Chapter 2　Contents of the Project

Chapter 2. Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Overall Goal and Project Purpose

The Hashemite Kingdom of Jordan has been planning economic growth through attraction of direct foreign investment, and promotion of free trade through accession to the World Trade Organization, conclusion of treaties of free trade with Arab, European and American countries, and establishment of a free trade zone in Aqaba, as the major initiatives. In consequence, competition among industrial products has intensified in both export and domestic markets; the need for quality control of industrial products as a means of increasing their competitiveness has grown. In the draft version of the "Economic & Social Development Plan (2004-2006)" of the country, two related objectives are improving the quality of Jordanian industrial products and increasing their competitiveness in the export market and domestic market.

In Jordan, in accordance with the "General Framework of National Industrial Policy, The National Program for Jordan's Industrial Sector Qualification and Development (GFNP)" and "Social and Economic Transformation Program (2002-2005; SETP)" which are in effect now, many measures have been taken to increase the competitiveness of Jordanian industrial products, i.e., advocating technical and financial supports to enterprises, encouragement of acquisition of ISO9001, policies for establishment of a certification system with testing institutions in conformity with international practices and levels. Among these diverse measures, this project aims improving functions of calibration and testing service of the Royal Scientific Society, through provision of equipment for calibration and testing.

2-1-2 Basic Concept of the Project

This project is to provide the Royal Scientific Society (RSS) with equipment for calibration (electricity, temperature, length, mass, pressure, force, volume and density, flow, speed, and light) and equipment for testing of industrial products (home use electronic appliances, lead acid starter batteries, materials and products of plastics and metals, textiles and paper, cigarettes, food products, petro-chemical products, inorganic chemical products, etc.) to achieve the project’s basic objective. Overall, the project consists of procurement and installation of the abovementioned types of equipment, instruction and training on operation and maintenance, renovation of buildings, increasing the staff for operation and maintenance, etc. Among them, grant aid is to be utilized as the means of procuring equipment which would otherwise be difficult to be procured by the Jordanian authorities, and for installation, instruction and training on operation and maintenance for the equipment.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

(1) Basic Policy

Through the discussions during the field survey, equipment that was finally requested by the Jordanian side is as follows:

1) Equipment for Calibration (National Calibration Laboratory, in Electronic Service and Training Center)

A. Electrical Calibration System
B. Temperature Calibration System
C. Length Calibration System
D. Mass Calibration System
E. Pressure Calibration System
F. Force Calibration System
G. Volume & Density Calibration System
H. Flow Calibration System
I. Speed Calibration System
J. Light Calibration System
K. (Medical Equipment Calibration System was omitted during the field survey.)

2) Equipment for testing

1. Equipment for Electronic Service and Training Center

1-1. Equipment for testing safety of Home Use Electronic Appliances
1-2. Equipment for testing of Electric Irons
1-3. Equipment for testing of Switches, Plugs and Sockets
1-4. Equipment for testing of Refrigerators, Freezers, and Bottle Coolers
1-5. Equipment for testing of Lead Acid Starter Batteries
1-6. Equipment for testing of Television Receivers
1-7. Equipment for testing of Circuit Breakers

2. Equipment for Mechanical Design and Technology Center

2-1. Equipment for the Plastics & Rubber Unit
2-2. Equipment for the Strength of Materials Unit
2-3. Equipment for the Measurement & Calibration Unit

2-4. Equipment for the Metallography & Heat Treatment Unit

2-5. Equipment for the Thermal Testing Unit

2-6. Equipment for the Non-Destructive Testing Unit

2-7. Equipment for the Radiation Measurement and Calibration Laboratory

2-8. (Equipment for the Personal Dosimetry Laboratory System was omitted during the field survey.)

