV electrical equipment cannot carry out at those laboratories. Have to be focused on Type test of electrical equipment. There have to be a data analysis- ➤ How many customers are going to the CPRI, KEMA or any other overseas Lab per year? ➤ How many electrical products are designed in our country to carry out the Type test at those Labs? ➤ Is it possible to establish a HV Lab having Type test facilities following Standard Test Method? Otherwise Lab will not get the accreditation. ➤ If HV Lab establishes without type test facilities, it will be just parallel Lab like BSTI, CERS or any other private Lab. ➤ HV & MV electrical equipment to be considered as priority.



Power Cell

DeMEPA
DESIGN and MANAGEMENT of ELECTRICAL POWER ASSETS

Iconic Engineering & Trading Company

Dear Sir,

We hope this letter finds you in good health and high spirits. On behalf of Iconic Engineering Ltd, We are writing to express our heartfelt gratitude to the Bangladesh government for taking the visionary steps of creating independent LV (Low Voltage), MV (Medium Voltage), and HV (High Voltage) testing facilities under the guidance of Power Cell. This wonderful attempts indicates the country's commitment to maintaining the greatest quality standards in the power industry, which surely opens the way for infrastructural developments and overall progress.

While applauding these efforts, we would want to draw your attention to a critical component that must be carefully considered to maintain the long-term sustainability and effectiveness of these testing laboratories. It is about implementing adequate calibration and traceability procedures.

Calibration and traceability are the cornerstones of any reputable testing laboratory, particularly in the field of electrical and power-related testing activities. The importance of these practises cannot be emphasised, as they are critical in generating accurate and reliable measurement findings, which serve as the foundation for effective decision-making and conformity to national and international standards.

In brief, the importance of calibration and traceability can be summarized as follows:

1. **Accuracy and Reliability:** Calibration is the process of comparing measurement instruments to recognised standards and validating their correctness. Without regular calibration, test results may lack trustworthiness, resulting in incorrect conclusions and even dangerous outcomes in important situations.
2. **Consistency:** Traceability ensures that measurement results are linked to recognized national or international standards through a meticulously documented chain of comparisons. This facilitates consistent measurements and enables seamless comparisons of results across different laboratories, fostering trust and validation of findings.
3. **Compliance with Standards:** Numerous national and international regulations and standards mandate calibration and traceability for testing laboratories. Adhering to these requirements showcases the government's commitment to upholding these benchmarks and instills confidence in stakeholders.
4. **Risk Mitigation:** In the power sector, precision testing is paramount to identify potential hazards and ensure the reliability of power systems. Calibration and traceability mitigate the risks associated with inaccurate measurements, reducing the likelihood of accidents and ensuring the safety of personnel and assets.



Power Cell

DeMEPA
DESIGN and MANAGEMENT of ELECTRICAL POWER ASSETS

- 5. International Recognition:** Laboratories that diligently implement calibration and traceability practices gain international recognition and credibility. This opens avenues for collaboration, mutual acceptance of test results with other accredited laboratories, and bolsters confidence among international partners.

By incorporating these essential practices into the proposal, the independent LV, MV, and HV testing laboratories can realize their full potential, fostering sustainability, credibility, and effectiveness in propelling the power sector's growth and development.

Bangladesh is currently in a position where blocking imports is no longer feasible. However, we can effectively solve this difficulty by employing rigorous testing procedures to ensure the excellent quality of our exported products. We can ensure the adherence to correct quality standards by thoroughly inspecting our export items and comparing them to locally manufactured products. By adopting this day by day, we can reduce our dependency on export.

The Bangladesh Standard Testing Institute (BSTI) is the country's National Metrology Institute (NMI), and it has been essential in providing calibration services throughout the country. With its extensive capabilities and expertise, BSTI is well positioned to make a significant and positive impact on this project. Through its established proficiency in calibration, BSTI can contribute valuable insights and resources to ensure the successful establishment of the Electrical Testing Laboratory. Collaborating with BSTI will undoubtedly enhance the quality and reliability of the laboratory's services, bolstering confidence in the testing procedures and outcomes.

Finally, we want to express our heartfelt appreciation for considering the relevance of calibration and traceability in this crucial endeavour. Please do not hesitate to contact me if you require any additional information or support.

Thank you for your attention, and we look forward to witnessing the success of these testing laboratories in contributing to the progress of Bangladesh's power sector.



Power Cell

Office of the Chief Electric Inspector

Questionnaires for Certification and Inspection Bodies

Organization of the Certification and Inspection Bodies

Questions	Comments/Remarks
1. Are there Certification Bodies in Bangladesh? If so are they owned by the Ministry of Energy & Power & Mineral Resources or by electricity companies or are they independent organizations?	Yes, there is a certification Body named Bangladesh Standard and Testing Institution (BSTI) under Ministry of Industry.
2. Are there Inspection Bodies in Bangladesh? Are they connected with the Certification Bodies	Yes, there are Inspection Bodies named Office of the Chief Electric Inspector under Ministry of Power, Energy and Mineral Resources. All inspection Bodies Indirectly connected with certification body.
3. Who carries out the accreditation of the laboratories ? And according to what standards?	Bangladesh Accreditation Board (BAB).
4. To which standards do the electrical utilities mainly refer for Certification and Inspection activities ? Are they different for different equipment and their rated voltage (HV, MV and LV)?	Certification Body mainly follows some IEC, IEEE, ANSI Standards routine test of the HV, MV and LV Electrical Products. Inspection Bodies are follows the Electricity Acts, Electricity Rules and Bangladesh National Building Code (BNBC) with IEC-60076 or other relevant IEC Standards HV, MV & LV Tests.
5. What role do the Technical Universities play?	Technical University usually awarded B.Sc. Engineering/M.Sc. Engineering/PhD to the students.

Service portfolio of Certification and Inspection Bodies

Question	Comments/Remarks
1. For which electrical equipment are more required the services of the Certification Bodies? And who are the customers? Electrical companies, Manufacturers, Energy Intensive Industries	IEC, IEEE, ANSI Standards routine and Type test of the HV, MV and LV Electrical Products are required for the Certification Bodies. All type of Electrical product Manufacturers and supplier are the customer of the Certification Bodies.
2. For which electrical equipment are more required the services of the Inspection Bodies? And who are the customers? Electrical companies, Manufacturers, Energy Intensive Industries	IEC-60076 or other relevant IEC Standards HV, MV & LV Routine Test facilities are required for the Inspection Bodies. In accordance with the Electricity Rules, All type of Electrical product Manufacturers and supplier in addition the electrical installation of any Residential or Commercial or Industrial stakeholders.
3. From the point of view of Certification and Inspection Bodies what are the existing weakness in the verification of the quality of electrical equipment? - What are the suggested interventions? On which equipment and relevant rated voltage (LV, MV, and HV) are these interventions to be considered as priority?	- At present situation, The Type test facilities are not available for any electrical equipment in Bangladesh. - Some Technical universities and Electrical product Manufacturers have the Routine test facilities, but this is not sufficient for the customers. Suggestion for Interventions: - Calibration facilities for all types of Electrical measuring Instruments and Electrical Testing Equipment. - IEC, IEEE, ANSI Standards routine and Type test of the HV, MV and LV Electrical Products.

Pico Labs Ltd

Scope of the questionnaire

The aim of this questionnaire is to make an overview on the **existing Certification and Inspection Bodies in Bangladesh, their organization and the services provided** in the framework of quality verification of the electrical equipment.

Organization of the Certification and Inspection Bodies

Questions	Comments/Remarks
1. Are there Certification Bodies in Bangladesh? If so are they owned by the Ministry of Energy & Power & Mineral Resources or by electricity companies or are they independent organizations?	Yes, there are Certification Bodies in Bangladesh. These bodies are independent organizations and are not owned by the Ministry of Energy & Power & Mineral Resources or electricity companies. Certification Bodies are typically separate entities that specialize in providing certification services for various industries, including the electrical sector. While the Ministry of Energy & Power & Mineral Resources may have regulatory oversight and set certain standards or requirements for electrical equipment, the actual certification activities are carried out by independent Certification Bodies in Bangladesh. PICO Labs Ltd is one of the independent certification body who is maintaining international standard to certify Electrical, Mechanical, Thermal as well as Biomedical equipment's in many industry vertical throughout Bangladesh.
2. Are there Inspection Bodies in Bangladesh? Are they connected with the Certification Bodies	Yes, in Bangladesh, there are Inspection Bodies. These bodies are separate entities that specialize in conducting inspections to assess the compliance, safety, and quality of various products, systems, and processes. PICO Labs Ltd is one of the independent Inspection body who is maintaining various international Inspection standards such as ISO

	9001:2015, NFPA 70, 70E, 70B for conduct audit in various Industries to improve their compliance, safety, Process. Certification Bodies often work closely with Inspection Bodies to gather inspection reports, audit findings, and test results as evidence for certification.
3. Who carries out the accreditation of the laboratories ? And according to what standards?	In Bangladesh, the accreditation of laboratories is carried out by the Bangladesh Accreditation Board (BAB). BAB is the national accreditation body responsible for assessing and accrediting testing laboratories, calibration laboratories, medical laboratories, inspection bodies, and certification bodies in the country. The accreditation process conducted by BAB follows internationally recognized standards and guidelines. The primary standard used by BAB is ISO/IEC 17025:2017, which specifies the general requirements for the competence, impartiality, and consistent operation of testing and calibration laboratories. PICO Lab's Ltd also following ISO/IEC 17025:2017 Standard for Certification of various equipment/Instrument as per standard procedure. Apart from ISO/IEC 17025, BAB may also use other relevant standards and guidelines depending on the specific type of laboratory or accreditation sought. For example, medical laboratories may be assessed against ISO 15189:2012, which specifically addresses the competence requirements for medical laboratory testing.
4. To which standards do the electrical utilities mainly refer for Certification and Inspection activities ? Are they different for different equipment and their rated voltage (HV, MV and LV)?	In electrical utilities, the standards referred to for certification and inspection activities may vary depending on the equipment and its rated voltage (High Voltage [HV], Medium Voltage [MV], and Low Voltage [LV]). For, certification they follow ISO 17025:2017 Standard. Here are some commonly referenced standards for inspection in electrical utilities: 1. IEC 60038: This standard defines the nominal voltage ratings for electrical systems. It provides voltage levels and tolerances for HV, MV, and LV systems. 2. IEC 60071: This standard addresses

	insulation coordination for HV systems. It covers the selection of insulation levels, testing methods, and coordination of insulation for different equipment in HV systems. 3. IEC 62271 series: This series of standards covers high-voltage switchgear and controlgear. Some specific standards in this series include: • IEC 62271-1: Common specifications for HV switchgear and controlgear. • IEC 62271-100: Circuit breakers for HV systems. • IEC 62271-200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV. 4. IEC 61439 series: This series of standards focuses on low-voltage switchgear and controlgear assemblies. Some specific standards in this series include: • IEC 61439-1: General rules for LV switchgear and controlgear assemblies. • IEC 61439-2: Power switchgear and controlgear assemblies. 5. IEC 60529: This standard defines the degrees of protection provided by enclosures of electrical equipment against the ingress of solid objects and liquids. It is commonly known as the IP (Ingress Protection) code. PICO LAB'S Ltd has the capabilities for all the Certifications and Inspection standards for Calibration and Testing of Electrical Equipment's.
5. What role do the Technical Universities play?	Technical universities in Bangladesh play a crucial role in certification and inspection by providing education, research, and collaboration opportunities. They offer specialized training, conduct research to advance standards and techniques, collaborate with industries and organizations, and provide professional development programs. Their contributions enhance competence, quality, and professionalism in certification and inspection activities.



Power Cell

DeMEPA
DESIGN and MANAGEMENT of ELECTRICAL POWER ASSETS

Service portfolio of Certification and Inspection Bodies

Question	Comments/Remarks
1. For which electrical equipment are more required the services of the Certification Bodies? And who are the customers? Electrical companies, Manufacturers, Energy Intensive Industries	Certification Bodies in Bangladesh are primarily sought after for certifying high voltage and low voltage switchgear, transformers, electrical cables, wiring and appliances. The customers include electrical companies, manufacturers, and energy-intensive industries. PICO Labs Ltd. Has all the Primary Standard Instruments to carry out calibration of all electrical instruments from high voltage to low voltage. PICO Labs Ltd. Has highly accurate instruments and qualified trained engineer to perform those certification work.
2. For which electrical equipment are more required the services of the Inspection Bodies? And who are the customers? Electrical companies, Manufacturers, Energy Intensive Industries	Inspection Bodies in Bangladesh are commonly engaged in inspecting electrical installations, power generation and distribution equipment, electrical machinery, and energy-intensive equipment. Their customers include electrical companies, manufacturers, and energy-intensive industries seeking to ensure safety, compliance, and performance in their electrical systems and equipment. PICO Labs Ltd. Has all the Necessary Instruments to carry out Specific Inspection according to international standard for Electrical Sector to ensure Compliance, Safety and Performance of their Machine and Process. PICO Labs Ltd. Has highly accurate instruments and qualified trained engineer to perform those Inspection work.



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3. From the point of view of Certification and Inspection Bodies **what are the existing weakness in the verification of the quality of electrical equipment?**

- What are the **suggested interventions?**
- **On which equipment** and relevant rated voltage (LV, MV, HV) are these interventions to be considered as priority?

Weaknesses in the verification of electrical equipment quality include the lack of standardization, limited surveillance, counterfeit products, and challenges posed by technological advancements.

Suggested interventions include enhanced standardization, strengthened surveillance mechanisms, improved collaboration, and strict enforcement against counterfeit products.

Regarding priority, these interventions should be considered across various equipment types and relevant rated voltages (LV, MV, HV). It is important to ensure quality verification across the entire spectrum of electrical equipment to maintain safety, reliability, and compliance at all levels.

Bangladesh University of Engineering and Technology, Department of Electrical and
Electronics Engineering

List of the performed Tests

Sl No	Name of the Product	Test Items	Rating
1	Transformer		3 phase, Upto 100 kVA, 11/0.415 kV
		1. Measurement of Turns Ratio	3 phase, 100 < kVA ≤ 250, 11/0.415 kV
		2. Vector Group Test	3 phase, 250 < kVA ≤ 500, 11/0.415 kV
		3. Measurement of Winding Resistance at 75°C	3 phase, 500 < kVA ≤ 1000 11/0.415 kV
		4. Measurement of Insulation Resistance	3 phase, 1 < MVA ≤ 5 11/0.415 kV
		5. Measurement of No-load Loss and No-Load Current	3 phase, 10-13 MVA 11/0.415 kV or 33/0.415 kV at supplier lab
		6. Measurement of Impedance Voltage and Load Loss at 75°C	3 phase, 10-26 MVA 11/0.415 kV or 33/0.415 kV at supplier lab
		7. Power Frequency High Voltage Test	single phase, 10-20 kVA 11/0.415 kV
		8. Test of Transformer Oil	
		9. Temperature Rise Test	
2	Cable	1. Dimensional Test	1.0 rm-10 rm BYA/NYY XLPE
		2. DC Resistance Test	10 rm-20 rm BYA/NYY XLPE
		3. Insulation Resistance Test	20 rm-50 rm BYA/NYY XLPE
		4. Current carrying capacity Test	
		5. AC high voltage withstand test	



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			50 rm-120 rm BYA/NYY XLPE
			120 rm-240 rm BYA/NYY XLPE
			240 rm-400 rm BYA/NYY XLPE
			400 rm-630 rm BYA/NYY XLPE
3	Circuit Breaker (MCB/MCCB)	1. Mechanical operation test 2. Insulation resistance test 3. High voltage test 4. Impulse voltage 5. Tripping test 6. Temperature rise	Depending upon rating
4	Circuit Breaker (VCB/ACB)	1. Mechanical operation test 2. Insulation resistance test 3. High voltage test 4. Impulse voltage 5. Tripping test 6. Temperature rise	Depending upon rating
5	Instrument Transformer (CT/PT)	1. Mechanical operation test 2. Insulation resistance test 3. High voltage test 4. Ratio Test 6. Temperature rise	Depending upon rating
6	Overhead conductor	1. Dimensional Test	Depending upon rating



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DESIGN and MANAGEMENT of ELECTRICAL POWER ASSETS

		2. DC Resistance Test 3. Insulation Resistance Test (if insulated) 4. Current carrying capacity Test 5. AC high voltage withstand test (if insulated)	
7	LT panel	1. Mechanism Operation Test 2. Rated Current Test 3. Temperature Rise Test 4. Thermal Overload Test 5. Magnetic Trip Test 6. Insulation Resistance Measurement Test 7. Power Frequency High Voltage Test	
8	Room Air-conditioning Unit	1. Earthing 2. Insulation Resistance 3. Total Harmonic Distortion	
9	HT panel	1. Dimensional 2. Fitment & Alignment 3. Physical Test 4. (Sample) 5. Measurement of IR Value a) Before HV Test b) After HV Test 6. High Voltage test/Dielectric 7. Impulse Test 8. Partial Discharge Test 9. Heat run /	Depending upon rating

		10. Temperature rise test 11. Enclosure Protection Test / Ingress Protection (IP) 12. Calibration 13. Noise & Vibration 14. Operational & functional check 15. Clearance and creepage Distance	
10	Earth resistivity	1. Earth Resistivity 、	
11	Washing machine	1. Earthing 2. Insulation Resistance 3. Total Harmonic Distortion	
12	PFI plant Test	1. Discharge rate of the capacitor bank 2. AC voltage test of the capacitor bank between terminals and the casing. 3. Insulation test 4. Performance test at rated voltage of the capacitor banks 5. Operations of the PFI controller, digital display, contactor, fuse and ON/OFF indicators. 6. Auto Mode Operation Sequence and Manual Mode Sequences 7. MCCB test.	Depending upon rating
13	ATS	1. Mechanical Operation Test Satisfactory 2. Functionality Test Satisfactory 3. Rated Current and Temperature Rise Test Satisfactory	Depending upon rating

		4. Insulation Resistance Test Satisfactory	
		5. Power Frequency High Voltage Test	
14	Lift, Escalator, Moving Platform	1. Control System, 2. Motor Braking System, 3. Sensor and any other opto-electrical component	
15	BUSBAR	1. Dimensional Test 2. DC Resistance Test 3. Insulation Resistance Test (if insulated) 4. Current carrying capacity Test 5. AC high voltage withstand test (if insulated)	
16	BBT system	1. Dimensional Test 2. Heat run 3. Insulation Resistance Test 4. Current carrying capacity Test 5. AC high Voltage withstand test	
17	Auto Voltage Regulator (AVR)	1. AVR Performance Test 2. Efficiency 3. Input Harmonic Distortion 4. Input Power Factor 5. Output Voltage Regulation 6. Load Transfer Test	
18	Capacitor bank		
19	Insulator	1. Insulation resistance 2. High voltage width stand	
20	Pin, dis type insulator	1. Insulation resistance	

		2. High voltage width stand	
21	Surge arrestor		
22	Uninterrupted Power Supply (UPS) Integrated Power System (IPS)	1. UPS Performance Test 2. Efficiency 3. Input Harmonic Distortion 4. Input Power Factor 5. Output Voltage Regulation 6. Load Transfer Test 7. AC Main Input Failure and Return Test 8. Step Load Test 9. Overload Test 10. Voltage Distortion with Balanced Load 11. Voltage Distortion with Unbalanced Load 12. Battery Capacity 13. Protection (Under Voltage, Over voltage, Phase Failure)	
23	Test and calibration of meters	1. Test of meters for calibration and comparison with standard meter	
24	PA system		
25	Motor	1. Efficiency 2. Power factor 3. Torque	
26	Motor starter	1. Smooth conversion from Wye (START) to Delta (RUN). 2. Protections against single phasing in start condition.	