2-9. Equipment for the Casting Technology Unit

3. Equipment for the Industrial Chemistry Center

3-1. Equipment for the Textile & Paper Unit

3-2. Equipment for the Cigarettes Unit

3-3. Equipment for the Organic & Food Unit

3-4. Equipment for the Petrol & Lubricants Laboratory

3-5. Equipment for the Paints, Lacquers & Solvents Laboratory

3-6. Equipment for the Inorganic Material Division

4. Equipment for the Building Research Center

4-1. Equipment for the Cement and Concrete Unit

4-2. Equipment for the Ceramic Unit

4-3. Equipment for the Building Components & Insulation Materials Unit

5. Equipment for the Environmental Research Center

5-1. Equipment for the Chemical Testing Unit

5-2. Equipment for the Microbiological Testing Unit

5-3. Equipment for the Air Quality Measurements Unit

Of the above, the Medical Equipment Calibration System is for calibration of medical equipment in hospitals in Jordan, and Equipment for Personal Dosimetry Laboratory is to enable maintenance of the working environment. The equipment in the both categories is not closely related to improving the quality of products and increasing the competitiveness of the industrial sector. As a result of the discussions during the field survey, those were removed from the request.

In reply to the request, it is planned that necessary and minimum equipment to achieve the project aim should be the scope of grant aid assistance, and the equipment is planned in accordance with the Table 2-1, "Criteria for Selection of Equipment and Decision on Quantities and Specifications."

Table 2-1. Criteria for Selection of Equipment and Decision on Quantities and Specifications

	Calibration equipment	Testing equipment
Selection of equipment (Necessity)	① Calibration equipment for laboratory equipment of RSS ② Calibration equipment for measuring or testing equipment of firms etc.	① Testing equipment for Jordanian industrial products
Selection of equipment (Propriety)	Not to fall into any one of the following categories: ① Items without reliable allocation of staff and budget necessary for good operation and maintenance after procurement ② Items which require high technique, expensive cost or many staff members for good operation, maintenance and traceability/calibration ③ Items which require large-scale modification/construction of buildings for installation ④ Items for which installation areas or storage places are not secured. ⑤ Items for which frequency of use is low or needs of calibration or testing from the industrial sector are rare ⑥ Items necessary for calibration or testing which is conducted more efficiently by other institutions ⑦ Items which may be prepared by other donors at present or in future ⑧ Simple equipment, tools, standards etc. which can be easily procured by RSS ⑨ Items which can be substituted by existing equipment etc. ⑩ Items which have difficulty to procure spare parts or consumables locally ⑪ Short-lived items ⑫ Consumables ⑬ Items which are manufactured or supplied by only one company	
Quantity	① Setting up necessary quantities based on frequency of use, necessary time of use and traceability/calibration ② Planning common use of equipment among centers/divisions/units/laboratories ③ Deducting the numbers of existing equipment	
Specifications	① Considering specifications (ranges, accuracies, etc.) of testing equipment for calibration or those of industrial products for testing ② Considering ranges, accuracies, etc. required by standards in Jordan or countries importing Jordanian products ③ Considering specifications necessary for keeping or acquisition of accreditation of international authoritative institutions ④ Setting up specifications provided that more than one (generally three or more) manufacturers are applicable.	

(2) Policy on Natural Conditions

The city of Amman is located in the Mediterranean climate zone, and it has calm weather all the year round. In addition, the equipment will be generally kept and used in air-conditioned rooms. Therefore, it is not necessary to consider special specifications of the equipment itself against natural conditions. However, cabinets etc. are considered to be necessary for some calibration equipment in order to keep them in good condition.

(3) Policy on Social and Economic Conditions

In Jordan, 93% of the population is Islamite, and social and economic models are mostly in accordance with the Islamic religion. Government offices and private companies have different systems for working times. In case of the Government offices, normal working time is from 8:00 am to 3:00 pm without lunch break, and Friday and Saturday are holidays. In case of most private companies, working time is from 8:00 am to 5:00 pm with a lunch break, and Friday and Saturday are holidays. The Royal Scientific Society adopts the latter system. There are consecutive holidays for a few days (actually about one week) twice a year, i.e., "Eid El Fitr in the week after Ramadan and Eid El Adha from the 9th day of the last month in the Islamic calendar. In 2004, Eid El Adha was from 1 February, and the Eid El Fitr will be around the middle of November. Those two holidays are in accordance with Islamic calendar system, and come around 11 days earlier than the previous year. These dates should be considered for planning and implementation of installation, instruction on operation and maintenance for the equipment, etc. at the site.