		3. Protection against reverse phasing. 4. Initially protection against over load condition was not working satisfactorily due to a mechanical jam in the spring. However when the jam was removed from the spring the thermal overload protection was working satisfactorily. 5. Protection against over voltage 6. Protection against under voltage.	
27	Variac, current injector	1) Voltage range test 2) Current capacity test 3) Insulation test	
28	Copper terminals lugs and service ball		
29	Transformer, Generator sound level	1. Sound level of transformer	
30	Sound and Noise Test of electrical equipment		
31	Battery Industrial 2V Battery Block Pb-acid Battery Li-based Battery		
32	Solar PV Panel	1. Rated Power/Maximum Power under STC, Pmax (Watts) 2. Open circuit voltage under STC, Voc (Volts) 3. Short circuit current under STC, Isc (Amps) 4. Maximum working voltage at Pmax under STC, Vmp (Volts) 5. Maximum working current at Pmax under STC, Imp (Amps)	

		6. Cell efficiency 7. Module efficiency 8. Fill factor, FF	
33	Street Light System consisting of Light, battery, charge controller	1. Testing of light 2. Testing of battery 3. Testing of charge controller	
34	Inverter	1. Voltage and current ratings 2. Power ratings 3. Efficiency	
35	Charge Controller	1. MPPT mechanism 2. Labeling on charge controller casing 3. Rated Voltage 4. High voltage disconnect 5. Low voltage disconnect 6. Low voltage reconnect 7. Maximum current handling capacity 8. Maximum self current drawn 9. Reverse current leakage protection 10. Short-circuit protection 11. Reverse polarity protection 12. Efficiency of the Charge Controller 13. Charging indicator	NA
36	DC - DC Converter with charge controller	1. Voltage ratio 2. Conversion efficiency 3. Current rating	

37	Solar Pump	1. Inverter efficiency at different frequency	
38	Switch/Socket	1. Mechanical operation test 2. Insulation resistance test 3. High voltage test 4. Ratio Test 5. Temperature rise	NA
39	Fan Dimmer	1. Insulation resistance test 2. Power frequency High Voltage test 3. Temperature rise test 4. Leakage current test 5. Voltage Drop test 6. Uniformity Test	NA
40	Generator	1. Rated output 2. Maximum output 3. Power factor 4. Rated voltage 5. Voltage regulation 6. Frequency	
41	Firefighting generator	1. Rated output 2. Maximum output 3. Power factor 4. Rated voltage 5. Voltage regulation 6. Frequency	



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42	Optical Fiber	1. Dimensional test 2. Attenuation 3. Dispersion	
43	CCTV system		
44	Incubator		
45	Computer Hardware (motherboard, CPU, Speaker, microphone, power supply, webcam)		
46	Kitchen Appliances (Washing machine, grinder/blender/juicer, dish washer, rice cooker, microwave / electrical oven, kitchen hood etc.)		
47	Data communication Cables (all electrical tests)		
48	Wireless Walkie Talkie/ VHF test (repeater test)		
49	Cable connector	1. Resistance test	
50	Monitor	1. All electrical test	
51	LED Light	1. LED Input Power(W) 2. Color Rendering Index (CRI) 3. Lumen 4. Lumen per Watt 5. PF 6. Correlated Color Temperature (CCT)	
52	Fan	1. Input voltage, current, power 2. Air flow	
53	CFL	1. LED Input Power(W) 2. Lumen 3. Lumen per Watt 4. PF 5. Efficiency	

54	Fluorescent lamp	1. LED Input Power(W) 2. Lumen 3. Lumen per Watt 4. PF 5. Efficiency	
55	Incandescent lamp	1. LED Input Power(W) 2. Lumen 3. Lumen per Watt 4. PF 5. Efficiency	
56	Personal computer and laptop	1) motherboard 2) CPU 3) Speaker 4) microphone 5) power supply 6) webcam 7) Earthing 8) Insulation Resistance 9) THD	
57	Router/switch/modem	All electrical test.	
58	Drop out fuse		
59	Biomedical Equipment	Test related to medical Imaging and instrumentation.	
60	Electrical Safety Test of any kind of equipment and Machinery	Electrical safety test	
61	Pump-Generator Set	1. Rated output 2. Maximum output	



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		3. Power factor 4. Rated voltage 5. Voltage regulation 6. Frequency	
62	Power Conditioning Unit		
63	Fire-Pump Generator Set	1. Rated output 2. Maximum output 3. Power factor 4. Rated voltage 5. Voltage regulation 6. Frequency	
64	Electric Vehicle	1. Power train 2. Inverter / Converter 3. Charger 4. Storage (Battery)	



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Ministry of Power, Energy & Mineral Resources
Govt. of the People's Republic of Bangladesh

**Consultancy Services for Setting Up Electrical Testing
Laboratory**
(Contract Package: S-10)



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1. Summary

This document deals with two fundamental aspects for the success of the project. It concerns the evaluation of the:

- Bangladesh testing market assessment,
- Direct and Indirect benefits deriving for the Bangladeshi power system and electromechanical sector.

The evaluations carried out in this document derive from the **Consultant's knowledge of the Business Model of Electrical Testing Laboratories** and above all from **his experience in similar situations of Bangladesh**. Similarly to China 25 - 30 years ago, to India 15 -20 years ago, Bangladesh is a country undergoing strong demographic and economic growth with an expanding electricity sector thanks to an ambitious investment plan (see Vision 41 program) which can **help the development of the local manufacturing sector** to become a protagonist first on the Bangladesh market and later (which can be achieved in a few years) on the international market, with particular regard to neighboring countries such as Western India, Nepal, Bhutan and ASEAN countries.

The **testing market assessment** allows to **better define the configuration of the Laboratory** (types of equipment to be tested, maximum test ratings of the testing facility) on the basis of the demand of testing services and also **the organization of the Laboratory**.

The **evaluation of the of Direct Benefits** (the income statement of the Testing Laboratory and of the National Independent Authority) **as well of the Indirect Benefits** (the benefits for the country) **makes available important elements to the Government** (and the Stakeholders) **to justify the financial intervention** for the development of the Laboratory. In fact, the testing laboratories can be able to cover the O&M costs when they are fully operating but very often are not in condition to assure the return on the total required investments. The evaluation of the indirect benefits allows the country's institutions to evaluate the return on the country of the investment and therefore to justify the financial intervention.

The evaluation processes of the Test Market and of the Direct and Indirect Benefits are of **an iterative type and based on consolidated approaches**. These assessments **must be reviewed and fine-tuned together with the Client and the Stakeholders during** the subsequent tasks of the project.

The testing market assessment reported in this document has to be considered as the first iteration of an iterative process to be carried out taking into consideration the final configuration of the Laboratory.



2. Rationale

The evaluations carried out in this document derive from the **Consultant's knowledge of the Business Model of Electrical Testing Laboratories** and above all from **his experience in similar situations of Bangladesh**. Similarly to China 25 - 30 years ago, to India 15 -20 years ago, Bangladesh is a country undergoing strong demographic and economic growth with an expanding electricity sector thanks to an ambitious investment plan (see Vision 41 program) which can **help the development of the local manufacturing sector** to become a protagonist first on the Bangladesh market and later (which can be achieved in a few years) on the international market, with particular regard to neighboring countries such as Western India, Nepal, Bhutan and ASEAN countries.

The **Testing Market Assessment** allows to **better define the:**

- **Configuration of the Laboratory** (types of equipment to be tested, maximum test ratings of the testing facility) on the basis of the demand of testing services,
- **Organization of the Laboratory.**

Before going into the merits of the evaluation of Direct and Indirect Benefits, it is better to recall their definitions:

- **Direct Benefits:** are the income statement of the National Independent Authority, including therefore the income from the Testing Laboratory,
- **Indirect Benefits:** are the benefits for the power sector (for utilities and manufacturers) and therefore for the country (for example with an increase in employment) due the establishment of the testing Laboratory.

The evaluation of the of Direct Benefits, as well of the Indirect Benefits makes available important elements **to the Government** (and the Stakeholders) **to justify the financial intervention** for the development of the Laboratory.

In fact, the testing laboratories can be able to cover the O&M costs when they are fully operating **but very often are not in condition to assure the return on the total required investments**. The evaluation of the indirect benefits allows the country's institutions to evaluate the return on the country of the investment and therefore to justify the financial intervention.

The **Methodology for the evaluation of the Direct and Indirect Benefits** described in the document needed some information for its implementation, such as the current **reliability of the transmission and distribution networks** (back out - service interruptions), the **power quality of the electricity service**, the **accessibility of the electricity service** in rural distribution.

The document is subdivided into the following three chapters:

- Presentation of the model used for the testing market assessment,
- Evaluating the Bangladesh Market according to a Top-Down approach,
- Methodology for the evaluation of Direct and Indirect Benefits.



3. Presentation of the model used for the testing market assessment

3.1 Assessment approach

The Consultant has many years of experience in carrying out these kinds of assessments. Starting from about 20 years ago testing market assessments were carried out in China, Taiwan, Malaysia, Vietnam, then in Korea (about 15 years ago) and recently in Colombia and Turkey.

From an operational point of view, the following approaches can be used:

- **Top-Down approach.** This activity is carried out when the **electricity sector is not already structured and where the local manufacturing industry only partially covers** (for example a large part of the low voltage and less than half of the medium voltage) **the needs of the electricity utilities.** In this case there are limited information - at least by the manufacturers (Producers and Sellers) - while the purchasing policies applied by the electricity companies (Buyers) are quite clear. In this case, the Laboratory is above all a useful tool to support the development of the electricity sector, as regards the creation of a local manufacturing industry and the creation of a culture of quality in the country. In this case the **test market does not exist and must be created through Government Support** (see Chapter 2). The collected information through detailed questionnaires can only give answers of a qualitative nature but not sufficient to give numerical responses that could be considered in market valuations.
- **Bottom - Up approach.** This activity is carried out when the **electricity sector is already structured** and where the **necessary information already exists** to conduct the market assessment. The purchasing policy of the electricity companies (Buyers) is well understood and the development policy of the manufacturers (Producers and Sellers) regarding the local and international markets are well defined. In this case, the **testing market already exists** and only needs a promotion to make the manufacturers aware of the advantages of having a local laboratory facilitating the business (reducing times and costs for carrying out tests). The existing of available information allow to collect information through dedicated questionnaires for the collection of market information that can be treated numerically, according to the best practices.

Based on the above the "Top down" approach seems the most suitable one for the Bangladeshi testing market of electrical equipment.

3.2 Top-Down approach

This approach, to be adopted when the market that has not yet been structured, is usually carried out through steps.

In the **first step** a preliminary definition of the testing demand based is carried on the basis of the planned investment in the power system of the country.



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The information drawn from national development programs of the electricity sector (Generation, Transmission, Distribution) or studies financed by organizations such as World Bank and Asian Development Bank are the starting point. These programs or studies on the basis of **political objectives** (such as Environmental Sustainability, growth of renewables, strengthening of energy efficiency, access to electricity in rural areas, interconnections with neighboring countries, strengthening of the local manufacturing industry) **define the structure of the electricity system in the 10 ÷ 20-year horizon**, indicating the main solutions and applications and therefore proposing the necessary investments for their implementation.

From these Programs and based on similar situations of other countries it can be defined:

- the trend over time of investments for the electrical equipment used in the generation, transmission and distribution (rural electrification included),
- the investments related to the different type of equipment considering the objectives of the development program,
- a very rough percentage of the investment that will be devoted to quality verification activities (tests).

It should be noted that the **value resulting from this first evaluation does not represent the testing laboratory reference market** (and nor much less the accessible market), but **a first wholesale valuation of the testing market**.

In the **Second Step** the output of the First Step is in-depth analyzed, also with the support of dedicated questionnaires and interviews, in order to take into consideration:

- **Government policy encouraging a better quality in the electricity sector**, through the development of testing laboratories, certification, and inspection bodies;
- **Priority interests of the electric utilities towards** some specific type of equipment that may have significant impact on network performances,
- **Other services** (e.g. certification, inspection) **that can be proposed on the market** in addition to the testing services,
- Interest of the Manufacturers to use the testing facilities of the laboratory for the **execution of Type Tests and Development Tests on new equipment**, as well as to obtain useful **information on their priorities** (type of equipment and their maximum ratings and reference standards).
- **Degree of maturity achieved by Manufacturers in the quality achievement process** (e.g. execution of routine tests on all the produced equipment, internal laboratory accreditation)
- **Propensity to export of the local manufacturing industry**, to evaluate the demand for type testing related to exports.

This additional information allows to cut out and refine the results of the First Step to obtain a better focused assessment considering also the specific aspects of the country.



3.3 Bottom-Up approach

This approach is carried out **when the electricity sector is already structured and above all when the local manufacturers cover an important part of the demand for equipment by the electrical companies.** In this case, the evaluation of the testing market follows the typical market research approach considering:

- **Buyers of equipment:** the electrical companies and energy intensive companies
- **Manufacturers and Sellers of equipment** (Manufacturers and Systems Integrators)
- **Third Party Bodies**, such as Independent Laboratories (if any), Inspection Bodies and Accreditation Bodies (having detailed information on the existing accredited laboratories).
- Organizations of the **Electrical Manufacturing industry** who have information about the trends of the growth of the sector.

3.4 Considerations on the two approaches and impact on the commercial policies

The Bottom-Up approach **defines the existing total testing market in the country**, while the Top-Down approach **defines a reasonable market value** which responds to the interest of the development of the country's electricity sector.

This different outputs of the two approaches implies different commercial policy to be implemented.

In the case of the Bottom-Up, obtaining the maximum possible share of the evaluated total market requires the development of an adequate commercial and communication policy aimed to convince the local manufacturers to use the local laboratory instead of the International one to perform the type and development tests on new equipment. A similar policy should be adopted for the related services, such as certification and inspection.

The actual achievement of the testing market evaluated through the Top-Down approach requires a strong support from the Government of the country through actions such as those below listed:

- **Strong incentive (or even obligation) to the buyers of electrical equipment to include in the purchase specifications that:**
 - prototype of purchased equipment has been 'type tested',
 - in any case after 5 years from the execution of the type tests, these must be repeated, since the evolution of the used materials, the reference standards and the unavoidable design changes implemented by the manufacturer to optimize its production cycle introduce significant modifications between the tested prototype and the samples subsequently produced;
- **Support Manufacturers** - also from an economic point of view - **in carrying out development tests at the local laboratory during the development of new equipment;**



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- Repeat the type tests at the local laboratory if the international manufacturer has not carried out the tests at independent laboratories,
- **Organization of information and Capacity Building campaigns**, involving electrical companies, energy intensive industries, manufacturers (and their trade organizations) and universities to make everyone aware of the opportunities to improve the quality of the equipment locally manufactured.

3.5 Impact on organization, trade development policy and ownership of a new Testing Laboratory

Whichever approach is adopted between the two that have been discussed in the previous paragraphs some common issues have to be taken into consideration.

A new Testing Laboratory will have to **organize itself in such a way as to offer competitive services from a technical point of view, efficiency, commercial response speed** (prices, framework agreements with important Manufacturers) compared to international competitors.

At the same time, it will **necessary to find an organization, and perhaps even a form of ownership, capable of involving the Stakeholders of the electricity sector** as much as possible in the development of the Laboratory.

From an operational point of view, the Laboratory will therefore have to equip itself to have:

- Commercial structure that **knows the market of Competing Laboratories** (e.g., CPRI, others in the Asia Pacific area and CESI & Kema) and the **needs of local Electrical Utilities and the development plans of local Manufacturers**,
- Engineering Structure supporting Manufacturers during the development of new equipment, especially in case of failures of tests and when there is the need of interpretation of the Standards; during the startup phase, **engineering services can be carried out in collaboration with local universities and international consultants**.

The new Laboratory will have to **achieve two different accreditations**:

- Accreditation of the Laboratory quality system issued by an internationally recognized accreditation body,
- Accreditation from the Market, appearing as an organization having the **same quality of international testing laboratory** (such as CPRI, Keri, CESI & Kema), but with lower prices and less waiting time to test an equipment.

Both accreditations are important, but it should be emphasized that quality system accreditation is necessary, but not sufficient for the successful development of the Laboratory. **Only commercial accreditation is capable of giving credibility to the Laboratory.**

4. Evaluating the Testing Market according to a Top-Down approach

This evaluation is developed according to the methodology explained at par. 2.2.

4.1 Evaluation of expected investments in T&D sector

In a recent document on behalf of INMR, the consultancy firm Goulden Reports (a reputed consultancy company offering research and data for different industrial sectors) estimates the breakdown of the worldwide investments¹ in the T&D system in 2030 year shown in Figure D2-3-1.

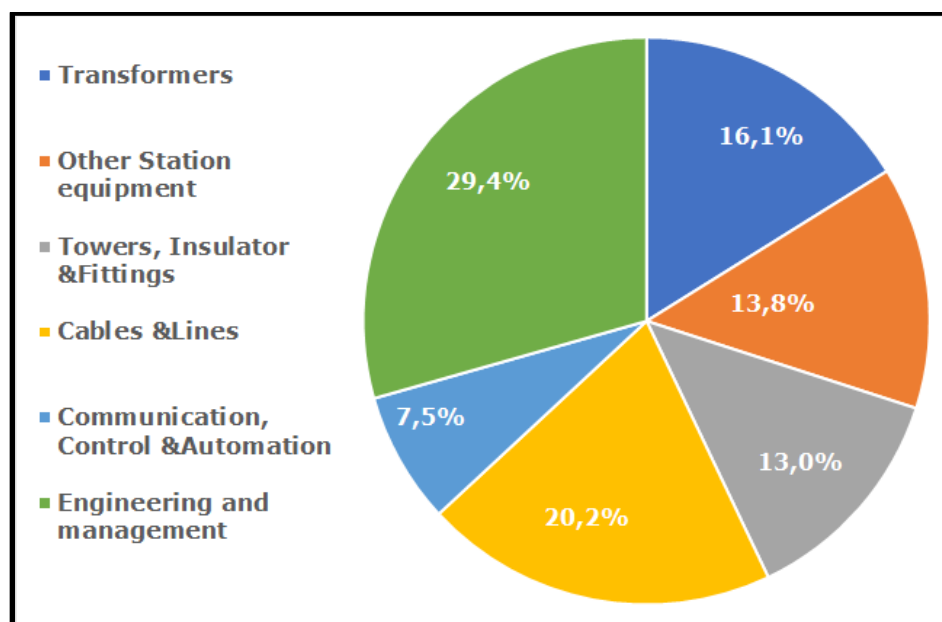


Figure D2-3-1: Breakdown of worldwide investment in 2030 year on T&D

The International Energy Agency evaluates for the period 2019-2022 that worldwide the investments for Distribution networks range between 63.4% and 65.2%² of the total investment in T&D infrastructure. In the case of developing countries, such share in the period 2016-2020 amounted to 70,6%³, likely due to rural distribution.

The Government of Bangladesh intends to invest in the period 2021-2041 an average value of 1.8 billion dollars per year⁴ to strengthen the Transmission and Distribution infrastructures for an effectively use of the planned additional 60 GW of generation plants.

¹ Steve Aubertin of Goulden Reports: Funding the Next Global T&D Investment Cycle: 2020-2040

² International Energy Agency-World Energy Investment 2022, pag.30

³ International Energy Agency-World Energy Investment 2021: Financing Clean Energy Transition in Emerging and Developing Economies, pag.102

⁴ VISION 41 - Perspective Plan of Bangladesh 2021-2041

On the basis of the above data, the breakdown of equipment annually purchased on average in the period 2021-2041 by the national T&D power system is listed in Tab. D2-3-1.

Table D2-3-1: Breakdown of the equipment annually purchased for T&D infrastructure on average during period 2021-2041 by the Bangladesh power system (Million USD)

Type of equipment	Distribution networks	Transmission Networks
Transformers	177	113
Other Station equipment	152	97
Towers, Insulator & Fittings	142	91
Cables & Lines	222	141
Communication, Control & Automation	83	52
Total	776	494

Considering the Bangladesh Testing Laboratory will take into consideration tests on equipment used in the MV/LV and HV/MV Station (such as Circuit Breakers, Disconnectors, Switchgears, Busducts, Instrument Transformers), insulators and power cables the annual investment of interest for the Laboratory becomes the ones listed in Tab. D2-3-2 assuming:

- the share related to insulator is 25% of the total investment for towers, insulator & fittings,
- the share related to power cables power is 35% of the total investment for Cables & Lines in the Distribution networks and 10% in the Transmission grid.

Table D2-3-2: Breakdown of the equipment annually purchased for T&D infrastructure on average during period 2021-2041 to be considered (Million USD)

Type of equipment	Distribution networks	Transmission Networks
Transformers	177	113
Other Station equipment	152	97
Insulator	35.5	22.7
Cables	77.2	14.1
Total	442.2	246.8

The annual investments to be considered for the Top-Down Approach amount to 689 Million USD considering the T&D infrastructure.

Taking into consideration also the investments for electrical utilities in new Generation Plants and in the energy intensive sectors of the country (Railways, Port and Airports, Industry) a **total amount of 800 Million USD** to be considered for the purpose of the Top-Down methodology seems to be affordable. The corresponding annual investments for these Other Sectors therefore amount to 111 Million USD, equal to 16% of the investment related to Distribution and Transmission infrastructures.

4.2 Evaluation of the Reference Market of the Testing Laboratory

This evaluation starts with the definition of the cost required for the execution of tests needed for the development and qualification of a new prototype as a percentage of the selling price of each sample of the new equipment.

The Testing Laboratory is mainly addressed to perform type tests and development tests (the tests executed during the development process of the prototype of the new equipment).

Table D2-3-2 defines the costs for the performing of type and development tests required from a new prototype as a share of the selling price of each sample of the new equipment, distinguishing between two different cases:

- the prototype is the re-engineering of an already existing product,
- the prototype concerns a completely new product.

Table D2-3-3: Cost for development and type tests execution on the prototype referred to the selling price of each sample of the new product

	Case of the re-engineering of an existing equipment	Case of the development of a completely new product
Development tests	2.6%	7.5%
Type tests	0.75%	2.6%

It has to be considered that a significant part of the development tests and some type tests (for instance the dielectric tests) are carried out at the manufacturer's testing laboratory. Therefore, in order to evaluate the share of costs related to the actual tests performed in the Testing Laboratory, the values listed in Tab. D2-3-2 are to be reduced to:

- 10% for the development tests, considering the remaining 90% are executed at the internal laboratory of the manufacturer;
- 75% for the type tests supposing 25% are related to the tests executed at the manufacturer's laboratory.

In the event all the new equipment was derived from others pre-existing the reference testing market would be as shown in Table D2-3-4.

Table D2-3-4: Reference testing market in the case of all the performed tests are related to the re-engineering of already existing products (Million USD/year)

Type of equipment	Distribution networks	Transmission Networks	Other Sectors
Total yearly investments	442.2	246.8	111.0
Development test	1.15	0.64	0.29
Type test	2.49	1.39	0.62
Total	3.64	2.03	0.81

In a similar way, Table D2-3-5 lists the value of the reference testing market when all the new equipment is totally unrelated to the pre-existing ones.

Table D2-3-5: Reference testing market in the case of all the performed tests are related to completely new product (Million USD/year)

Type of equipment	Distribution networks	Transmission Networks	Other Sectors
Total yearly investments	442.2	246.8	111.0
Development test	3.32	1.85	0.83
Type test	12.3	6.85	3.08
Total	15.62	8.70	3.91

The reference testing market resulting from the above tables lies:

- between 6.48 and 28.23 Million USD/year considering the total investments of 800 Million USD/year
- between 3.64 and 15.62 Million USD/year considering the investments of 442 Million USD/year related to the electrical equipment used in the Distribution network.

Really, we know that currently not less than 80% of the equipment used in the Transmission Network are supplied by foreign manufacturers⁵.

Moreover, from the filled questionnaires by the local manufacturers⁶ only few new products are planned in the next 10 years. This leads to consider in fact negligible in first approximation the market share attributed to the new equipment for Transmission Network.

⁵ See Chapter 3 of the D2-1: Conceptual Configuration of the Testing Laboratory.

⁶ See D2-2: Existing Testing Laboratories and Certification & Inspection Bodies.

This confirms the validity of the proposal⁷ to build in a first phase a Medium Voltage Testing Laboratory able to carry out tests on all the equipment used in MV/LV Stations as well as the Medium Voltage equipment used in HV/MV Stations.

The reference market related to the investments planned for Distribution network and for Other Sectors ranges between 4.45 and 19.53 Million USD /year if all investments were related to new products developed by local manufacturers.

In actual fact on the total planned investments on Distribution network and Other Sectors:

- a share of them will surely concern products already on the market,
- another share will concern the equipment supplied from foreign manufacturers,
- part of the type tests related to new equipment may be performed at foreign testing laboratories.

In the absence of structured data supporting the evaluation of which part of the planned investments will lead to testing services provided by the national laboratory, credible assumptions have to be made.

Considering a potential market of 12 Million USD/year (average value between 4.45 and 19.53) for testing services related to the investments planned for Distribution network and for Other Sectors and assuming that at the 5th year of operation of the laboratory the share of investments related to new equipment produced by local manufacturers is equal to 10% or 20% or 30% of total investments, the reference market of Testing Laboratory would amount to 1.2, 2.4 and 3.6 Million USD, respectively. A probable 5-year trend of the reference market for the test laboratory is shown in Fig. D2-3-2.

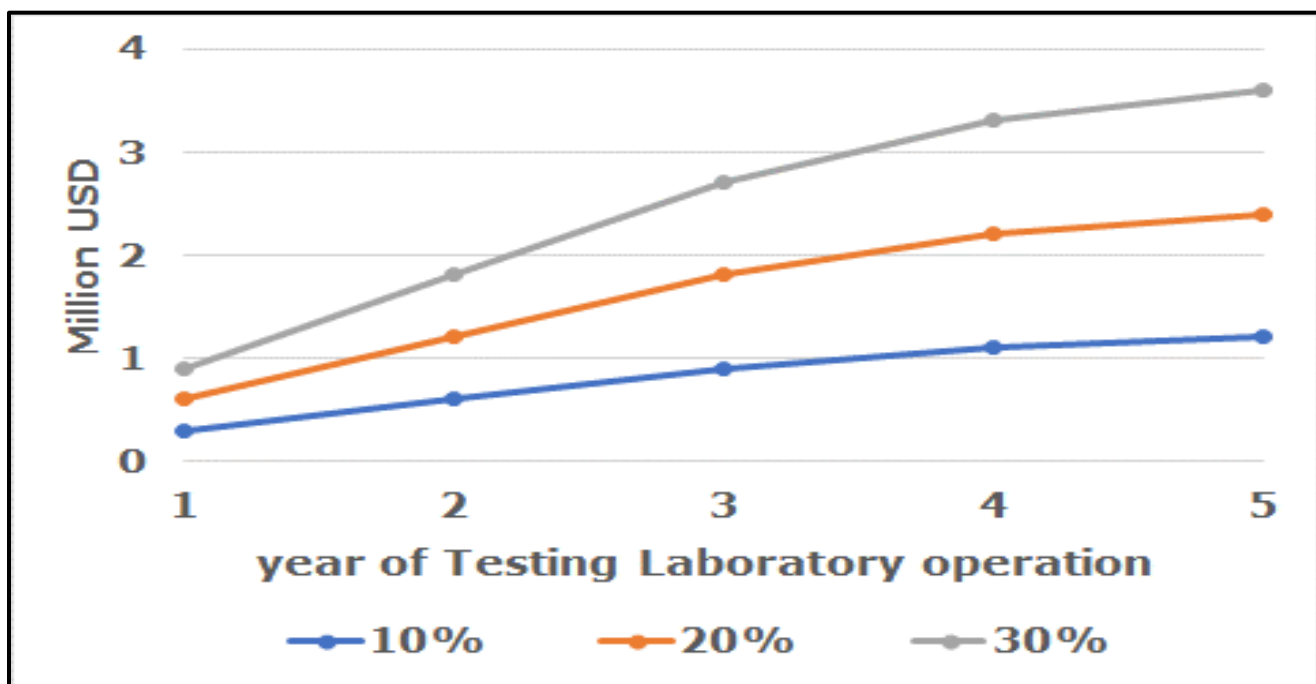


Figure D2-3-2: Reference market trends for the Testing Laboratory

⁷ See Chapter 4 of the D2-1: Conceptual Configuration of the Testing Laboratory



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The share of this reference market that the Testing Laboratory will be able to acquire depends on several aspects:

- the political support from the Government to the development of the Testing Laboratory,
- the decision of the Buyers (not only Electrical Utilities) to always include the type tests in the purchase specifications,
- the number of samples sold for each qualified prototype, considering that the qualification remains valid for a period of around 5 years, after which, due to changes in the design or materials used or increased performance, a new qualification is needed,
- the amount of equipment purchased on the international market,
- the development of new components, or the re-engineering of the existing ones, by the existing manufacturers and the entry of new players favoured by the considerable internal market.



5 Methodology for the evaluation of direct and indirect benefits related to the establishment of the Testing Laboratory

5.1 The Direct and Indirect benefits

The decision to establish in Bangladesh a first-class Testing Laboratory able to provide-in a first phase tests on Low Voltage and Medium Voltage Equipment and in perspectives also on High Voltage equipment- is conditioned by economic evaluation but above all by political considerations on the advantages for the country.

The **new Laboratory must become the National reference testing center** and, in perspective, maybe also for neighboring countries (Western India, Bhutan, Nepal and all ASEAN region). This strategic decision is based on the following expected benefits:

- *direct benefits*
 - developing the business of the testing and all the related services: certification and inspections and on Field tests, having as first reference market of Bangladesh and in perspectives the neighboring countries,
 - developing the business of the Engineering (such as fault analysis, equipment design review, specification of special equipment, maintenance plan review) taking advantages from the knowledge and references deriving from the testing activities;
- *indirect benefits*
 - supporting the National Electromechanical Manufacturer Industry in the enhancing of the equipment performances and then improving their competitiveness in the market of Bangladesh and in perspective in the international one.
 - supporting the National Electrical Power System in its availability and power quality increasing due to higher quality components and systems
 - strengthening the capacities of the national electricity system, thus reducing dependence on foreign countries.
 - in perspective, creating a center of technical intelligence, capable of monitoring the evolution of the standards, technologies, and applications of interest in the country.

The evaluation of the Direct Benefits allows to **evaluate the Profit and Loss Account of the Project**, and the return on the Investments.

The Evaluation of Indirect Benefits makes it possible **to valorize these aspects from an economic point of view, justifying the financial intervention of the Government** and possibly of other Stakeholders to cover the required capital expenditures.



While the evaluation of the Direct Benefits is a **standard and well-known process** based on information on the identified the market, the type of tests, the tariffs (taking into account the commercial conditions of the competitors), it is much more complex the evaluation of the Indirect Benefits.

5.2 The Indirect Benefits

The Indirect Benefits are identified as:

- a) **Supporting the National Manufacturer Industry in strengthening their production:** this point can be evaluated as a small percentage of the development costs of a new product;
- b) **Reinforcing the National Electrical Power System in its availability and power quality:** the enhancement of these aspects is a small percentage of the costs of the lack of power supply (in case of Black - Out and service interruption) and **poor Power Quality**;
- c) **Strengthening the technical capacities** (know-how and know why) **of the national electricity system:** the valorization of this benefit is more difficult than the others above and is normally based on carrying out training courses and Capacity Building initiatives;
- d) **Creating a center of technical intelligence:** Analogous difficulty of the previous point and solvable in the same way.

the evaluation of these benefits has a significant impact on the project.

The complexity of the evaluation of these benefits derives not so much from the methods of valorizing (a sufficiently known process), **but above all from the involvement by the Government and the Stakeholders.**

Based on the Consultant's experience the Indirect Benefit can have great weight in one country but may be irrelevant in another one, following, for example, the institutions' lack of interest in this aspect.

The needed information on the above listed a) and b) points (the most important ones) are in the hands of the Stakeholders (Manufacturers and Electricity Companies). The Consultant may evaluate the economics related to the achievable improving starting from inputs from the Stakeholders.



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**Consultancy Services for Setting Up Electrical Testing
Laboratory**
(Contract Package: S-10)



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Document	4 – Institutional Organization of National Authority
Revision	1
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1. Foreword

The second main objectives of the Project concerns "the design of an independent authority for testing and certification of High-Voltage, Medium-Voltage and Low-Voltage electrical equipment".

The Consultant identified for this authority, named Bangladesh's National Independent Authority, four micro-services, namely testing, certification, inspection and engineering services.

These macro-services have been described in the Inception Report¹ with the identification for each of them of the related reference market.

This document is aimed to define the conceptual organization of the National Independent Authority able to improve the quality of electromechanical equipment and more generally to support the development of the whole national electrical sector including utilities and manufacturers.

This rev.1 of the document complements the results of the Interim Meeting and the comments subsequently made by the Stakeholders.

¹ See D1-Inception Report



2. The National Independent Authority mission

The mission of the National Independent Authority is intrinsically related to how it is intended to manage at government level **the conformity assessment**² on the electrical equipment.

Two major options are available:

- a) Conformity assessment based on a single central authority (NIA), backed by the government and the corresponding legislation, requiring NIA approval for all products intended to be installed in the national power system or imported in the country;
- b) Conformity assessment based on the international framework, including test laboratories, certification inspection bodies, mostly of private ownership, fairly competing in the market and duly accredited in conformity to international competence standards (ISO-IEC).

The Consultant's view is that option a) is not recommended for a fast-growing economy like Bangladesh because the volume and territorial distribution of the demand of conformity assessment activities would always exceed the capacity of a single national operator. It is unavoidable that distributed testing capabilities shall spontaneously grow as private businesses to respond to the market demand, and it is convenient that all useful capabilities are encouraged and exploited for the benefit of the national economy.

In this context, the mission of a National Independent Authority would be to provide the government, the power system (utilities, power generation plants) and the manufacturers of the electromechanical sector with:

- a presidium of general competence in the testing techniques, linked to the international framework of standardization and conformity assessment bodies;
- a concentration of public resources ensuring strong testing facilities exceeding the capabilities of individual national testing laboratories;
- an impartial assessment body, enjoying the confidence of both the government and the market, that could take care of the necessary surveillance and scrutiny of the national testing activities, in any case of conflict.

² Conformity assessment refers to any activity that determines whether a product, system, service fulfil the requirements and characteristics described in a standard or specification



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3 The institutional requirements of the Bangladesh's National Independent Authority

The compliance with the NIA purpose requires the fulfilment of several objectives:

- **Conformity with the international practice for conformity assessment bodies**

The international practice requires:

- Competence in testing and inspection, with reference to testing facilities, testing and calibration procedures and impartiality in the presentation of testing and inspection results
- Third party organization for the certification body, that is independence from the parties involved. That may be obtained by a joint participation in the management of the certification body by government, manufacturers, users, scientific community.

- **Credibility with respect to national stakeholders and international market**

The market acceptance of a conformity assessment body is usually based on the recognition of the conformity with the international practice that may be obtained after assessment by national or international accreditation bodies according to the relevant ISO IEC standards.

In addition, the acceptance by the international market of the NIA products (Test or inspection reports, Certificates of conformity) could be enhanced by the participation in MRAs (Mutual Recognition Agreements) among peer organization in the world market. Such agreements or networks exist for Testing laboratories, certification bodies, inspection bodies and are accessible by NIA, based on previous accreditation and expectations of fair competition.

- **Consistency with the national electrical utilities' strategy**

The links between NIA and the national electrical utilities should be as tight and friendly as possible. The national electrical utilities will be the main client of the NIA services and it is vital for NIA that its activity is transparent, required and appreciated by the them.

In addition, NIA will require a special power supply from the Power Grid Company of Bangladesh, with specific reference to the supply of the Short-circuit testing facility of the Testing Laboratory, that must be taken into consideration by the TSO long term planning. Failure to do so might lead to impairing the NIA testing capabilities.

- **Operations financial sustainability**

NIA shall be financially sound, in the sense that their operation, including all the business legs in the portfolio, shall be economically self-sustained, even if the return of the initial investments concerning the Testing Laboratory may not be ensured. The capability of producing profits is not necessarily expected from Independent Authorities. Recourse to additional grants from the



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shareholders should be limited to the significant new investments that may be approved by the Administration Board in the following years.

- **Competitiveness with respect to equivalent regional (international) organizations**

The economics of the Independent Authority (prices of the services and operating costs) shall be consistent with the regional market competition in the field of testing, inspection and certification. As far as the regional manufacturers are free to choose the provider of the testing and certification services, they are expected to make their choice on the basis of the value for money.

As regards the ownership of NIA, there are several solutions, such as a **Public Organization** depending, for example, on the **Ministry of Energy** and/or **Ministry of Industry** or a **Private Company** managed by the State and shared with other organizations.

The Consultant suggests considering also the solution based on the establishment of a **private business company, most likely a shareholder's company**, with participation of the major stakeholders (government agencies, electric utilities manufacturers). This would ensure NIA to enjoy the maximum flexibility of operation and to set up confidence among the economic operators.

It is expected that the governance of NIA shall be mainly in the hands of the national electrical utilities.



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4 The Bangladesh's National Independent Authority independence

NIA has to appear on the market as independent **to be successful**. This means that in all its activities NIA must be able to demonstrate that **all their evaluations are based on objective criteria and fairness rather than bias or preference to the benefit one entity over another for improper reasons**. NIA staff must be free from any undue commercial, financial and other pressures which might influence their technical judgement. **Moreover, NIA should not engage in any activities** (such as manufacture, construction, assembly, repair, reconstruction) because **that may endanger the trust in its confidentiality, independence and integrity of judgement**.

The need to "appear on the market as independent" has an impact on the following key items concerning the Independent Authority:

- **the organization:** the testing and the certification activities have to be managed by an organizational model ensuring their independent role; internal regulations and procedures shall ensure objectivity of the test and certification results and ban any form of conflict of interest with other NIA activities. Also, confidentiality of the test results between NIA and the clients shall be ensured,
- **the accreditation:** although not explicitly related to the independence, accreditation contributes significantly to a perception of specific skills of staff (recognized expert in their field of operation) and valuable technical structures and organization as necessary prerequisites for a truly independent role.

From the above it results that **Testing and Certification have to be accredited**, with two different accreditations being different their functions and the business model.