(4) Policy on Procurement and Trading Customs

It shall be confirmed that exporting of every item of the equipment will not contravene the law of export control of the both Japan and countries of origin.

(5) Policy on Use of Local Companies

There is no item made in Jordan among the requested equipment, and therefore all the equipment will be imported from Japan, America, Europe, or elsewhere. Local companies will be engaged for a part of work, such as transportation of equipment within Jordan (by transportation companies), and installation, instruction on operation and maintenance for equipment in the Royal Scientific Society (by local agents of manufacturers). There are other items for which the presence of experts from Japan, America or Europe

will be necessary on-site, but it shall be planned that such costs are minimized by using local agents wherever feasible.

(6) Policy on Operation and Maintenance Ability of the Executing Agency

Almost all major items of the existing equipment were procured 10-25 years ago, and are still utilized, with care, in the Royal Scientific Society. Durability periods have been already passed, and production of most spare parts has been ended, but the Royal Scientific Society has been able to use the old equipment through the present day, by overcoming the accompanying trials and tribulations. In regard to the conditions of operation and maintenance of the requested existing equipment, there will be no technical problem in operation and maintenance of newly supplied equipment. In addition, it shall be planned that costs of operation and maintenance after procurement of the equipment shall be minimized.

(7) Policy on Determination of Equipment Grade

Regarding the grade of the calibration equipment to be provided, levels of the primary and the secondary standards shall be the grade of the specific second standards or reference standards respectively in terms of traceability, and levels of equipment for general calibration services shall be the grade of working standards. For the working standards, items which meet demands shall be selected in considerations of specifications of measuring and testing equipment that are calibrated with the standards.

About the equipment for testing, specifications (test items, ranges, accuracies, etc.) for industrial products and requirements of applicable standards shall be considered, and equipment of a suitable level shall be selected. In addition, in consideration of developing situations of industrial sector in Jordan and frequencies of tests expected with actual results, equipment with suitable functions and capacities.

(8) Policy on Methods and Schedule of Procurement of Equipment

Procurement of the equipment shall be executed in accordance with the Japan's grant aid procurement procedures. Procurement shall be planned so that costs are minimized by methods including consideration of procurement of equipment of third-country origin. The equipment will be imported from Japan, America, Europe and elsewhere provided that there is a service agent in Jordan so that spare parts and repair service can be easily obtained domestically.

2-2-2 Basic Plan

2-2-2-1 Overall Plan

The site of the Royal Scientific Society is large, at 340,000m^2, and each center is set far back from adjoining roads. There is very little traffic on internal roads other than staff's arriving and departing time in morning and evening. Therefore, there is almost no influence from car traffic, and the circumstances are ideal for centers of calibration and testing services. Water is supplied from a tower tank; there is no problem in regard to its pressure, quality etc. for use with the equipment. Power fluctuation is within several percent, and there is no problem related to operation of the equipment. In addition, telephone lines and LAN have been provided.

Buildings of the centers are made of reinforced concrete. The Industrial Chemistry Center has two one-story buildings, and the other centers have two-story buildings. The Thermal Testing Unit and Casting Technology Unit of the Mechanical Design and Technology Center are separated from the main building. The Paints, Lacquers & Solvents Laboratory of the Industrial Chemistry Center has an annex building laboratory in addition to a laboratory in the main building. The Air Quality Measurements Unit is separated from the main building too. Heavy equipment will be installed on the ground floor, and the buildings have sufficient strength for the equipment.

The equipment is planned for the calibration and testing services in the centers, provided to meet the demands from the industrial sector in Jordan.

2-2-2-2 Equipment Plan

The equipment has been planned in accordance with the abovementioned "Criteria for selection of equipment and decision of quantity and specification." Specifications for the equipment have been planned in accordance with the criteria and other policies mentioned above. In particular, demand from the industrial sector for calibration and testing services have been confirmed by four methods, i.e., statistical data, a questionnaire submitted to the Royal Scientific Society, a questionnaire sent to enterprises, and visits to enterprises.

Study results for each item of requested equipment are set forth in the annex, "List of Requested Equipment and Study Results." And, the study details of each center, unit and laboratory, and major items are as follows:

(1) Electronic Service and Training Center (ESTC)

1) Standards and Calibration Division (National Calibration Laboratory)

Industries related to this division in Jordan constitute the entire industrial sector (number of enterprises, 18,384; number of employees, 140,009; annual sales, JD 4,080,020,700 [source: Department of Statistics]). This division calibrates production equipment, machines and measuring tools used by the enterprises in their factories. Such calibration is very important for industry to be able to increase output and maintain the quality of its products. In addition, this division calibrates existing equipment and planned equipment in each unit or laboratory. Calibration of existing equipment and planned equipment is indispensable for provision of testing services to industrial sector in Jordan. Such calibrations when performed in external institutions take longer times than internal calibrations, and testing services cannot be provided while calibration is being done. In addition, the cost of such calibrations are transferred to the prices for testing services, and expenses incurred by the enterprises are increased, having an effect on competitiveness of enterprises and their products. Therefore, it is very important that this division be able to calibrate existing equipment and planned equipment internally as much as possible.

For the reasons stated above, both purposes of use are considered in this plan, i.e., calibration of production equipment, machines and measuring tools used by the enterprises in their factories, and calibration of existing equipment and planned equipment.

Desires from or requirements of enterprises and others which have not been met with the existing equipment are as follows:

Table 2-2. ESTC-Standards and Calibration Div. - Unsatisfied Requests

Requested Services	Enterprises etc.	No. of request (2002, 2003)	Necessary Equipment
Calibration of electricity with high accuracy	LG Factory (Middle East Complex) Jordan Cement Factories General Delux Factory Electrical Equipment Industries, etc.	always	Requested items A-1 - A-25
Calibration of temperature with high accuracy	The United Pharmaceutical Mfg. Co. Ltd., etc.	always	Requested items B-1 - B-31
Calibration of length with high accuracy (scale, gage block, angle block, protractor)	JT International Jordan Limited, Jordan New Cable Co., etc.	always	Requested items C-1 - C-32
Calibration of weight (E2, F1), balance, comparator with high accuracy	Cement Factories, Potash Factory, all constructional factories, etc.	always	Requested items D-1 - D-16
Calibration of pressure with high accuracy and wide range	Kent Overseas Ltd., Jordan Cement Factories, Petra Eng. Industries, etc.	always	Requested items E-1 - E-10

Calibration of force	Cement Factories, Potash Factory, National Paints, all constructional factories, etc.	always	Requested items F-2 - F-11
Calibration of volume and density	Pharmaceutical industries Dar Al Dawa Co., IPRC, Potash Factory, Jordan Industrial State, Arab Pump Manufacturing Company, Agrochemical Industry, etc.	always	Requested items G-1 - G-17
Calibration of flow	Dar Al Dawa Co., Petra Engineering Industries, Arab Pump Manufacturing Company, etc.	always	Requested items H-1, H-2
Calibration of speed	Al Hikma Industry Co., IPRC, Potash Factory, Jordan Industrial State, etc.	always	Requested items I-1, I-2
Calibration of light	Electrical and Light Industries Ex. Wafa Electrical Industries, JTI (Japan Tobacco Co.) , etc.	always	Requested items J-1 - J-3
(Source: Answers to questionnaires to the Royal Scientific Society)			

In the fields where calibration is now being provided (electricity, temperature, length, mass, pressure), higher accurate and wider range calibration is requested. In the new field (force, volume and density, flow, speed, light) too, many demands on calibration services are found.

In addition, research of demands is conducted with questionnaires to enterprises during the field survey. Data in the answers to the questionnaires are arranged in the following table.