These accreditations must be carried out with the Bangladesh Accreditation Board (BAB); being BAB member of the **Asia Pacific Accreditation Cooperation (APAC)** and of the **International Laboratory Accreditation Cooperation (ILAC)** the accreditation will be internationally recognized.

There is also the possibility of accrediting the inspection activity, but this need almost never arises as it is not essential for carrying out the inspection business.

Concerning the engineering services, the fourth business leg, there is **no need for accreditation**, as the main driver of success is the credibility of the involved experts and the availability of adequate modelling tools.

The following Table D2-4-1 summarizes the need of accreditation and an independent organizational model for the four NIA business legs.



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Table D2-4-1: Accreditation and organizational model of NIA four business legs

Business Legs	Need of accreditation	Independent organizational model
Testing	Yes	Mandatory
Certification	Yes	Mandatory
Inspection	Rarely	Not required
Engineering services	No	Not required



5. The conceptual structure of the National Independent Authority

There are at least two different organizational models of entities performing testing, certification and inspection services:

- **Centralized models** such as those of **CESI-Kema**³ (Italy-Netherland), **CPRI** (India) and **Keri** (South Korea), in which the existing business legs are managed by a single parent company, beyond an internal organization in Business Units in order to ensure to each of them its specific functions, as for example for the Certification which must be guaranteed a role of third party with respect to the activity of Testing;
- **Distributed models** involving different actors and different characteristics and properties. This is the case of **PEHLA** (Germany-Switzerland), **ESEF ASEFA** (France), **STLNA** (North America: USA, Canada and Mexico), **SATS** (Scandinavian countries: Norway and Sweden). This solution provides for a central organization supervising distributed test facilities operating in the framework of **harmonized procedures** and regularly **assessing the conformity** of measurement and testing practices, expertise of test engineers, transparency of behaviour.

With a fully functioning Testing Laboratory, the centralised solution is probably the most suitable for NIA.

However, it should be considered that the distributed solution has the advantage of not replicating investments, in particular as there are structures already accredited and with already established roles in the market and with which it is possible to define collaboration agreements.

Moreover, in the initial phase during which the Testing Laboratory is under construction, a different solution can be considered. Some tests could be carried out at an existing national enhanced laboratory (for example, a manufacturer's laboratory) in the presence of a NIA Inspector. In this approach NIA would immediately affirm its coordinating role through the two activities of inspection and certification and it would begin to reap some of the expected benefits related to the establishment of the Independent Authority.

The Consultant will consider the possible solutions that are really viable with the aim of identifying, in close collaboration with Power Cell and the Stakeholders the most effective one.

³ As known, Kema Testing Laboratory has been acquired by CESI Group, whereby CESI and Kema form a unique organization for testing services.



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**Consultancy Services for Setting Up Electrical Testing
Laboratory**

(Contract Package: S-10)



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1. Summary

This document describes the organization adopted by the Consultant to perform the project "**Consulting Services for Setting Up Electrical Testing Laboratory**" and the team of Experts engaged to carried out the contractual tasks in order to achieve all the required project deliverables. The project management, assessed risks included, is considered.

The second part of the document is addressed to the **Conceptual Configuration of a Testing Laboratory** being the assessment of the potential for the establishment a testing laboratory one of the main objectives of the project. On the basis of the main issues concerning a new National Independent Laboratory an overview of four High-Power laboratories having gradually increasing testing capability is presented, considering the executable tests on Low, Medium and High Voltage equipment. The required capital expenditure and the achievable revenues for each considered laboratory are shown.

In the third part of the document a comprehensive proposal on the **Independent Authority for testing and certificating of electrical equipment in Bangladesh** is considered in terms of macro-services to be provided and related conceptual organization.

This rev. 01 of the documents takes into consideration the comments received by the Stakeholders on the rev. 00 of the report issued in May 2023.

All relevant remarks raised by Stakeholders are therefore included in this report, while **Addendum 1** collects all the received comments.



2. Foreword

The objectives and targets of Bangladesh power and energy sector will put on a sustained path for a high-income economy through a strong expansion of power generation, Transmission network reinforcement, modernization of the Distribution networks and strengthening of rural electrification. This huge growth in the sector requires the electric utilities to supply and install a considerable number of lines, power stations, distribution and power transformers, circuit breakers, switches and instrument (voltage and current) transformers.

This favourable prospect is calling International players with the effects to strengthen and/or develop local production facilities as well as the interest of domestic manufacturers in building plants able to supply this equipment.

Despite this promising framework, Bangladesh does not have any accredited electrical testing laboratory able to perform third party testing and certification. So, utilities and local manufacturers need to resort to foreign testing laboratories for the purpose of certification of new products resulting in high costs of foreign currency.

For these reasons, Power Cell-Power Division under “TA for Strengthening and Development of Sustainable Power Sector in Bangladesh” Project, funded by The World Bank, has appointed the Consultant for conducting the **"Consulting Services for Setting Up Electrical Testing Laboratory"**.

In addition to the design of a **world class testing laboratory**, the assignment provides for a second main objective: the design of a **National Independent Authority** for testing and certificating of the equipment to be used in T&D networks.

This National Authority jointly with the testing laboratory should be able:

- to significantly reduce (to the extent of avoiding) the export of foreign currency relating to test activities carried out in foreign laboratories, through the availability of a well-qualified laboratory in Bangladesh,
- to strengthen the local electromechanical industry expected to produce new enhanced equipment with improved performances resulting in a reduction of equipment purchase from abroad,
- to improve power quality and reliability of the national power system in connection with the installation of qualified equipment.



3. Project organization and Consultant team

3.1 Project main topics

The Consultant is requested to provide:

- **a conceptual configuration of the testing laboratory** consisting in a well-defined list of equipment (voltage, current, short-circuit current ratings) to be tested in the laboratory, on the basis of:
 - Investments planned by the Ministry of Power & Energy, Power Grid Company, Power Distribution and Electric Supply companies, Rural Power Company and the electricity-intensive companies (trends over the years, type of equipment, adopted quality control methods);
 - Product portfolio of the main electromechanical manufacturers operating in the country (including the international ones);
 - Existing testing laboratories, including those owned by manufacturers;
 - Certification and Inspection Bodies existing in the country;
 - Accreditation Bodies and Standard bodies in the country.

Based on the above information, collected through questionnaires, the configuration of the testing laboratory will be closely related to:

- needs of the domestic power system in the light of its expected evolution,
- the current and expected growth of the domestic electromechanical sector,
- the already existing national testing facilities;
- **the conceptual organization of the National Independent Authority** considering its macro-services:
 - Testing (through the testing laboratory),
 - Certification,
 - Inspection,
 - Engineering services,

two of which can be delivered even in the absence of a testing capacity (since the laboratory is under construction or in the absence of a specific testing facility);

- **a feasibility study of the testing laboratory** mainly addressed to define the required area, the preliminary layout and single line diagram, the power supply (from a power line coming from a nearby station or/and a Short-circuit generator);
- **proposals for testing laboratory and National Independent Authority organization** ensuring efficient and effective ways in performing the assigned tasks;
- **the electrical and civil conceptual design** of the Testing Laboratory aimed to:
 - specify the testing facilities (sizes, power supply, main testing equipment),



- specify the layout (including also offices, workshops, storage, meeting rooms), auxiliary services (water, low voltage supply, fire-fighting system, IT communication system) and buildings,
- capital expenditure evaluation;
- an action plan and relevant procedures for **national and international accreditation** of the macro-services provided by the National Independent Authority;
- a **capacity building** addressed to the manpower of the National Independent Authority:
 - identification of the required expertise and skills (also for recruitment purposes by drawing of technical staff of public utilities),
 - identification of training needs,
 - setting priority for action,
 - definition of a continuous training plan;
- a **review of the existing policy and regulations** in order to propose integration in the existing laws for enabling the Laboratory and the National Independent Authority to fully perform its intended functions.

3.2 Project organization

The Consultant organised the Project into an Organisational Task (Task0) lasting for the whole duration of the Project and 9 Operational Tasks, all listed in the Table D1-1.

Table D1-1 - Project Organization in Tasks

Task	Title
Task 0	Project Management and Technical Supervision
Task 1	Conceptual Configuration of the Testing Laboratory
Task 2	State of the art of local laboratories and Certification&Inspection bodies
Task 3	Testing Market assessment & Direct and Indirect benefits evaluation
Task 4	Design of a Institutional Organisation of Independent Authority
Task 5	Testing Laboratory Feasibility Study
Task 6	Testing Laboratory Organisation
Task 7	Electric, civil, architectural engineering of the Testing Laboratory
Task 8	Cost Assessment and Business Plan of the Testing Laboratory
Task 9	Capacity Building

The main outputs of each Task are below reported jointly with the 6 Deliverables of the project. The following Fig. D1-1 shows the time scheduling of the 10 Tasks and related Deliverables (Reports) and Meetings along the 6 months of the project started on May 16, 2023.



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Table D1-2 - Main Outputs for each Task and project Deliverables

Deliverables	Tasks and relevant subtasks	Main outputs
D1: Inception Report	• Task0 ○ Project Short Presentation ○ Project organization and Consultant Team ○ Quality Plan and Risk Management Plan	• Organizational, technical, and administrative coordination of all the Tasks and supervision of the output of the other Tasks, • Coordination of the activities within the Joint Venture, • How to manage the relation with the Client and main Stakeholders, • Project Quality and Management Plan, • Risk Management Plan.
	• Task1 ○ Conceptual Configuration of the Testing Laboratory ○ Four Business Legs of Bangladesh's NIA	• Equipment to be tested in compliance with Standards of the Testing Laboratory according to its development through subsequent stages, • The main macro services provided by Bangladesh's NIA.
D2: Interim Report	• Task2 ○ State of the art of local laboratories and certification & inspection bodies.	A summary of the information gathered on: • facilities, organization, business model of the Laboratories of local Manufacturers, utilities and System Integrators in Bangladesh, • Certification and Accreditation Bodies in the country.
	• Task3 ○ Evaluation of Bangladesh and Regional Demand of testing services, also considering the expected evolution ○ Evaluation of the direct benefits (revenues) and assessment of the achievable testing services market share ○ Evaluation of the indirect benefits	• Direct benefits that can be acquired by the Bangladesh's NIA considering all the provided services to local manufacturers and to Power Generation, Transmission and Distribution sectors, • Future revenues related to testing services provided to manufacturers of the neighboring geographical areas: East India, ASEAN countries, Western China, • Benefits for the Bangladesh power system related to Bangladesh's NIA.
	• Task4 ○ Design of an Institutional Organisation of Independent Authority	The following issues will be taken into consideration: • Ownership (public property or participated by private Shareholders), • Relations with the Ministry of Power, Electrical companies and the main Stakeholders, • Governance in connection with the choices on the Ownership, • Internal Organization, through the establishment of departments with different functions, • How to organize the testing activities as an independent and third-party Laboratory.



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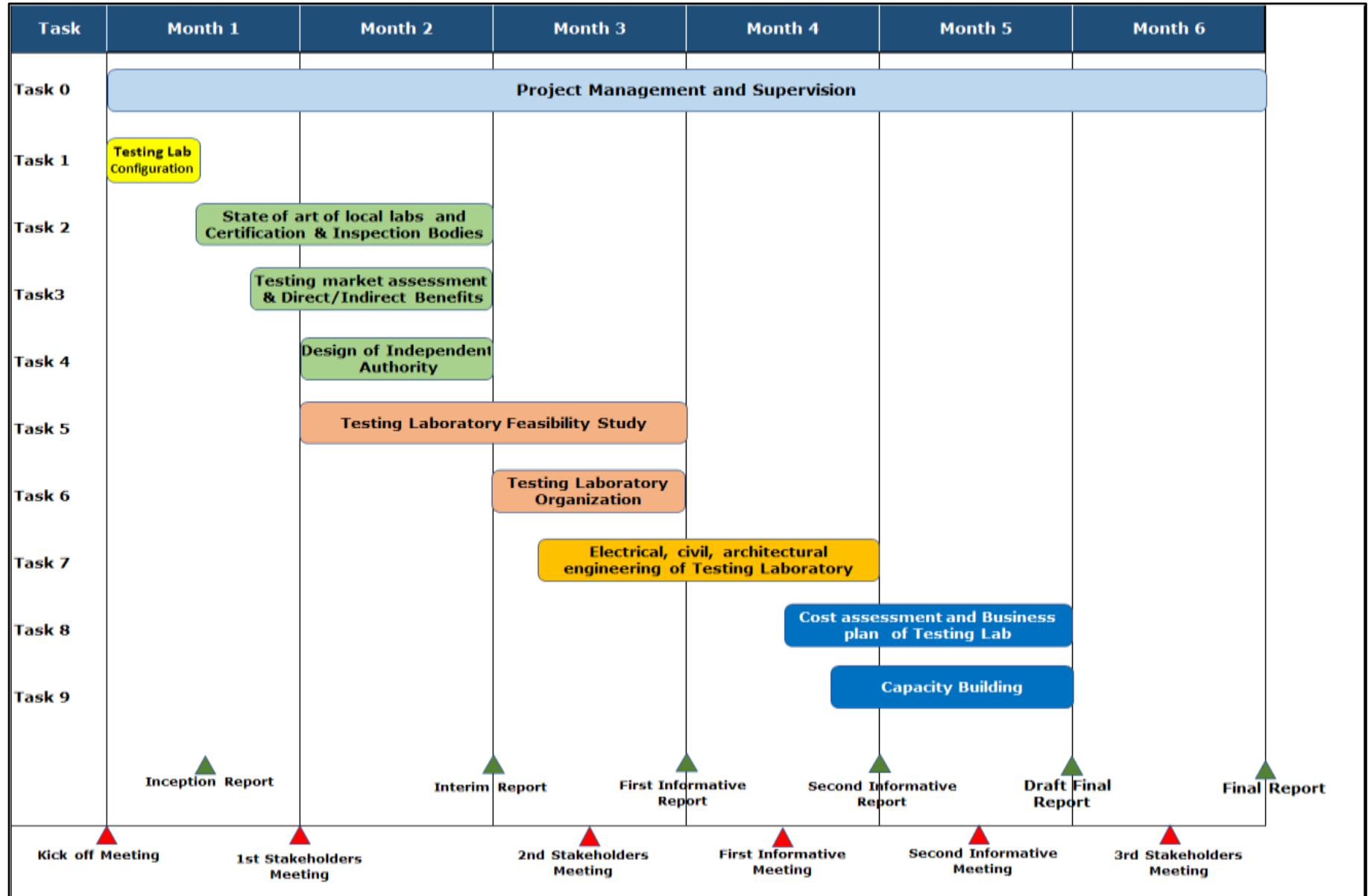


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Table D1-2 - Main Outputs for each Task and project Deliverables (continue)

Deliverables	Tasks and relevant subtasks	Main outputs
D3: First Informative Report	• Task5 ○ Feasibility Study of Testing Laboratory	The Study will take into consideration the following main issues of the Testing Laboratory: • organization of the testing facilities and relevant power sources, • ancillary area and main utilities, • preliminary electrical single-line diagram and layout. • criteria for the selection of the site.
	• Task 6 ○ Independent Authority Organisation	The organizational aspects concerning the establishment of the Independent Authority, as regards all 4 Business Legs and all related functions (Commercial, Purchasing, Personnel Management, R&D) will be processed.
D4: Second Informative Report	• Task 7: ○ Conceptual electric, civil and architectural engineering	The Report of this Task includes: • All testing facilities and main testing equipment specification, • layout: general space requirements, area allocation and building • required capital expenditure.
D5: Draft Final Report	• Task8: ○ Cost and benefit evaluation	The evaluation of O&M cost of the Laboratory will consider: • Staff cost on the basis of local salary and wages for the different professional figures • other operating cost (maintenance, laboratory services, transport and treatment of industrial waste, canteen for employees, etc.) Based on the above OPEX and the expected revenues (on the basis of a policy price for the provided services) will be defined the Business Plan (Profit & Loss, ROA) over a period of 15 years.
	• Task9: ○ Capacity Building presentation	The Report of this Task presents: • the assessments of the needs for strengthening skills and the organization) on the basis of the existing gap and the multi-year strengthening plan, • the main challenges to be faced and the Short-Term & Medium-Term Recommendations.
D6: Final Report		The structure and contents of the Draft Final Report will be defined during the development of the project and will take into consideration all the main aspects characterizing the project. The Final Report will incorporate what emerged from the Third Stakeholders meeting.

Figure D1-1 – Project work Plan



3.3 The Consultant's team

The Consultant Team, consisting in 15 Experts, is presented in the following Tab. D1-4: the qualification, the actual and past position and the experience for each Expert are summarized.

The project will be completed over a calendar period of 6 months and requires a Consultant **effort of 42 person-months** (6 months more than those requested by the ToRs), of which:

- 22 person-month performed by International Experts
- 20 person-month performed by Local Experts.

The below table lists the person-months related to each of the 6 Main Deliverables of the project and for each month of the 6 months of project duration.

Table D1-3 – Person-months for each Deliverable of the project

	Months						TOTAL
	1	2	3	4	5	6	
Deliverable 1	4.35						4.35
Deliverable 2	0.88	7.33					8.21
Deliverable 3		1.72	6.56				8.28
Deliverable 4			2.52	6.39			8.91
Deliverable 5				1.29	6.35	1.35	8.99
Deliverable 6						3.26	3.26
Total per month	5.23	9.05	9.08	7.68	6.35	4.61	42.0

The Experts responsible for the results (both in terms of technical content and respect of the time frame) of the 10 tasks of the project are identified in Fig. D1-2. This figure also highlights the relationships between the different tasks.