Table 2-3. ESTC-Standards and Calibration Div. - Demand for Calibration Services (Answer to the Questionnaire)

Requested Services	Enterprises	Expected Frequency	Necessary Equipment
Calibration of electricity with high accuracy	International Pharmaceutical Research Centre, Sayegh Group - National Paints Factories Ltd., Japan Tobacco International, International Storage Battery Co., Jordan New Cable Company, Arab Electrical Industries PLC., National Cable and Wire Manufacturer Co., Jordan Steel, NEGEMCO for Engineering & Contracting	once a year per each machine, measuring tools etc.	Requested items A-1 - A-25
Calibration of temperature with high accuracy	International Pharmaceutical Research Centre, Sayegh Group - National Paints Factories Ltd., International Storage Battery Co., National Cable and Wire Manufacturer Co., Jordan Pipes Manufacturing Co., Rum Alladdin Industries Co. PIC., Metal Industrial Co., General Engineering Industries, Jordan Vegetable Oils Industries Co. Ltd., Jordan Industrial Petrochemical Co. Ltd., Jordan Cement Factories (JCF), Pharma International, National Paints Factories Co. Ltd., Dar Al Dawa, Hikma Pharmaceuticals, United Pharmaceuticals Manufacturing Co.	once a year per each machine, measuring tools etc.	Requested items B-1 - B-31

Calibration of length with high accuracy (scale, gage block, angle block, protractor)	International Pharmaceutical Research Centre, Sayegh Group - National Paints Factories Ltd., Japan Tobacco International, Arab Electrical Industries PLC., Jordan Pipes Manufacturing Co., National Steel Industries. Metal Industrial Co., NEGEMCO for Engineering & Contracting, Nutu-Das, Middle East Can Co., National Paints Factories Co. Ltd., Hikma Pharmaceuticals, United Pharmaceuticals Manufacturing Co.	once a year per each machine, measuring tools etc.	Requested items C-1 - C-32
Calibration of weight (E2, F1), balance, comparator with high accuracy	International Pharmaceutical Research Centre, Advanced Pharmaceutical Industries Co. Ltd., International Storage Battery Co., Arab Electrical Industries PLC., Jordan Paper and Cardboard Factories Co. Ltd. Jordan Vegetable Oils Industries Co. Ltd., Jordan Cement Factories (JCF), Hikma Pharmaceuticals, United Pharmaceuticals Manufacturing Co.	once a year per each machine, measuring tools etc.	Requested items D-1 - D-16
Calibration of pressure with high accuracy and wide range	Advanced Pharmaceutical Industries Co. Ltd., Jordan Pipes Manufacturing Co., Metal Industrial Co., Jordan Industrial Petrochemical Co. Ltd., Jordan Cement Factories (JCF), Pharma International, Middle East Can Co., Dar Al Dawa, Hikma Pharmaceuticals, United Pharmaceuticals Manufacturing Co.	once a year per each machine, measuring tools etc.	Requested items E-1 - E-10
Calibration of force	Jordan New Cable Company, United Iron & Steel Manufacturing Co., Jordan Steel, Jordan Ceramic Industries Co. Ltd., Middle East Can Co.	once a year per each machine, measuring tools etc.	Requested items F-2 - F-11
Calibration of volume and density	Jordan Industrial Petrochemical Co. Ltd.	once a year per each machine, measuring tools etc.	Requested items G-1 - G-17
Calibration of flow	International Pharmaceutical Research Centre, Rum Alladdin Industries Co. PIC., Hikma Pharmaceuticals, United Pharmaceuticals Manufacturing Co.	once a year per each machine, measuring tools etc.	Requested items H-1, H-2
Calibration of speed	International Pharmaceutical Research Centre, Advanced Pharmaceutical Industries Co. Ltd., United Pharmaceuticals Manufacturing Co.	once a year per each machine, measuring tools etc.	Requested item I-1, I-2
Calibration of light	United Iron & Steel Manufacturing Co., Hikma Pharmaceuticals	once a year per each machine, measuring tools etc.	Requested items J-1 - J-3

Moreover, in addition to the questionnaire survey, demands are confirmed with visiting enterprises during the field survey. Data in the visiting research are arranged in the following table.

Table 2-4. ESTC-Standards and Calibration Div. – Demand for Testing Services (Visiting Research)

Enterprises	Requested Services	Expected Frequency	Necessary Equipment
Japan Tobacco International	Calibration of electric equipment, i.e. oscilloscopes etc., with high accuracy	once a year per each machine, measuring tools etc.	Requested items A-1 - A-25
	Calibration of temperature of thermometers etc. with high accuracy	once a year per each machine, measuring tools etc.	Requested items B-1 - B-31
	Calibration of scales, micrometers, rings etc. with high accuracy	once a year per each machine, measuring tools etc.	Requested items C-1 - C-32
	Calibration of weights etc. with high accuracy	once a year per each machine, measuring tools etc.	Requested items D-1 - D-16
	Calibration of pressure gages etc. with high accuracy and wide range	once a year per each machine, measuring tools etc.	Requested items E-1 - E-10
	Calibration of tachometers	once a year per each machine, measuring tools etc.	Requested items I-1, I-2
Jordan Universal Gas Cookers & Washing Machines,	Calibration of temperature of thermometers etc. with high accuracy	once a year per each machine, measuring tools etc.	Requested items B-1 - B-31

The expected frequency of the calibration services is about once a year as mentioned above, but there are some cases wherein a single enterprise has a large number of machines and tools for which calibration is necessary, and there are many such enterprises; therefore, it is judged that there is sufficient demand for the calibration services of this division.

To satisfy the abovementioned requirements, calibration equipment for the following 10 fields has been requested (for National Calibration Laboratory).

A. Electrical
B. Temperature
C. Length
D. Mass
E. Pressure
F. Force
G. Volume & Density
H. Flow
I. Speed

J. Light

As to the Electrical Calibration System (“A” above), the existing equipment is comparatively well provided, but is not composed of items that can calibrate internally, and, consequently, the Royal Scientific Society has been requesting standards institutions or manufacturers in Europe and America to calibrate many pieces of the existing equipment for traceability. With addition of the planned equipment, the system will be able to perform calibrations in external standards institutions or manufacturers are necessary for only some of the primary standards, and the other equipment can be calibrated with the primary standards.

The Electrical Calibration System consists of four subsystems, i.e., a voltage/current calibration system, a capacitance/inductance calibration system, a resistance calibration system, and a time/frequency calibration system.

In the voltage/current calibration system, the primary standards are two items, i.e., a Direct Voltage Reference Standard and a Direct Voltage Standard. Based on the voltage generated by the two items, voltage and current of other items of the equipment are calibrated. One of them shall be calibrated in external international standards institutions or relative manufacturer to keep traceability. Working standards which are used for calibration services provided to enterprises etc., are Oscilloscope Calibrator, Digital Multimeter, Microwave Frequency Counter, etc. A 1000A DC current source is necessary too for testing of welding machines, breakers etc. The Oscilloscope is necessary for internal calibrations of standards too, and Multifunction Calibrator and Calibration Asset Track/Management Software are necessary for that purpose. Using the Oscilloscope Calibrator and the Multifunction Calibrator, standards are calibrated including comparison of their voltage etc. Calibration Asset Track/Management Software is used for evaluation of uncertainty at the time of calibrations.

In the capacitance/inductance calibration system, the primary standards are two items, i.e. Standard Capacitances and Standard Inductance. Those consist of four kinds and five kinds of standards respectively. Those shall be calibrated externally to ensure traceability. Under the primary standards, existing equipment is used as working standards.

In the resistance calibration system, the primary standard is Resistance Standards. It consists of 10 kinds different capacities of items. Among them, 10k ohm Resistance Standard shall be calibrated externally to ensure traceability. Resistance Standards of the other capacities are calibrated internally. Under the primary standards, existing equipment is used as working standards.