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Table D1-4- The Consultant Team

Expert			Current Position	Past position	Regional experience
K1	Alfonso Caccia Dominioni	Team Leader	DeMEPA partner and International Project Manager	- Director of the Engineering Division of CESI (Italy) - Director of Certification Department: CESI (Italy) - Director of High-Power Division of CESI (Italy) - Lead Assessor in SINAL (Italian Laboratory Accreditation Body) - Member of Management Committee of STL - Member of Board of Directors of SINCERT-National Italian Accreditation System for Certification and Inspection Bodies	- India - Indonesia - Malaysia - Mexico - China - Taiwan - Turkey - Korea
K2	Virginio Scarioni	Electrical Expert	- General Secretary of ACAE - Senior Advisor of ACCREDIA	- Director of Testing and Certification Department of CESI Group [CESI-Milan (Italy), IPH-Berlin (Germany), FGH-Mannheim Germany] - Director of Testing Laboratory Department of CESI (Italy)	- India - Malaysia - Thailand - China
K3	Md. Quamrul Ahsan	Deputy Team Leader and Electrical Expert	Senior Consultant in electrical sector at ECBL	- Chief Engineer at Power Grid Company (Bangladesh) - Superintending Engineer at Power Grid Company (Bangladesh) - Member of The Institute of Engineers, Bangladesh	Bangladesh
K4	Md. Quamrul Hassan	Civil Expert	- Senior Consultant - Chief Business Developer	- Project Director of Power Grid Company - Deputy Manager of Power Grid Company - Member of The Institute of Engineers, Bangladesh	Bangladesh
K5	Md. Abdus Salam	Mechanical Expert	Senior Consultant at ECBL	- Technical Director of Rural Power Company - Chief Engineer of Electricity Company	Bangladesh
K6	Md. Munier Alam	Financial Analyst	Financial and Economic Analyst at ECBL	- Director of Finance in several projects - Manager Finance & Account - Member of Chartered Accountants of Bangladesh	- Bangladesh - India - Pakistan
K7	Md. Mahbubur Rahman	Environmental Specialist	Environmental Specialist at ECBL	- Environmental Engineer at Asian Development Bank - Environmental and Geomantic Specialist	Bangladesh



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Table D1-4- The Consultant Team (continue)

Expert			Current Position	Past position	Regional experience
K8	Gabriele Villafranca Soissons	HR Management Expert	DeMEPA Friend expert in HR sector	- Director of Human Resources & Organization Office at ARERA (Italy) - Head of Organization, Safety and General Services, directly reporting to Human Resource Director of CESI (Italy)	- Korea - China
K9	Carlo Masetti	Institutional and Capacity Building Specialist	DeMEPA senior Advisor for Capacity Building projects	- Director of Institutional and International Affairs of CEI (Italy) - Technical Director of CEI - Technical Director of the Certification Department of CESI (Italy) - Vice-President of CENELEC. - Italian Member of the Standardization Management Board of IEC	- India, - Malaysia - China - Taiwan - Korea
K10	A.K.M. Rabiul Hassan	Legal Expert	Legal Advisor at ECBL	- Legal Advisor/Legal Retainer/Panel Lawyer of Dhaka Power Distribution Company Limited and in several project - The Honorable Society of the Lincoln's Inn, London, United Kingdom - Advocate, High Court Division, Supreme Court of Bangladesh	Bangladesh
NK1	Ettore Figini	Chairman of the Advisory Committee	DeMEPA partner and Vice President	- Business Development Manager for the testing and certification activities of the CESI Group (CESI - Italy, IPH, Germany and FGH Germany) - Technical and Organizational Manager of the Testing Laboratories: CESI (Italy) - Chairman of the Technical Committee of Suzhou High Power Test and Technical Forum for five years - Chairman of the Technical Committee of STL (Testing Liaison) for eight years.	- Malaysia - China - Taiwan - Korea - Japan



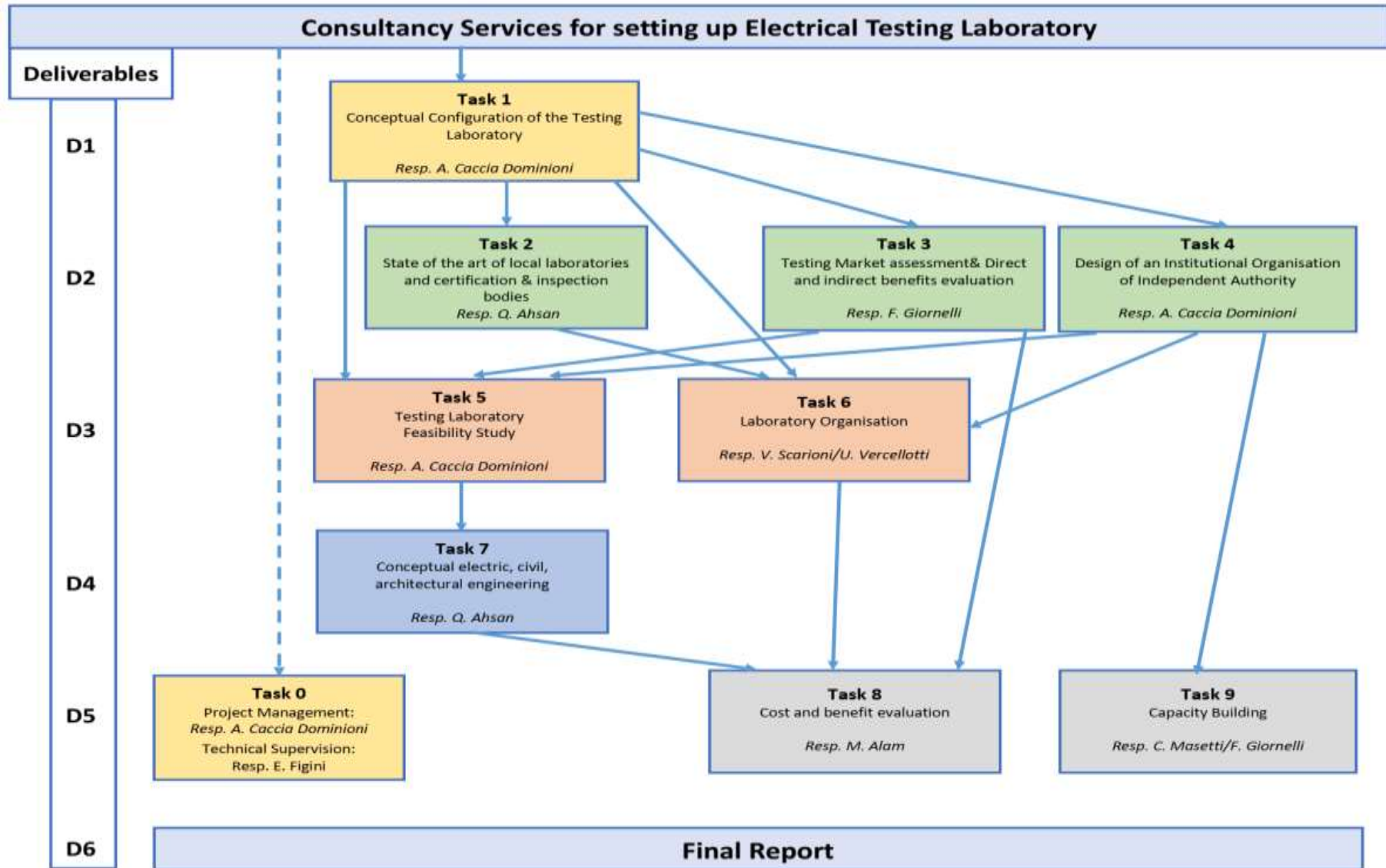
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Table D1-4- The Consultant Team (continue)

Expert			Current Position	Past position	Regional experience
NK2	Pasquale Motta	Investment Advisor	DeMEPA partner and Managing Director	- Business Development Director of CESI (Italy) - Director of the Generation Department of CESI (Italy) - Deputy Director of Planning Department of Enel R&D - Director of Industrial Diagnostics of CISE (Italy)	- India - China - Taiwan - Korea
NK3	Piero Andreuccetti	Purchase, Property and Asset Management	- DeMEPA Friend Expert - Assistant to University of Pisa	- Property and Asset Manager of CESI Group (Italy, Germany, The Nederland, China, USA) - Area Manager of South East Asia in CESI (Italy) - Responsible of Relation with EU and World Bank for ENEL International (Brussels, Belgium)	- India - Malaysia - Thailand
NK4	Ferruccio Giornelli	Commercial and Capacity Building Advisor	- DeMEPA Partner and Business Developer - Ianus Senior Advisor	- Business Development Director of MRC (Spain) - Sales and Marketing Director of CESI Group (CESI Italy, IPH Germany and FGH Germany) - Senior Expert on Modernisation of Distribution network - Senior Expert on Reinforcement of Transmission network	- India - Bangladesh - China - Taiwan - Korea - Japan
NK5	Uberto Vercellotti	Electrical Expert, Inspection and on Field testing	- DeMEPA consultant - CESI consultant	- Market and Product Development Manager of CESI Group (Italy, Germany, The Nederland, USA) - Area Manager for Testing Service of CESI Group (Italy, Germany, The Nederland, USA) - Expert Engineer on LV and MV testing Lab (CESI) - Chairman CEI CT 20 SC 20A HV Cables - Member STL (Short-Circuit Testing Liaison) TG 3 - High Voltage Cables - Italian Expert Cenelec TC14, Transformers	- ASEAN Countries - China - Korea

Figure D1-2 - Tasks Flow Chart





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3.4 Project management

The project will be coordinated by **Mr. Alfonso Caccia Dominioni** (DeMEPA), the Consultant Team Leader, who will enjoy of the support of:

- **Mr. Quamrul Ahsan** (ECBL) as Deputy Team Leader,
- **Mr. Ettore Figini** as Chairman of the Consultant Advisory Committee.

The administrative and accounting activity that will be managed by **Mr. P. Motta**.

The Project Management will ensure the proper organization of the following issues:

- Communication with the Client and Stakeholders,
- Project work distribution and management of the Consultant staff,
- Project configuration control and change control,
- Project documents issuing, filing and distribution,
- Document change control,
- Document approval from the Client.

The Project Manager, responsible for the Project Management function, will continuously monitor the progress of the project in order to take under control:

- the progress of the project work,
- the use of resources
- the quality of output.

In particular the Project Manager will verify that the exchanges between the various Tasks take place within the appropriate time frame and with the necessary quality.

To this purpose the Consultant will make use of the Critical Path Method “CPM”, a tool widely used in Consulting and Engineering projects for an effective planning of the activities. The Team Leader, in strong collaboration with the Deputy Team Leader, will follow all the key phases of the Project with particular attention to the evaluation of the CPM.

The Project Manager will produce dedicated Report, to be presented at each meeting in Dhaka, describing any critical issues and the solutions to be adopted.

Particular attention will be paid to controlling the Risks (see below Chapter 5) that may lead to the objectives of the project not being met in quality and or timely terms.



3.5 Risks assessment and Management

The Consultant experience suggests that it is necessary to implement **a risk management strategy**, up to the level of activity planning, periodically and carefully monitoring the development of the project, trying **to anticipate problems as much as possible** and by proposing alternative solutions capable of solving or mitigating them.

The potential risks - if not recognized and well managed - can negatively affect the progress of the project, the respect of the schedule of the activity and the preparation of reports.

At each stage of the project development, the following questions have to be considered:

- ✓ What are the potential problems?
- ✓ To what extent these problems can arise?
- ✓ What will be their impact?
- ✓ How to manage risk when it occurs.

Potential risks that may compromise the results of the Project are below considered together with the proposed technical or organizational solution.

a) Collaboration with the Client

In addition to the planned contractual meetings in Dhaka, the Client and the Consultant will meet remotely whenever necessary.

In addition, the local partner ECBL has a well-established relationship with Power Cell and therefore he is in condition to receive or transfer in an easy and timeliness way any need for intervention requested by the Client or addressed to the Client.

b) Collaboration between the partners of the Joint Venture

To solve this potential criticality, the Consultant has established since the submission of the technical and financial proposal a clear subdivision of the activities to be carried out (and related outputs) by the two partners. This framework has been reviewed following the Negotiating Meeting of the project and will be updated and adjusted after each contractual meeting with the Client in Dhaka.

c) Complexity of the project

The complexity of the project derives from the following considerations.

- **Tight deadlines for project completion.** The time of 6 months is really tight, but the Consultant is able to solve this criticality successfully thanks to the fact that he knows well the testing market of Region (including Bangladesh and the neighboring countries) and has tools allowing an easy configuration of the Testing Laboratory of interest for Bangladesh. As regards potential delay in performing the 9 Operating Tasks of the project, the Consultant intends to operate on two levels, trying to anticipate the problem as far as possible and making additional back stopping resources available to the Customer.

- **Involvement of 15 experts during 6 months with a total engagement of 42 persons months.** Figure D1-3 shows the Consultant commitment for each month of the project duration. The envisaged distribution of the resources seems reasonable and in line with projects of equal complexity. In fact, since the first months (in particular the second and third months) a strong involvement of personnel has been assumed, which subsequently decreases. This setting makes it possible to make up for any delay in the following months.



Figure D1-3 – Expert engagement along project development

- **Delay in receiving information from Client.** This is a very delicate point and the Consultant expects a strong involvement from Power Cell in providing the necessary information. In the event of delays the Consultant will propose solutions based on his experience, subsequently agreed with the Power Cell.
- **Technical complexity of the project.** Although the project appears ambitious and complex, the Consultant believes he can mitigate this criticality by knowing similar situations and having already engineered semi-finished products that can be assembled together to design the Laboratory configuration according to the customer's needs.
- **Capacity Building activities.** The Consultant recognizes this essential point for the success of the project. For this reason, from the beginning, it will conduct a preliminary skills diagnostic activity to understand the existing situation and define any gap with the required skills. Based on this analysis, a proposal for Capacity Building and Continuing Training will be formulated. At the end of the Consulting activity, Power Cell will obtain a multi-year plan of training and recommendations on the short and medium term to follow for the development of the Testing Laboratory.



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4. Conceptual Configuration of a Testing Laboratory

One of the main objectives of the “Consultancy Services for Setting up Electrical Testing Laboratory” project is the assessment of the potential of a **world class testing laboratory in Bangladesh**. This means an **Independent Testing Laboratory** able:

- to perform complete series of tests according to the International Standards (IEC, IEEE) on the main electromechanical components used in T&D infrastructures,
- to conduct research and development tests on new components and equipment deployed by the domestic manufacturers,
- to constitute an open and fruitful environment for know-how development of the scientific & technical point of view and business development (market & technology evolution, Standard evolution).

In the following, after an overview of the main issues related to the establishment of a new Independent Testing Laboratory, four different configurations of a testing laboratory are considered in order to make available to the Client and Stakeholders a complete scenario in terms of test capacity, capital expenditures and achievable turnover on the basis of which the possible options for the development of laboratories should be oriented.

4.1 Basic criteria for the configuration of an Independent Testing Laboratory

4.1.1 Type tests and Routine tests

A national independent testing laboratory has to be mainly addressed to the performance of the **type tests on a new electromechanical equipment** for the purpose of certification prior to the placing on the market. The type tests are performed only **on the prototype of a new product** and they:

- must cover the whole range of Standards test requirements,
- require the completion of many tests, using different techniques, to be carried out in sequence on the same object.

As an example, a high-power test program on switching equipment may include the performance of:

- ✓ Dimensional checks,
- ✓ Resistance measurements,
- ✓ Mechanical operation tests,
- ✓ High power tests and High Voltage tests,
- ✓ Temperature rise tests.

The routine tests, covering a subset of the tests specified by the International Standards, are carried out **on every production sample and are usually performed by the manufacturers at the factory** as a necessary extension of the production process.

The execution of a type test is more expensive than the routine tests to be done on every production sample and a testing laboratory able to perform type tests on several electrical equipment involve large capital expenditure and hard skills, not only by the test operators.

Table D1-5 – Distinctiveness of type and routine tests

Type tests	Routine tests
- Performed only on the prototype of a new product - Many tests are performed in sequence on the same test object - Hard skills and knowledge of different testing techniques are required to the test operators - Higher capital expenditure involved	- Performed on every production sample - Individual tests are performed at the end of the construction process - Usually the test operator performs a single defined test - Lower capital expenditure involved

4.1.2 Testing facilities organization

An electrical testing laboratory may be organized in principle into sections, each of which, with its own testing equipment, control and measurement systems, is dedicated to the execution of a specific tests, such as high-power tests or dielectric test or temperature rise tests.

Whereas the main aim of the **independent national testing laboratory** is the execution of type tests to be carried out in sequence on the same prototype, it appears more functional an organization that allows **only once transit of the test object in the laboratory** thereby reducing the execution time for the planned test program and thus **increasing the laboratory efficiency**. In this approach the different sections of the laboratory are organized on the basis of the size and requested power of the testing equipment able to perform the whole testing program. Usually this leads to sections that are distinguished on the basis of the operating voltage of the equipment to be tested: low, medium and high voltage.

4.1.3 Laboratory's power supply

Another important issue of a testing laboratory is **the way to supply the power required to the testing equipment**, especially for the high-power tests (short circuit tests, making and breaking tests, overloads, etc.) which are certainly the most power demanding.

The laboratory may be supplied by an **external power line coming from a MV or HV station** located nearby the laboratory (usually this laboratory is classified as on-line testing laboratory). This solution implies a certain limitation in the short-circuit power available for the laboratory but significant advantages in terms of less involved investment and operating costs.

The general and daily availability of the short-circuit power from the network is usually agreed between the Transmission System Operator and the Laboratory on the basis of a specific contract between the parties. In any case the short-circuit power is limited or cancelled in the event of system operation trouble (such as system components failures, system overloads).

The solution allowing the maximum testing capability consists in the supply of the tests circuit through a **Short-circuit Generator** with appropriate power.

Leaving aside the difference in short-circuit power, both solutions have the advantages and disadvantages summarized in the below Table D1-6.

Table D1-6 – Advantages and disadvantages related to different power supply of the laboratory



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	Laboratory supplied by the power grid	Laboratory supplied by a Short-circuit Generator
Involved investment	very low	very high
Installation and O&M cost	reduced	very high
Impact on the grid during tests with high demanding power	High	reduced
Power frequency	only at grid frequency (50 or 60 Hz)	both at 50 and 60 Hz
Test management & control	Very simple	Simple, but higher skills are requested
Risk of power source equipment failure & consequences	• Minimum risk level • Short stop in testing activity	• Medium risk level • Long stop in testing activity

4.1.4 The required capital expenditure and the turnover of a testing Laboratory

The required capital expenditure of an electrical testing laboratory is highly dependent on the maximum ratings of tests to be performed.

The turnover of a testing laboratory is related both the acquired share of the achievable testing market and the productivity (number of executed test programs per week or month or year) of the laboratory.

As a matter of fact, the productivity of a new laboratory is likely to grow at a slow pace, due to the learning process of the laboratory staff (from the chief engineers up to the testing operators).

So, a new testing laboratory covering all type tests requirements at their maximum ratings may lead to high investment with an inadequate return due to a low productivity and therefore low revenues.

A growth of the laboratory through successive steps allows instead to improve the overall competences and skills and thus the possibility to extend in effective way, from the technical and financial point of view, the capability of the laboratory.

Nevertheless, the testing laboratory concept should be open to provide for future expansion to higher testing ratings, as long as the testing market shall grant their effective exploitation.

4.1.5 The preparation time of test facilities

Different test facilities are likely to be commissioned at different times, due to the involved capital expenditure and the lead time of the procurement, installation, commissioning and staff training. Starting from the awarding of the supply contracts the delivery time of the testing equipment shall range from about one year (in the case of Dielectric testing) up to five years (in the case of High-power testing) as below shown.

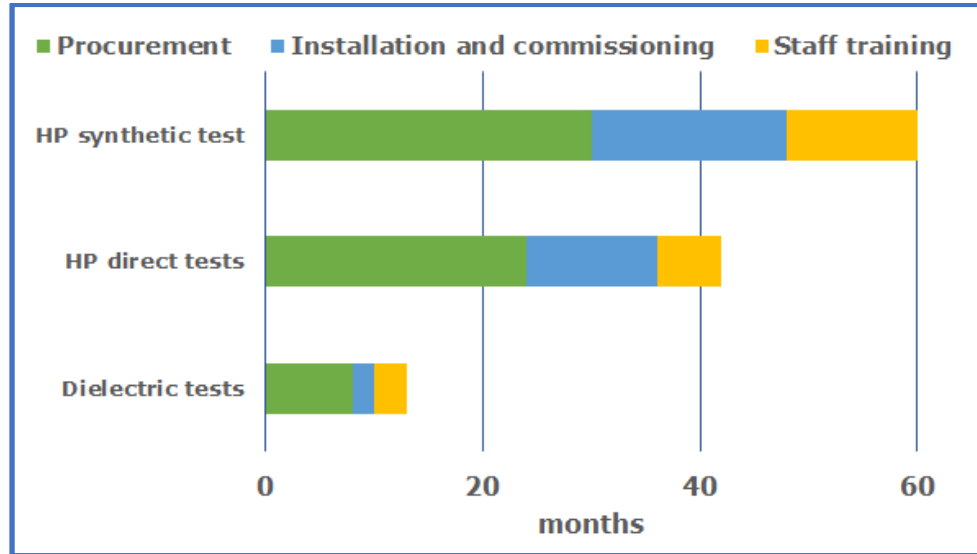


Figure D1-4 – Preparation time of different testing facilities

The spread in the construction delays of the various test facilities and the evolution of the test capabilities **has to be planned according to the market demand and the expected construction time**. Obviously, the construction or revamping of each test facility should be possible without impairing the operation of the neighboring facilities. The laboratory layout (including the testing facilities, the power hall, the control rooms, the assembly/disassembly area, workshop, warehouse, roads and parking area) and the auxiliary services (low voltage supply, compressed air, water) must provide sufficient flexibility for that purpose.