In the time/frequency calibration system, the primary standard is the Global Positioning System with

Time Interval Counter. It shall be calibrated externally to ensure traceability. Under the primary standard, existing equipment is used as working standards.

The planned equipment of the Electrical Calibration System is as follows:

Table 2-5. A. Electrical Calibration System - Planned Equipment

System	Planned Equipment
Voltage/Current Calibration System	Direct Voltage Reference Standard 1 unit, Direct Voltage Standard 1 unit, Oscilloscope Calibrator 1 unit, Ohm Meter 1 unit, Digital Multimeter 1 unit, Power Meter Calibrator 1 unit, Power Supply 1 unit, High Voltage Digital Voltmeter 1 unit, 1000A DC Current Source 1 unit, High Voltage Source 1 unit, Microwave Frequency Counter 1 unit, Voltage Reference Divider 1 unit, Calibration Asset Track/Management Software 1 set, Multifunction Calibrator 1 unit
Capacitance/Inductance Calibration System	Standard Capacitances (1pF - 1000pF, 4 kinds) 1 set, Decade Capacitor 1 unit, Standard Inductance 1 set
Resistance Calibration System	Resistance Standards 1 set
Time/Frequency Calibration System	Global Positioning System with Time Interval Counter 1 unit

Among the physical calibration systems (B – J in the list), there are a very limited number of pieces of existing equipment for B to F. In these fields, calibration systems are planned with considerations given to combination of the new with the existing equipment. F - J are new fields, and are planned so that system configurations are as simple as possible, for example, items of working standard level are used as the primary standards.

In the Temperature Calibration System, the primary standards are Triple Point of Water Cell, Freezing Point of Indium Cell, Freezing Point of Aluminum Cell, Freezing Point of Tin Cell, and Freezing Point of Copper Cell. Those shall be calibrated externally and regularly to ensure traceability. To make standard temperatures shown by the primary standards, Bath for Maintaining Triple Point of Water and Gallium Cells, Bath for Maintaining Triple Point of Water and Gallium Cells, and Bath for Maintaining Silver and Copper Cells are necessary. Reference and working standards under the primary standards are Dry Block Calibrator, Spherical Furnace, Reference Standard Thermocouples and Resistance Thermometers, Working Standard Thermocouples and Resistance Thermometers, etc. Those are used for calibration of dry blocks, long thermocouples, thermocouples and resistance thermometers, furnaces and ovens, etc. In addition, for calibrations of thermocouples that are used for manufacturing and quality control of products with comparisons of the Working Standard Thermocouples and Resistance Thermometers, Cold Junction Comparison is necessary. Furthermore, Humidity/Temperature Chamber, Water Bath, Fluid Bathes, Salt Bath are necessary to make certain circumstances for the calibration. Uses of the Water Bath, Fluid Bathes and Salt Bath

are same, but those are used for different temperatures. A conductor of the Water Bath is water, and the Water Bath is used from normal temperature to about 100 degree centigrade. Conductors of the Fluid Baths are fluids other than water. i.e., silicon oil etc., and the Fluid Baths are used for temperatures outside of the range of Water Bath. Tow units of the Fluid Bathes are necessary for low and high temperatures. One unit for low temperature that has cooling functions reaches about minus 35 degree centigrade, and one unit for high temperature reaches about 250 degree centigrade. For temperatures above the limit, i.e., up to about 500 degrees Centigrade, the Salt Bath is used in which molten salt is used as a conductor.

In the Length Calibration System, the primary standards are Gauge Block Sets. Those shall be calibrated externally and regularly to ensure traceability. For calibrations of the other gauge blocks using the primary standards, an Automatic Gauge Block Comparator is necessary. As working standards, Dial Gauge Tester, Machine for calibration of length standards, steel rulers, etc., Special Gauge Block Set for vernier caliper with control ring for inner diameter and height calibration, etc., are necessary. Those are used for calibrations of dial gauges, rulers, vernier calipers, etc. respectively.