The future test engineers in addition to a proper training on the testing techniques, are to be involved since the start of the construction phase of the laboratory. This allows both a client's supervision during the construction phase and a full awareness of the staff on the detailed characteristics of the Laboratory equipment and systems.

4.2 Four different configuration of a Testing laboratory

In the following **four different High-Power laboratories having gradually increasing testing capability** are taken into consideration, starting from a laboratory able to tests Low Voltage equipment until the one addressed to High Voltage equipment used in transmission infrastructure of the power system.

The information below reported are derived from the data base deployed by the Consultant in connection with the design of more than 20 electrical testing laboratory with different characteristics and sizes.

4.2.1 On-line Low Voltage laboratory

This laboratory is able to test equipment used in the distribution network as well in several industrial sectors, with **rated voltage from 220 V up to 415 V** and **rated current from 25 A up to 4000 A**:

- LV Circuit Breakers
- LV Switches, Disconnectors, Switch-Disconnectors and Fuse combination units,



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- LV Circuit Breakers for industrial uses
- LV contactors and motor-starters (Electromechanical type and AC semiconductor type)
- Residual current operated circuit-breakers for household and similar uses
- LV Fuses,
- LV Bus ducts,
- LV Assembly.

The main executable tests to be performed on the above equipment are below listed:

- ✓ Short circuit breaking capacity
- ✓ Short-time withstand Current
- ✓ Overload performance
- ✓ Temperature rise
- ✓ Dielectric tests
- ✓ Mechanical Operation

The laboratory may be supplied by any external power line coming from a nearby HV/MV station having a short circuit power about 3000 MVA in order to limit at 5% the voltage drop in the network in the case of the most demanding tests. **This laboratory covers an area of about 1000 square meters**, including the MV Power Supply area (housing the MV/LV transformer feeding the test circuits), the testing facility, the services and utilities rooms (compressed air, water) and offices.

4.2.2 On-line Medium Voltage laboratory

The second considered laboratory is addressed to perform tests on:

- LV equipment having **rated voltage up to 726 V and rated current up to 4 kA**,
- MV equipment with **rated voltage from 3.6 kV up to 33 kV and rated current up to 3.15 kA**,
- Distribution transformers **with primary winding from 11 kV up to 16 kV and rated power up to 2 MVA**,
- Power Transformers **with primary winding up to 33 kV and rated power up to 20 MVA**.

This Laboratory has to be supplied by an external HV power line coming from a station having a short-circuit power about 5000 MVA. Assuming the availability for the laboratory of a short-circuit power of 250 MVA, the following Table 2 lists for the different equipment the main tests that can be performed. Even in the event of the most power demanding tests the corresponding voltage drop into the grid supplied by the concerned station can be estimated, in the first approximation, in not more than 5% for a duration not greater than 0,3 s.

Table D1-7 – Equipment and relevant executable tests in an On-line Medium Voltage laboratory

Equipment	Tests
• LV Circuit-Breakers for industrial uses • LV Switches, Disconnectors, Switch-Disconnectors and Fuse combination units • LV contactors and motor-starters	✓ Short circuit breaking capacity ✓ Short-time withstand Current ✓ Overload performance ✓ Dielectric ✓ Temperature rise
• MV Circuit-breakers • MV Metal enclosed Switchgears • MV Switches, Disconnectors and earthing switches • MV Bus ducts	✓ Short-time withstand current and peak current ✓ Temperature rise ✓ Dielectric ✓ Mechanical
Distribution Transformers	✓ Ability to withstand short-circuit ✓ Applied Voltage ✓ Induced Voltage ✓ Measurement of winding resistance ✓ Measurement of short-circuit impedance and load loss
Power Transformers (having short-circuit impedance from 4% up to 8%)	✓ Measurement of voltage ratio and check of phase displacement ✓ Measurement of load and no-load losses and current at 90% and 110% of rated voltage ✓ Temperature-rise test

Short-circuit making and breaking tests on MV equipment are therefore not in the scope of this laboratory.

This MV laboratory has to be organized with different testing facilities, each with its own control room. A HV/MV transformers (feeding the testing facility addressed to MV equipment and power transformers) and a MV/LV (feeding the test circuit for low voltage equipment) are located in the Power Supply area. **The total required laboratory area**, including also the assembly /disassembling hall, workshop and warehouse, utilities and services area, offices, road and parking area **is about 6000 square meters**.

4.2.3 MV laboratory supplied by a 3000 MVA Short-circuit Generator

The considered Short circuit Generator¹ has an output voltage of 21 kV and is able to supply a 3ph testing circuit with a current of 82 kA (74 kA in the case of single-phase test) during 1 s and thus a short-circuit power of about 3000 MVA.

To make available all the required testing voltages and current for the different test objects it is used a MV/MV Short-circuit Transformer fed by the Short-circuit Generator and whose secondary windings are series and/or parallel connected to obtain the required test voltage in the downstream testing circuits. This laboratory is able to perform the test listed in Table D1-9 on **low impedance equipment** (such as Circuit-breakers, Metal and Solid insulated enclosed Switchgears and Controlgears, Switches) **with rated**

¹ While a Generator has to withstand to a small number of short-circuit in its service life, a Short-circuit Generator is designed and built in such a way as to be able to withstand to a very high number of short-circuits during its service life



voltage from 3.5 kV up to 52 kV, MV Bus duct with rated current up to 4000 A and Current&Voltage transformers.

The availability of a 3000 MVA short-circuit power allows to significantly extend the testing capability of the MV laboratory compared to the case of the short-circuit power drawn from the grid. For instance, in case of MV Circuit Breakers it can be performed the short-circuit making and breaking test that is not allowed in the On Line MV laboratory considered at paragraph 6.2.2.

Even for the laboratory powered by a Short-circuit Generator there are operational limits in performing **direct short-circuit tests in which the** rated short-circuit current **is simultaneously applied** to the rated voltage.

The maximum allowed performances in **direct three-phase short-circuit tests on low impedance equipment** (such as Circuit-breakers, Metal and Solid insulated enclosed Switchgears and Controlegars, Switches) when available a 3000 MVA short-circuit power are shown in Table D1-8.

Table D1-8 – Allowed performances in 3-phase direct short-circuit tests powered by a 3000 MVA Short-circuit Generator

Rated voltage [kV]	Rated short-circuit breaking current [kA]									
3.6	10	12.5	16	20	25	31.5	40	50	63	80
7.2	10	12.5	16	20	25	31.5	40	50	63	80
12	10	12.5	16	20	25	31.5	40	50	63	80
24	10	12.5	16	20	25	31.5	40	50	63	-
36	10	12.5	16	20	25	31.5	40	-	-	-
52	10	12.5	16	20	25	-	-	-	-	-

This table makes clear the use in some laboratories up to 4 Short-circuit Generators to perform direct short-circuit tests on MV and HV equipment with high rated short-circuit current.



Table D1-9 – Equipment and relevant executable tests in a Medium Voltage laboratory supplied by a 3000 MVA Short-circuit Generator

Equipment	Equipment Ratings		Tests
	rated voltage	Rated current	
• MV Circuit-breakers	from 3.6 kV up to 52 kV	up to 6.3 kA	✓ Short-circuit making and breaking ✓ Short-time withstand current ✓ Single phase and double earth fault
• Generator Circuit-breakers	from 12 kV up to 36 kV	up to 6.3 kA	✓ Short-circuit making and breaking ✓ System-source short-circuit making and breaking ✓ Load current breaking
• MV Disconnectors and Earthing switches	from 3.6 kV up to 52 kV	up to 6.3 kA	✓ Short-time withstand current and peak withstand current
• MV Metal enclosed Switchgears	from 3.6 kV up to 52 kV	up to 3.15 kA	✓ Short-circuit making and breaking ✓ Short-time withstand current
• MV Solid insulated enclosed Switchgears		from 400 A up to 800 A	✓ Short-time withstand current ✓ Making and breaking switching
• MV Switches			✓ Short-time withstand current ✓ Making and breaking at the maximum breaking I^2t ✓ Breaking at the rated transfer current ✓ Breaking at the rated take-over current
• MV Switch-fuse combination	from 3.6 kV up to 52 kV	from 400 A up to 800 A	✓ Short-time withstand current and peak withstand current
• MV Bus ducts	from 3.6 kV up to 52 kV	up to 4000 A	✓ Short-time withstand current ✓ Accuracy tests
• Current Transformers	up to 420 kV	up to 6300 A	✓ Short-circuit withstand capability ✓ Accuracy tests
• Inductive Voltage Transformers • Capacitor Voltage Transformers • Combined Voltage Transformers	from 3.6 kV up to 52 kV	up to 6300 A	✓ Short-circuit withstand capability ✓ Accuracy tests



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In the case of **high impedance equipment**, such as power transformer or current limiting reactors, it has to be used a suitable MV/HV short-circuit transformers fed by the Short-circuit Generator. Table D1-10 lists the Power Transformers that can be tested in the considered MV testing laboratory and the relevant main tests.

This table derives from DeMEPA database concerning previous developed projects of power transformers testing. For an accurate assessment of the laboratory capability it is necessary to take into consideration the detailed configuration of the MV/HV laboratory short-circuit transformer as well as the ratings of the transformers to be tested (primary and secondary windings, tap changer included, actual short circuit impedance).

Table D1-10 – Power Transformers and relevant executable tests in a laboratory supplied by a 3000 MVA Short-circuit Generator

Primary voltage [kV]	Secondary Voltage [kV]	Short-circuit impedance	Rated power [MVA]	Tests
33	11	4 ÷ 8 %	up to 20	✓ Ability to withstand short-circuit ✓ Applied Voltage ✓ Induced Voltage ✓ Measurement of winding resistance ✓ Measurement of short-circuit impedance and load loss ✓ Measurement of voltage ratio and check of phase displacement ✓ Measurement of load and no-load losses and current at 90% and 110% of rated voltage ✓ Temperature-rise test
66	11	7 ÷ 10 %	up to 31.5	
132	11	15 ÷ 22 %	up to 65	
132	33	15 ÷ 22 %	up to 65	
132	66	15 ÷ 22 %	up to 100	

The MV laboratory supplied by a Short-circuit Generators still requires an external power line to feed all the electric services of the laboratory (including the excitation of the Short-circuit Generator).

The availability of a single power source feeding the test circuits often leads to duplicate the test cells in order to allow the test performing in one facility while in the second one the test setting up of another equipment is carried out. This increases the laboratory productivity that is one of the key aspects to be considered in testing laboratory design.

According to Consultant experience, **the required area** for the different buildings and common areas (roads, parking, etc.) for the considered MV laboratory supplied by a 3000 MVA Short-circuit **can be estimated in 10000 square meters**.



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DESIGN and MANAGEMENT of ELECTRICAL POWER ASSETS

4.2.4 HV laboratory with synthetic test facility and supplied by a 3000 MVA Short-circuit Generator

In the previous paragraph 6.2.3 we have seen that for direct tests on MV equipment with high rated short-circuit current more than one Short-circuit Generator may be needed.

This is even more true for HV equipment.

An alternative effective solution for HV equipment (mainly for HV Circuit Breakers) testing using only one Short-circuit Generator consists in the replacing of direct tests with synthetic tests. In **the synthetic testing** the current source and voltage source are connected to the test objects with relatively low voltage and low current, respectively. The Short-circuit Generator provides the short circuit current while the voltage source, mainly consisting in a previously energized capacitor bank, provides the recovery voltage.

In this way short-circuit tests on low impedance equipment having rated voltage up to 420 kV and high rated short circuit current (up to 63 kA) may be carried out.

Differently from the direct testing, the synthetic ones consist of several tests each of which aimed to verify the equipment performances under different possible fault conditions of the electrical system in order to assure the equipment reliability in the real situation. Moreover, the synthetic tests eliminate the damage of the test sample in case of failure.

It has to be outlined that a synthetic test is more time consuming and expensive than a direct test. A laboratory using synthetic methods is far more complex than a laboratory designed to carry out direct tests. This implies a greater investment involved and very high skills required to test engineers.

Table D1-11 lists the main short-circuit test for the main HV and low impedance equipment (Circuit Breakers, Disconnectors and Earthing Switches) having rating voltage from 52 kV up to 420 kV and for each test defines whether it is performed through synthetic methods or by direct tests in a laboratory whose test circuits are fed by a 3000 MVA Short-circuit Generator.

Regarding the power transformers testing, the obtainable performances are the same of the MV laboratory powered by a Short-circuit Generator because synthetic methods do not apply to transformers. The test of power transformer with rating power higher than 100 MVA must be fed through an HV power line coming from a HV station with adequate short-circuit power.

A synthetic test plant occupies much more space than other testing facilities and needs very high buildings (even up to 20-30 meters for capacitor banks housing). A HV laboratory equipped with Synthetic facility and whose test circuits are powered by a Short-circuit Generator occupies **an area not less than 15000 square meters** taking into consideration the necessary the auxiliary (generator room, assembly/disassembly room, utilities room, warehouse, workshop) and ancillary areas (offices, staff dressing rooms, internal roads, parking).



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Table D1-11 – Equipment and relevant tests in a HV testing Laboratory with synthetic test facility and supplied by a 3000 MVA Short-circuit Generator

Equipment	Equipment ratings and tested phases			Tests	
	Rated Voltage	Rated Short-circuit current			
HV Circuit-Breakers	52 kv	from 10 kA up to 63 kA	3-phase	Basic short-circuit test-duties	synthetic
				Short-time withstand current and peak withstand current	direct
				Single phase and double earth fault	synthetic
	from 72.5 kV up to 170 kV	from 10 kA up to 63 kA	3-phase	Out-of-phase making and breaking	synthetic
				Capacitive current switching	direct or synthetic
	from 245 kV up to 420 kV	from 31.5 kA up to 63 kA	1-phase	Shunt reactor current switching	direct
				Special requirements for making and breaking tests on class E2	synthetic
HV Disconnectors (air or gas insulated)	from 52 kV up to 420 kV	from 2 kA up to 8 kA	1-phase	Short-time withstand current and peak withstand current	direct
				Bus-transfer current	direct
				Bus-charging current (on the gas insulated)	direct
HV Earthing Switches	from 52 kV up to 420 kV	from 2 kA up to 8 kA	1-phase	Making test again short-circuit	synthetic
				Short-time withstand current and peak withstand current	direct
				Induced current switching	direct
				Test to prove the short-circuit making performance	synthetic

4.2.5 Involved investment and turnover for the considered testing laboratory

Based on the Consultant previous developed design of testing laboratories, in Fig. D1-5 the required investment for the testing laboratory described in the previous paragraphs 4.2.1, 4.2.2, 4.2.3 and 4.2.4 are shown.

For each laboratory the investment lies in a range determined by the type and number of the equipment considered.

The reported values of investment include the building construction, the purchasing and site transportation of the procured equipment, the laboratory erection and commissioning while they do not include the cost of the land because it greatly varies from country to country.

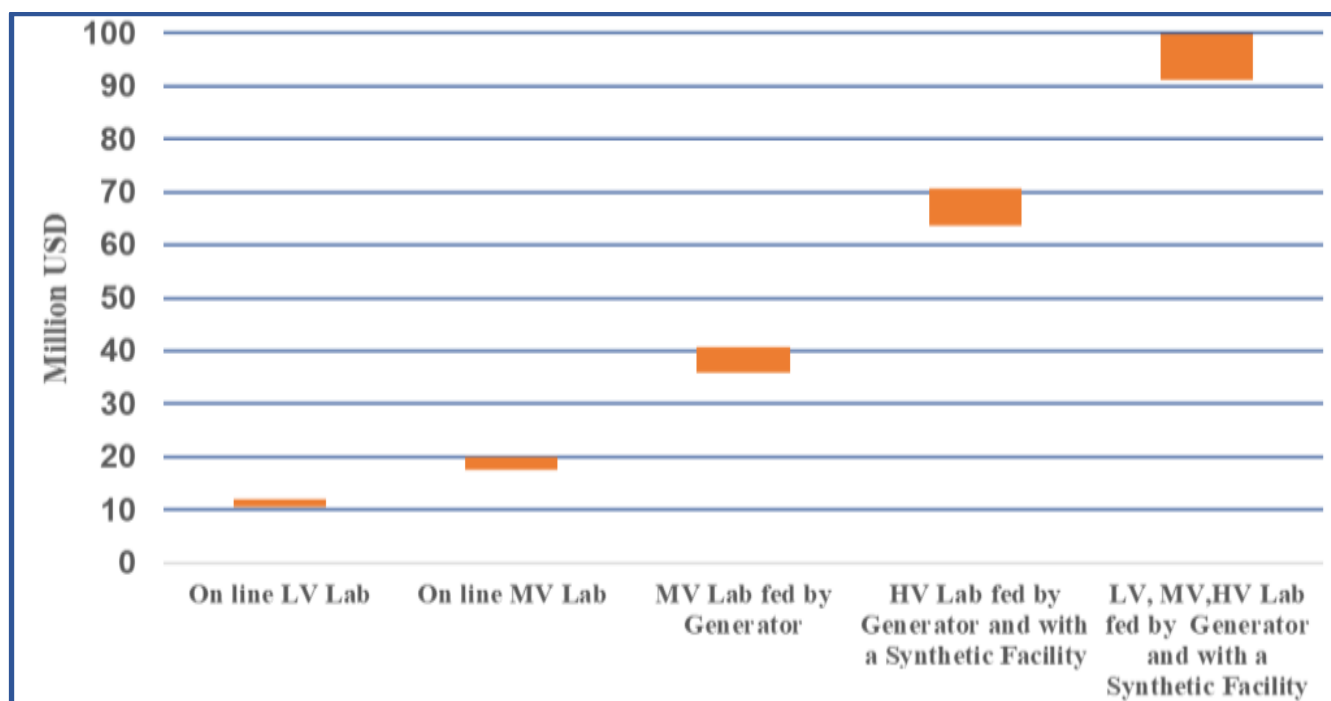


Figure D1-5 – Capital expenditure for different testing laboratories

In the above figure is also presented the estimated investment related to a laboratory able to perform testing on **all the LV, MV and HV considered equipment making use of a 3000 MVA Short-circuit Generator and a synthetic facility.**

In order to assure a **financial viability** of the laboratory the involved investment for its establishment has to be related to the **revenues over the time for the provided testing services.** For this purpose, the following Fig. D1-6 shows the typical distribution of the revenues of a laboratory able to perform tests on all the equipment of the electrical system.

The turnover related to the MV equipment testing is greater than that related to the remaining equipment because **MV equipment are the most widespread in the T&D system** and thus several new prototypes of these equipment are developed by the electromechanical sector resulting in an increased need for qualification tests and thus increased turnover for the testing laboratory.

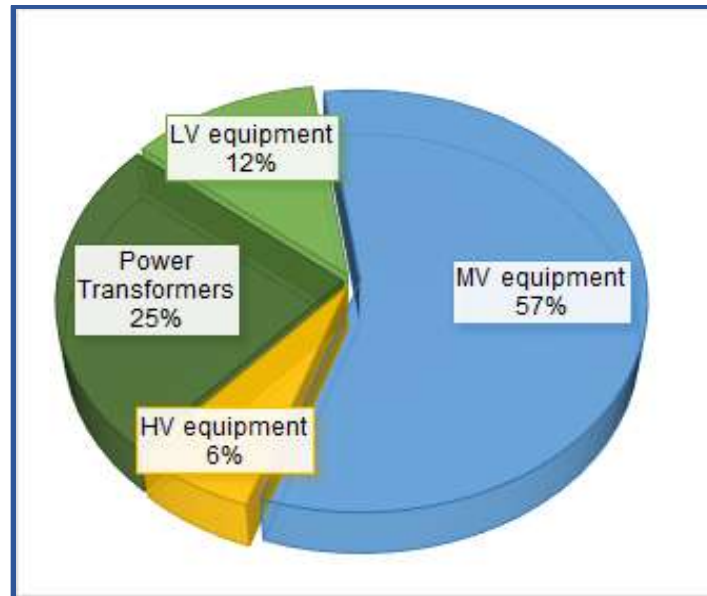


Figure D1-6 – Revenues from testing services of different equipment

The data in the above figure reflect the average values of the turnover of different laboratories able to test almost the totality of the equipment installed in the T&D infrastructure. They demonstrate that the choice of the capability of the Independent Testing Laboratory to be established in Bangladesh does not necessarily have to cover all testing needs. The testing facilities to be taken into consideration should be defined considering the expected revenues that the laboratory is able to acquire.

For this reason, the Consultant intends to assess the potential market of a National Testing Laboratory (see Task 3 of the project) considering the planned investments of all the national electric utilities as well as the development programs of manufacturers in order to define the most convenient configuration of the Laboratory (equipment to be tested and their maximum operating ratings). This configuration will be confirmed or modified on the basis of the Laboratory business plan (see Task 8 of the project) that will take into account the involved CAPEX (resulting from the Feasibility Study and Engineering Design of the laboratory carried out under Task 5 and 7, respectively) and the evaluated OPEX.



5. The National Independent Authority of Bangladesh

The second main objectives of the Project concerns "**the design of an independent authority for testing and certification**" of High-Voltage, Medium-Voltage and Low-Voltage electrical equipment".

Four micro-services have been identified by the Consultant, namely testing, certification, inspection and engineering services, to allow an effective role of this "independent authority for testing and certification" of electrical equipment.

These macro-services are described below, identifying for each the relevant reference market.

The need for this authority to be seen as independent for the market is justified and the related implications considered.

Lastly, the organisational structure of the Independent Authority is addressed by considering two possible options with regard to existing international models of entities providing similar services.

5.1 The macro-services provided by the Bangladesh's National Independent Authority

The **Bangladesh's National Independent Authority** (in the following **Bangladesh's NIA** or more simply **NIA**) has to be able to provide world-class services addressed to:

- improve the quality of the manufactured electromechanical equipment in the country,
- enable the compliance of the electrical equipment with the quality requirements of Buyers (Utilities, Ministries and Industries),
- support to development of Bangladesh electrical system.

As a result of the above and assuming that a measurements traceability system² is already in force in Bangladesh, **the service portfolio** of the Bangladesh's NIA will be based conceptually on **four business legs**:

- **testing**
- **certification**
- **inspections**
- **engineering services.**

The Bangladesh's NIA will likely also find it useful to consider also:

- an internal service of **Calibration**, in the framework of the national calibration system, for carrying out the calibration of the measuring chains of the laboratory performing the testing activities,
- a **technological window function** following the evolution of the main international Standards of interest for the testing and certification activities.

² The measuring traceability system is usually based on a National Calibration Institute in charge of the maintenance of the National measurement standards and of a National calibration system ensuring the traceability of the laboratory measuring systems to the National standards.



Figure D1-7 – The 4 Business Legs of Bangladesh’s National Independent Authority

These four business legs are equally important to improve the quality of the equipment to be installed on T&D infrastructure and they have to assure the financial sustainability over the time of the Bangladesh’s NIA.

It should be emphasized that the NIA organization does not necessarily have to coincide with the 4 business legs: it will be defined in close collaboration with Power Cell and taking into consideration the involved stakeholders and the expected impact on the market.

5.2 The business leg “Testing”

5.2.1 Service Description

Testing activity consists of **a set of processes and procedures** aimed to assess the characteristics of an equipment according to the procedures defined in the reference standards or/and to specific requirements by the Customer purchasing the equipment. Standard defines the test method to be applied, the testing parameters (voltage, current, etc.) in connection with the ratings of the equipment under tests, as well as the criteria for considering the test successfully passed.



Sometimes the Standards require the execution of tests according to a well-defined sequence, as may be in the case of type tests.

The various types of tests applicable to electrical equipment are defined in Annex 1 specifying the related role of the Bangladesh' NIA. For an Independent Authority the testing activities of greatest interest are:

- the **type tests** that are performed on the prototype of a new equipment before its placing on the market,
- the **R&D test** performed during the development of a new equipment and for which the manufacturer does not have adequate testing facilities.

Testing facilities able to perform type tests in full compliance with International Standards require large capital expenditure and high O&M costs as well as hard skills. Therefore, it is sensible that such facilities are set up in a central organization able to concentrate the required resources and to make them available to several users.

5.2.2 Reference market

From the previous paragraph it follows that the market for NIA testing services is made up of:

- **National manufacturers interested to develop new product** for the domestic and international market,
- **Buyers** (utilities and industries) **asking to verify by laboratory tests specific requirements** for products they intend to use.
- **Public administration**, in charge of the market supervision, **to verify, in case of complaints, the conformity to the national regulations of the products sampled in the market.**

Consequently, **the commercial actions have to be addressed to the manufacturers with a parallel communication activity addressed to utilities and national industries** so that they contractually require equipment that have passed the relevant type tests.

5.3 The business leg "Certification"

5.3.1 Service Description

The Certification of an electrical equipment consists in the evaluation of its total compliance with the reference standards and the Customer specification. This evaluation is usually carried out on prototypes through tests, measurement, visual checks, and sometimes even through modelling.

For electrical equipment the Certification is based on a testing activity upon completion of which a **Test Report** is issued **indicating the quantitative results of the tests required by the reference Standard.**

The activity carried out by the **Certification Body** makes an identification of the equipment, including the design, its main components, dimensions, weights, used materials, functional interfaces with other equipment and systems and specifies the list of type tests to be carried out. After the conclusion of the test activity, proven by the Test Report, The Certification body scrutinizes the Test Reports and evaluates their compliance with the Customer's specification.



The result of this assessment is a **Product Conformity certificate** on the basis of which the manufacturer can demonstrate to the market the conformity of the equipment design.

A **Certification Body** - unlike a Testing Laboratory - **does not necessarily have testing facilities** but it may rely on the Test reports issued by accredited testing laboratories.

To enhance the market acceptance of the Certificates of Conformity issued, a **Certification Body may be accredited** according to IEC 17065 and may carry out conformity certification within selected IAF³ sectors within the scope of its accreditation.

The accreditation procedure provides for the assessment of the technical competence of the Body, but also of the impartiality of the governance. The impartiality is assumed only if the governing body having the final power of issuing or denying certificates (Board of Directors or Certification Board) includes members fairly representing all the stakeholders (government, manufacturers, end users, academic institutes, consumers, ...) without any single interest predominating.

5.3.2 Reference market

The Bangladesh's NIA reference market is certainly that of the National manufacturers. A communication activity has to be addressed to the Minister, utilities and industries also for this activity, pointing out that they have to purchase certified equipment not only for the use in T&D infrastructures or similar applications but also for the low voltage industrial equipment (such as Contactors, Motor-starters, Switch-disconnectors) and low voltage device for household and similar uses (Circuit Breakers for overcurrent protection, Residual current operated Circuit Breakers).

5.4 The business leg "Inspection"

5.4.1 Service description

Inspection activities cover in general terms various assessments concerning samples of industrial products or complete systems.

The services may include the assessment of the conformity of the products delivered to the contract and shipping documents and to the prototypes submitted for the type tests. They also include the witnessing to:

- the routine tests carried out in the Testing Laboratories (mainly operated by the manufacturer at the factory) and the review of the test reports issued thereafter,
- the Site acceptance tests,
- the field tests intended to evaluate the system performances or to investigate in case of failures.

³The International Accreditation Forum (IAF) is a worldwide association of accreditation bodies and other bodies interested in conformity assessment in the fields of management systems, products, processes, services and personnel.



Annex 1 in describing the Bangladesh NIA role defines the Inspection services that can be performed for the different testing activities on electrical equipment.

For any Inspection activity a corresponding Inspection Report is issued in which in the tested equipment is unambiguously identified. The Inspection report summarizes the result of the performed tests or measurements (with the relevant measurement uncertainty) and the reference Standards and/or Technical Specification that are generally provided in detail by the Test Reports issued by the Testing Laboratories involved.

5.4.2 Reference market

The business “Inspection” is usually a second-party service, in the sense that it is conducted on behalf of the end user of the products. Meanwhile the business may also be requested on behalf of the manufacturer as first-party service, to enhance the confidence of the customers, or on behalf of a certification body, as an outsourcing of some of their typical activities.

Three types of customers can be identified for this business leg:

- Buyers of equipment asking experts to witness tests performed at manufacturer premises or sometimes even at independent laboratories,
- Business leg “Testing” for witnessing any part of the test program to be conducted in the manufacturer laboratories,
- Electrical Utilities which requires to carry out measurements on its operating equipment or systems.

“Testing” business leg will be likely the core business of Bangladesh’s NIA after some years of operation of its testing facilities, considering the timing for testing facility building and the achievement of a share of its potential testing market.

But already after a short time of its establishment, NIA can benefit from revenue deriving from “Inspection” activities. National utilities and industries, that are the major buyers of electrical equipment, may ask the National Independent Authority to witness through its inspectors some of these tests (the most significant) in order to ensure full compliance with the reference standard and specific customer requirements.

5.5 The business leg “Engineering services”

The business leg “Testing” builds up, within the testing laboratory, a huge amount of unique competence, covering several issues:

- Operation, organization and performance of the testing laboratories,
- Performance of the special laboratory equipment,
- Statistics concerning the performance of test objects,
- Appraisal of the impact of different design solutions with respect to the test results.

Those competences are shared within all the Laboratory staff, and may be made available to the industry.



An Engineering service can be likely developed when the skills of NIA testing staff will have reached a high level and especially when a remarkable competence will be acknowledged by the potential customers that are below identified, together with the relevant asked services:

- **Manufacturers** in the developing process of new products need support to know in advance if the actual constructive solutions will be **able to pass the type tests or to identify the causes of a failed tests**;
- **Buyers of electrical equipment** for the purpose of **the comprehensive and effective definition of the tests** to be considered for a Factory Acceptance Tests or On-site Acceptance Test;
- **Buyers and Manufacturers** during the **design review** of a new electrical equipment in order to evaluate the current design against its requirement: deep knowledge of possible behaviour during qualification tests may usefully support the engineering simulations.

5.6 The Bangladesh's NIA must be really Independent

NIA has to appear on the market as independent **to be successful**. This means that in all its activities NIA must be able to demonstrate that **all their evaluations are based on objective criteria and fairness rather than bias or preference to the benefit one entity over another for improper reasons**. NIA staff has to be free from any undue commercial, financial and other pressures which might influence their technical judgement. Moreover, **NIA should not engage in any activities** (such as manufacture, construction, assembly, repair, reconstruction) because **that may endanger the trust in its confidentiality, independence and integrity of judgement**.

The need to "**appear on the market as independent**" has an impact on the following key items concerning the Independent Authority:

- **the legal form and the shareholders** which must take into account the beneficiaries of NIA activities and their interests; domestic manufacturers will take advantage from testing, certification and inspection performed by the Independent Authority which will lead to improve the quality of their products and thus increase their performances on the local and international electromechanical market; therefore they will be in condition to make a financial contribution to NIA (thus becoming shareholders) but through the establishment of internal regulations and procedures any form of dependence on the results of NIA activity must be excluded; different is surely the position of the public electrical utilities whereas they are already public service providers; in any case a NIA controlled by the state seems the best option to guarantee its complete independence;
- **the organization**: the **testing and the certification activities have to be managed by an organizational model ensuring their independent role** without any connection with other NIA activities, particularly in respect of engineering services activities;
- **the accreditation**: although not explicitly related to the independence, accreditation contributes significantly to a perception of specific skills of staff (recognized expert in their field of operation)



and valuable technical structures and organization as necessary prerequisites for a truly independent role.

From the above it results that **Testing and Certification have to be accredited**, with two different accreditations being different their functions and the business model.

These accreditations must be carried out with the National Accreditation Body; if the Accreditation Body is member of an international network, the accreditation will be internationally recognized. If application to a National **Accreditation Body** is not viable, the Testing Laboratory and the Certification Body must be accredited by International Foreign Accreditation Bodies.

There is also the possibility of accrediting the inspection activity, but this need almost never arises as it is not essential for carrying out the inspection business.

Concerning the engineering services, the fourth business leg, there is **no need for accreditation**, as the main driver of success is the credibility of the involved experts and the availability of adequate modelling tools.

The following Table D1-12 summarizes the need of accreditation and an independent organizational model for the four NIA business legs.

Table D1-12 – Accreditation and organizational model of the four business legs

Business Legs	Need of accreditation	Independent organizational model
Testing	Yes	Mandatory
Certification	Yes	Mandatory
Inspection	Rarely	Not required
Engineering services	No	Not required

5.7 The conceptual organization of the Bangladesh's NIA

There are at least two different organizational models of entities performing testing, certification and inspection services:

- **Centralized models** such as those of **CESI-Kema** (Italy-Netherland), **CPRI** (India) and **Keri** (South Korea), in which the existing business legs are managed by a single parent company, beyond an internal organization in Business Units in order to ensure to each of them its specific functions, as for example for the Certification which must be guaranteed a role of third party with respect to the activity of Testing;
- **Distributed models** involving different actors and different characteristics and properties. This is the case of **PEHLA** (Germany-Switzerland), **ESEF ASEFA** (France), **STLNA** (North America: USA, Canada and Mexico), **SATS** (Scandinavian countries: Norway and Sweden). This solution provides for a central organization supervising distributed test facilities operating in the framework of **harmonized procedures** and regularly **assessing the conformity** of measurement and testing practices, expertise of test engineers, transparency of behaviour).



With a fully functioning Testing Laboratory, the centralised solution is probably the most suitable for NIA. But in the initial phase during which the Laboratory is under construction, a different solution can be considered: some tests could be carried out at an existing national enhanced laboratory (for example, a manufacturer's laboratory) in the presence of an Inspector Nia. In this approach NIA would immediately affirm its coordinating role through the two activities of inspection and certification and it would begin to reap some of the expected benefits related to the establishment of the Independent Authority.

The Consultant will consider the possible solutions that are really viable with the aim of identifying, in close collaboration, with Power Cell the most effective one.

Based on the chosen solution in the Task 4 "Design of an Institutional Organisation of Independent Authority" the organization NIA will be designed taking into consideration the four business legs and considering the following main functions:

- Market monitoring and commercial activity,
- Human Resource Development and Management,
- General Services, including Purchasing, Quality, Safety and Environmental Departments,
- Administration and Financial management.

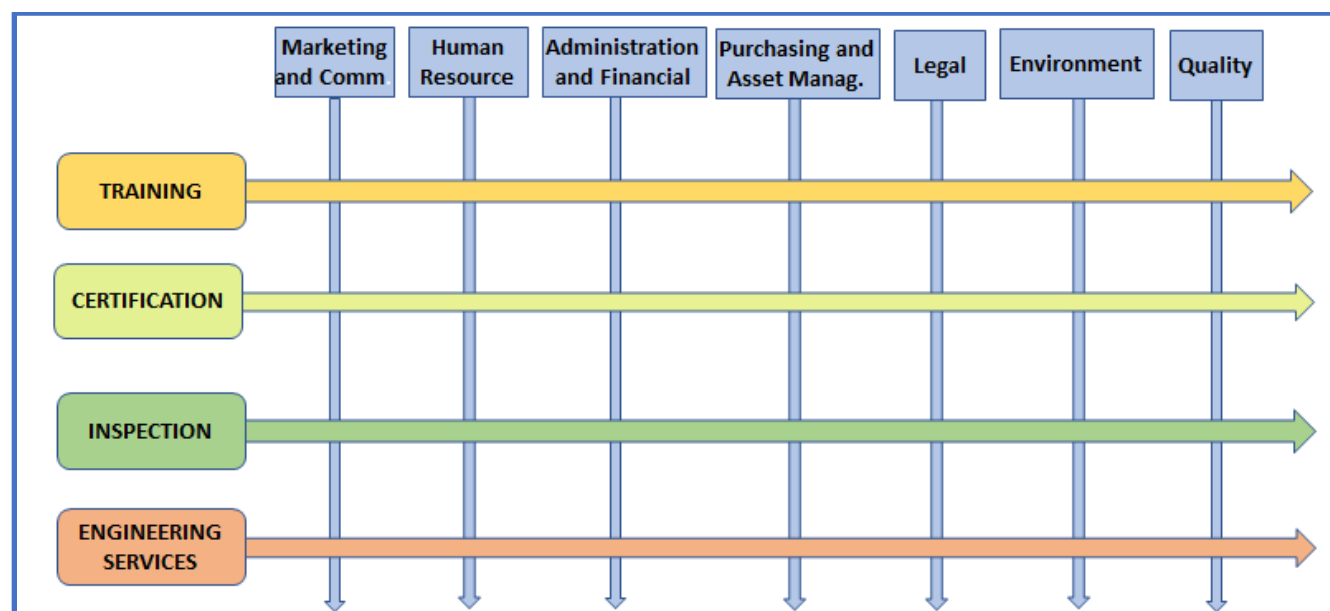


Figure D1-8 – The 4 Business Legs and the main functions of Bangladesh'S NIA



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Annex 1 – The various tests applicable to electrical equipment

Tests	Description	Test object	Test reference	Where are performed	Role of Bangladesh's NIA
Type Tests	Tests performed on a prototype of new equipment before its placing in the market order to: • verify its conformity to the reference Standards or • demonstrate its features and performances meet specified customer requirements	A prototype of a new equipment	• National and International Standards • Customer specific requirements	• in the test facilities of an accredited Laboratory • in the test facilities of Manufacturers in the presence of an Inspector	• Carry out the tests at its own testing facilities • Send its Inspectors witnessing the tests carried out in the manufacturer's laboratory
Routine Tests	Tests made by the manufacturer to demonstrate the compliance with the prototype type tested	Each sample of manufactured equipment		in the test facilities of Manufacturer, with possibility of witnessing by an inspector	If requested by the Customer (e.g. electrical utilities), NIA can send its Experts to witness the tests
Research and Development Tests	Experimental activity to support the development of new equipment or reengineering of existing ones. During the development process, various prototype alternatives and approaches can be evaluated by testing activities	Prototypes under development		• in the test facilities of Manufacturers • in the test facilities of an accredited Laboratory	Carry out some tests requesting test facilities not owned by the manufacturers
Factory Acceptance Tests	Tests performed at the end of the manufacturing processing to verify the compliance of the equipment with Customer specification	One or more sample of the equipment to be accepted	Customer specification (usually including National and International reference Standards)	in the manufacturer's factory	Send inspectors to witness the tests carried out in the manufacturer's factory
On Site Acceptance tests	Tests performed on the equipment after installation and previously its commissioning to verify the compliance with Customer specification	One or more sample of the equipment to be accepted		On site after installation of the equipment	• Send its Inspector witnessing the tests • Send its testing operators performing the tests
In field tests on equipment	Tests carried out on operated equipment in the framework or maintenance operation or following a malfunctioning or a failure of the equipment	Equipment in operation		They are carried out at the site where the equipment is installed	• Send its Inspector witnessing the tests • Send its testing operators performing the tests



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ADDENDUM

Comments received by Stakeholders on the document rev. 0

Comments received by Office of the Chief Electrical Inspector

**Opinion of Office of the Chief Electric Inspector
On
Inception Report of “Setting up Electrical Testing Laboratory”**

New inclusions are marked by bold and underline
Excluded parts are marked by strikethrough

General Comments:

- In this inception report, the actual scenario of the establishment on Electrical Testing Laboratory in Bangladesh is shown very clearly and coherently.
- It is a great opportunity for Bangladesh to meet the overall demand of the involved stakeholders by utilizing the executable tests on Low, Medium and High voltage electrical equipment.
- This is high time to set up Electrical Testing Laboratory, which is able to perform third party testing and certification for utilities and local manufacturers. As a result, a significantly huge amount of foreign currency can be reduced.
- The name of the National Independent Authority may be the “National Electrical Testing Authority”
- This inception report is the first step to develop a completely upgraded “Electrical Testing Laboratory”.
- The approach methodology of the consultant is quite satisfactory. The consultant will meet the goal with the support and encouragement of the Ministry of Power, Energy & Mineral Resources.

Specific Comments:

Page No.	“Setting up Electrical Testing Laboratory”	Comments of Chief Electric Inspector
Page 10 Table D1-2	Task 5 o Feasibility Study of Testing Laboratory Main outputs The Study will take into consideration the following main issues of the Testing Laboratory: • organization of the testing facilities and relevant power sources, • ancillary area and main utilities, • preliminary electrical single-line diagram and layout. • criteria for the selection of the site.	Task 5 o Feasibility Study of Testing Laboratory Main outputs The Study will take into consideration the following main issues of the Testing Laboratory: • organization of the testing facilities and relevant power sources, • ancillary area and main utilities, • preliminary electrical single-line diagram and layout. • criteria for the selection of the site. • <u>Testing facilities of the utilities (Licensee) and local manufacturer (This point should be added).</u>

Page No.	"Setting up Electrical Testing Laboratory"	Comments of Chief Electric Inspector									
Page 10 Table D1-2	• Task 7: - o Conceptual electric, civil and architectural engineering The Report of this Task includes: • testing facilities and main testing equipment specification,	• Task 7: - o Conceptual electric, civil and architectural engineering The Report of this Task includes: • <u>Low, Medium and High voltage</u> testing facilities and main testing equipment specification,									
Page 42 Annex-1 Row-2 Column 5-6	Annex 1 – The various tests applicable to electrical equipment <table><tr><th>Where are performed</th><th>Role of Bangladesh's NIA</th></tr><tr><td>in the test facilities of Manufacturer</td><td>If requested by the Customer (e.g. electrical utilities), NIA can send its Experts to witness the tests</td></tr></table>	Where are performed	Role of Bangladesh's NIA	in the test facilities of Manufacturer	If requested by the Customer (e.g. electrical utilities), NIA can send its Experts to witness the tests	Annex 1 – The various tests applicable to electrical equipment <table><tr><th>Where are performed</th><th>Role of Bangladesh's NIA</th></tr><tr><td>in the test facilities of Manufacturer <u>in the presence of an Inspector and Carry out the tests at its own testing facilities</u></td><td>If requested by the Customer (e.g. electrical utilities), NIA can send its Experts to witness the tests <u>NIA can Carry out the tests at its own testing facilities</u></td></tr></table>		Where are performed	Role of Bangladesh's NIA	in the test facilities of Manufacturer <u>in the presence of an Inspector and Carry out the tests at its own testing facilities</u>	If requested by the Customer (e.g. electrical utilities), NIA can send its Experts to witness the tests <u>NIA can Carry out the tests at its own testing facilities</u>
Where are performed	Role of Bangladesh's NIA										
in the test facilities of Manufacturer	If requested by the Customer (e.g. electrical utilities), NIA can send its Experts to witness the tests										
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আবুল খায়ের মোঃ আকাস আলী
(মুদ্রা-সচিব)
প্রধান বিদ্যুৎ পরিদর্শক
গণপ্রজাতন্ত্রী বাংলাদেশ সরকার।



Power Cell

Comments received by ADEX Corporation Ltd

Adex Corporation (Engr. Moshahed Ali Khan, Director Technical)

On-line Low Voltage laboratory

The proposed laboratory should have test equipment with the following items with the specification as follows:

- rated operational current: I_e (A) : 25A - 6300 A
- Rated operational voltage: U_e (V) : 690 V
- rated insulation voltage: U_i (V) : 1 000 V
- rated impulse withstand voltage: U_{imp} (kV) : 12 kV
- number of poles : 3 and 4 poles
- rated frequency: (Hz)..... : 50/60 Hz
- rated short-time making capacity: I_{cm} (kA) : 150kA, 550~690 V
- rated ultimate short-circuit breaking capacity: I_{cu} (kA).. : 25kA, 36kA, 45kA, 50kA, 65kA, 85kA, 100kA (600~690 V)
- rated service short-circuit breaking capacity: I_{cs} (kA) : $I_{cs} = 100\% \times I_{cu}$
- rated short-time withstand current: I_{cw} (kA/s) : 85 kA, 1 s

LV (Low Voltage) equipment to be tested

- LV Circuit Breakers
- LV Switches, Disconnections, Switch-Disconnections and Fuse combination units,
- LV Circuit Breakers for industrial uses
- LV contactors and motor-starters (Electromechanical type)
- Residual current operated circuit-breakers for household and similar uses
- LV Fuses,
- LV Bus ducts,
- LV Assembly.

The main executable tests to be performed on the above equipment are below listed:

- ✓ Short circuit breaking capacity
- ✓ Short-time withstand Current
- ✓ Overload performance
- ✓ Temperature rise
- ✓ Dielectric tests
- ✓ Mechanical Operation
- ✓ Tripping limits and characteristics (Spot check on tripping functionality)
- ✓ Operational performance capability
- ✓ Verification of main contact position (for circuit breakers suitable for isolation)
- ✓ Rated service short-circuit breaking capacity
- ✓ Rated short-time withstand current



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- ✓ Short-circuit breaking capacity at maximum short-time withstand current
- ✓ Verification of overload releases Sequence
- ✓ Electromagnetic compatibility (EMC) tests
- ✓ Harmonic currents

On-line Medium Voltage laboratory

The laboratory is addressed to perform tests on:

- MV equipment with **rated voltage from 3.6 kV, 7.2kV, 11kV, 33kV and 132kV and rated current up to 4kA,**
- Distribution transformers with **primary winding from 11 kV and rated power up to 4 MVA,**
- Power Transformers with **primary winding up to 33 kV and rated power up to 28/35MVA.**
- Power Transformers with **primary winding up to 132kV and rated power up to 75/100MVA.**

This Laboratory has to be supplied by an external HV power line coming from a station having a short-circuit power about 5000 MVA. Assuming the availability for the laboratory of a short-circuit power of 250 MVA, the following Table 2 lists for the different equipment the main tests that can be performed. Even in the event of the most power demanding tests the corresponding voltage drop into the grid supplied by the concerned station can be estimated, in the first approximation, in not more than 5% for a duration not greater than 0.3 s.

Type Test Required for Voltage up to 11kV to 132kV Breakers

- i) Dielectric tests (1.2/50 micro second lightning impulse) and 1 minute power frequency voltage with stand (dry & wet) test
- ii) Radio interface voltage (R.I.V.) tests
- iii) Temperature rise tests
- iv) Measurement of the resistance of the main circuit
- v) Short-time withstand current and peak withstand current tests
- vi) Mechanical and environmental tests
- vii) Miscellaneous provisions for making and breaking tests
- viii) Short circuit making and breaking tests
- ix) Basic short circuit test duties
- x) Critical current tests
- xi) Single phase short making and breaking tests
- xii) Capacitive current switching tests
- xiii) Magnetizing and small inductive current switching tests



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Routine Test Required for Voltage up to 11kV to 132kV Breakers

- i) Power frequency voltage withstand dry tests on the main circuit
- ii) Voltage withstand tests on control and auxiliary circuits
- iii) Measurement of the resistance of the main circuit
- iv) Mechanical operating tests
- v) Design and visual checks

Routine Test required for transformers Voltage up to 11kV /33kV/ 132kV

Routine Tests: These tests are performed on every transformer to verify its basic electrical and mechanical characteristics. Routine tests include:

Ratio Test: Verifies the turn's ratio between primary and secondary windings.

Polarity Test: Determines the polarity of windings and their connection.

Resistance Test: Measures the DC resistance of transformer windings.

Impedance Test: Determines the impedance voltage and percentage impedance.

Insulation Resistance Test: Checks the insulation resistance of windings.

No-Load Loss and Excitation Current Test: Measures the losses and magnetizing current with no load.

Load Loss and Impedance Voltage Test: Measures the losses and voltage drop with rated load and short-circuited secondary winding.

Type Test required for transformers primary Voltage up to 11kV /33kV/ 132kV

Temperature Rise Test: This test evaluates the ability of the transformer to withstand continuous operation under specified load conditions. It measures the temperature rise of various parts, such as windings, core, and oil, and ensures they remain within acceptable limits.

Short-Circuit Withstand Test: This test assesses the transformer's ability to withstand high short-circuit currents without damage. It is performed by applying a high current to the secondary winding or by short-circuiting the secondary terminals.

Insulation Level Test: This test verifies the insulation capability of the transformer against overvoltage's. It typically includes lightning impulse voltage and switching impulse voltage tests.



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Partial Discharge Test: This test detects and measures partial discharges within the transformer. It helps assess the insulation condition and overall reliability of the transformer.

Noise Level Test: This test determines the noise level generated by the transformer during operation. It is important to ensure the noise remains within permissible limits.

These are some of the common type tests conducted on transformers. The specific tests and their procedures may vary depending on the applicable standards and specific transformer requirements. It's essential to consult the relevant standards and guidelines specific to your region or the transformer's intended application for detailed information on type tests.

Second part

We appreciate your pragmatic endeavor to set up an independent testing laboratory in Bangladesh. The electrical equipment manufacturer have been longing for an independent testing laboratory for long. At last it is come to light as a milestone achievement of the present Government. We know it will take time & huge financial involvement to set up a world class independent testing laboratory. If the project authority feels a budget constraint for the full-fledged high voltage testing laboratory our opinion is to limit the project involvement for medium voltage testing laboratory with dynamic short circuit facilities for medium & low voltage equipment which is specially required for the country. To standardize the products made by Bangladeshi manufacturers to an international standard these facilities are crucial necessity of the country. This is a big boost for the local manufacturers and immense benefit for the country. Now the other testing facilities like impulse test, double voltage double frequency test, temperature rise test & partial discharge test may not be very costly. As many of the local manufacturers have facilities for impulse test, double voltage double frequency test, temperature rise test, partial discharge test & all the routine test facilities so, except the dynamic short circuit test all other test may be carried out from the local manufacturer's laboratory if the testing authority feels to reduce the initial investment. Experts nominated by the testing authority may witness these tests at the premise of the manufacturers having test facilities.

The proposed laboratory should have testing facilities for low voltage circuit breaker up to 6300 A, 100kA & that of medium voltage circuit breaker with rated voltage up to 36kV, rated current up to 4kA & rated short circuit current up to 31.5kA to execute following tests:

1. Dielectric tests (1.2/50 micro second lightning impulse)
2. Temperature rise tests (Using test transformer & capacitor banks)
3. Mechanical endurance tests
4. Short circuit making and breaking tests
5. Dynamic stability test

& routine test as required



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We also propose for the laboratory to perform tests on following low & medium voltage transformer:

- Distribution transformers with rated voltage 12kV and rated power up to 3.15 MVA
- Power Transformers with rated voltage 36kV and rated power up to 35MVA

Type Test required for above transformers are as follows:

Temperature rise test

Short-Circuit withstand test

Impulse test

Partial discharge Test

Noise level test

Double voltage double frequency test if require

& routine test as required

Our proposal & request considering the crucial necessity of the country the project will be implemented by the government authority as viable considering the budgetary constraint if any for either medium voltage or high voltage testing laboratory.

Thanking you

For Adex Corporation

Engr. Moshahed Ali Khan

Director – Technical

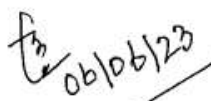
Comments received by West Zone Power Distribution Company Ltd

SI No.	Ref. and description	WZPDCL's Opinion
01.	Table D1-7 Page No: 26 ▪ MV Circuit Breakers ▪ MV Metal enclosed switchgear	✓ Mechanical Endurance Test for Circuit Breaker
02.	Table D1-7 Page No: 26 Distribution Transformer Tests	✓ Vector Group Test ✓ Mesurement of Insulation Resistance ✓ Dielectric Test of Transformer Oil ✓ Tan-Delta Test of Transformer
03.	Table D1-9 Page No: 28 Current Transformers	✓ Excitation Test (Knee point Voltage) ✓ Burden Test ✓ Polarity Test ✓ Mesurement of Insulation Resistance ✓ Mesurement of Winding Resistance
04.	Table D1-9 Page No: 28 Potential Transformers	✓ Burden Test ✓ Polarity Test ✓ Mesurement of Insulation Resistance
** The above mentioned testing facilities can be included within the scope of the Testing laboratory.		

Additional item than can also be included in the Testing Facility of the Laboratory.

SI No.	Description	WZPDCL's Opinion
01.	Transformer Oil	1. Breakdown voltage test 2. Water content test: 3. Oxidation stability test 4. Dissolved gas analysis (DGA) 5. Dielectric dissipation factor (tan δ) test 6. Furan analysis 7. PCB (Polychlorinated biphenyl) content test 8. Oil Resistivity


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Comments received by Coal Power Generation Company Bangladesh Ltd

SL	Clause No	Page No	Content of Inception Report	Comment of CPGCBL
1	Table D1-2 - Main Outputs for each Task and project Deliverables	9	- Task 3: - Evaluation of Bangladesh and Regional Demand of testing services, also considering the expected evolution	During evaluation of regional demand of testing service, consultant should consider requirements of testing services in Power Generation, Transmission and Distribution sector.
2		10	- Task 8: - Cost and benefit evaluation	Procedure of determining testing fee could be assessed
3	3.5 (C) Complexity of the project	20	Capacity Building Activities	The employees from Government and Private Power Sector Organizations may be given opportunity to receive training under capacity building activities.
4	4. Conceptual Configuration of a Testing Laboratory	21	"to perform complete series of tests according to the International Standards on the main electromechanical components used in T&D infrastructures"	International Standards can be specified such as IEC and others.
5	4.2 Four different configuration of a Testing laboratory	24		1. The Following Additional Test Facility can be considered. a) Electromagnetic Interference (EMI) / Electromagnetic Compatibility test Facility b) Energy Efficiency Test Facility c) DC (Direct Current) operated equipment's test facility 2. Generator, Lightning arrester, Cables, Insulator, Energy meter, Protection, Control and metering panel, Instrumentation and Control (I&C) Systems of Power Plants can be added in the equipment list of each configuration.
6	4.2.5 Involved investment and turnover for the considered testing laboratory	32	Based on the Consultant previous developed design of testing laboratories, in Fig. D1-5 the required investment for the testing laboratory described in the previous paragraphs 6.2.1, 6.2.2, 6.2.3 and 6.2.4 are shown.	The paragraphs 6.2.1, 6.2.2, 6.2.3 and 6.2.4 were not found in the report.

[Signature]

Depegn P... 16.10.2023

[Signature]
06/06/23
SM Abdul Mannaf
Superintendent Engineer (Mech)
(In-Charge), CPGCBL

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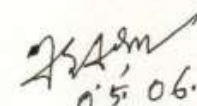
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DESIGN and MANAGEMENT of ELECTRICAL POWER ASSETS

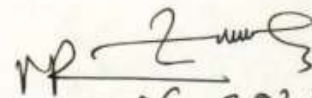
Comments received by B-R Powergen Ltd

Sl no.	Clause & Page no.	As per draft inception report	Comments of BRPL
1.	4.2.5 Involved investment and turnover for the considered testing laboratory; Page no: 32	In order to assure a financial viability of the laboratory the involved investment for its establishment has to be related to the revenues over the time for the provided testing services. For this purpose, the following Fig. D1-6 shows the typical distribution of the revenues of a laboratory able to perform tests on all the equipment of the electrical system.	In the Fig. D1-6 the typical distribution of the revenues of a laboratory able to perform tests on all the equipment of the electrical system are shown. <u>The typical distribution of the O&M cost of a laboratory able to perform tests on all the equipment of the electrical system may be shown in the report to understand which laboratory will be beneficial to establish.</u>
2.			<u>A typical organogram of a testing laboratory and National Independent Authority (NIA) may be included in the report.</u>


05-06-23

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Comments received by Bangladesh Rural Electrification Board

A. BREB's comments on Inception Report:

SL no.	Chapter and Page no.	As per Inception Report	Comments from BREB
01	2. Foreword [page 6]	This huge growth in the sector requires the electric utilities to supply and install a considerable number of lines, power stations, distribution and power transformers, circuit breakers, switches and instrument (voltage and current) transformers.	This line should be changed as below: 'This huge growth in the sector requires the electric utilities to supply and install a considerable number of lines, power stations, distribution and power transformers, energy storage systems, SCADA, circuit breakers, switches and instrument (voltage and current) transformers.'
02	2. Foreword [page 6]	To significantly reduce (to the extent of avoiding) the export of foreign currency relating to test activities no longer carried out in foreign laboratories	This line should be changed as below: 'To significantly reduce (to the extent of avoiding) the export of foreign currency relating to test activities ~~no longer carried out in foreign laboratories~~ by implementing well qualified and similar laboratories in Bangladesh '
03	2. Foreword [page 6]	To strengthen the local electromechanical industry expected to produce new enhanced equipment with improved performances resulting in a reduction of purchase abroad of equipment	This line should be changed as below: To strengthen the local electromechanical industry expected to produce new enhanced equipment with improved performances resulting in a reduction of ~~purchase abroad of equipment~~ equipment purchase from abroad.

B. The following components need to be incorporated in the NIA:

1. BREB requires testing and inspections of construction materials or devices for its distribution network. At present there are overhead distribution line, underground distribution line, submarine cable line, river crossing tower, fault locator, energy meter, prepayment meter, indoor/outdoor type substation, Gas Insulated Substation (GIS), switching station, solar pump in BREB distribution network. To meet uninterrupted quality electricity service and future demand, BREB has a plan to implement Advanced Metering Infrastructure (AMI), SCADA, Battery Energy Storage System, Geographic Information System (GIS) of distribution network etc. **Therefore, it would be convenient for BREB if the relevant testing, certification, inspection, engineering services, and training facilities are provided by the National Independent Authority.**