In the Mass Calibration System, the primary standards are Weight Sets E1 Class. Those shall be calibrated externally and regularly to keep traceability. Reference and working standards under the primary standards are Weight Sets E2 Class, Weight Sets F1 Class, etc. For calibrations of weights used by enterprises in their factories, Electronic Digital Balances and Digital Balance Comparators are necessary. Those are used for low-accuracy and high-accuracy weights respectively. In addition, at the time of calibrations of weights, it is necessary to measure density of the weights and magnetic susceptibility for compensation of their influence, then, Apparatus for Measuring Density of Weights, and Apparatus for Measuring Magnetic Susceptibility of Weights are necessary.

In the Pressure Calibration System, the primary standard is the Dead Weight Tester. It shall be calibrated externally and regularly to ensure traceability. Reference and working standards under the primary standards are Precision Pressure Gauge, etc.

In the Force Calibration System, the primary standards are Load Cells. For variation of forces, six kinds of items are necessary. And, for reading of the forces of the Load Cells, a Digital Force Read Out is necessary. The Load Cells and the Digital Force Read Out shall be calibrated externally and regularly to ensure traceability. It is planned that the primary standards are used as working standards too. For calibration of Load Cells, a Reference Standard Machine for Calibration of Load Cells is necessary. In consideration of the expected effects relative to equipment scale, the Reference Standard Machine is to be included in the planned equipment provided that it shall not be high accurate and large.

In the Volume & Density Calibration System, the primary standards are Standard Flasks, Standard

Pipettes, Standard Burettes, Standard Hydrometer, Pycnometer, etc. It is planned that those primary standards are to be used as working standards too. Standard Flasks, Standard Hydrometer, etc. shall be calibrated externally and regularly to ensure traceability.

In the Flow Calibration System, the primary standards are Reference Standard and Working Flow Meters. As mentioned in the name of equipment, those are used both as reference standards and working standards. Those shall be calibrated externally and regularly to ensure traceability.

In the Speed Calibration System, Reference Standard and Working Tachometers, etc. have been requested. However, those can be easily procured by Jordan without assistance, and are not included in the planned equipment.

In the Light Calibration System, the primary standards are Reference Standard and Working Luxmeters, etc. As mentioned in the name of equipment, those are used both as reference standards and working standards. They shall be calibrated externally and regularly to ensure traceability.

The planned equipment of the physical calibration systems is as follows

Table 2-6. B - J. Physical Calibration Systems - Planned Equipment

System	Planned Equipment
B. Temperature Calibration System	Water Bath 1 unit, Fluid Bath (low temp.)1 unit, Fluid Bath (high temp.) 1 unit, Salt Bath 1 unit, Ice Point Reference 1 unit, Ice Machine with Crusher 1 unit, Triple Point of Water Cell 1 pc, Freezing Point of Indium Cell 1 pc, Freezing Point of Aluminum Cell 1 pc, Freezing Point of Tin Cell 1 pc, Freezing Point of Copper Cell 1 pc, Bath for Maintaining Triple Point of Water and Gallium Cells 1 unit, Bath for Maintaining Indium, Tin , Zinc and Aluminum Cells 1 unit, Bath for Maintaining Silver and Copper Cells 1 unit, Dry Block Calibrator 2 kinds 1 set, Spherical Furnace 1 unit, Humidity/Temperature Recorder 1 unit, Humidity/Temperature Chamber 1 unit, Reference Standard Thermocouples and Resistance Thermometers 4 kinds 1 set, Working Standard Thermocouples and Resistance Thermometers 4 kinds 1 set, Digital Precision Thermometers 4 kinds 1 set, Liquid In Glass Thermometers 10 kinds 1 set, Clamps for holding thermometers and thermocouples 10 pc 1 set, Cold Junction Comparison 1 unit, Multiplexer Selector Switch 1 unit
C. Length Calibration System	Gauge Block Set 4 kinds 1 set, Angle Block Set (0-360°) 2 sets, Gauge Block Accessory Kit 1 set, Caliper checker 2 units, Inside Micro Checker 2 units, Depth Micro Checker 2 units, Black Granite Surface Plate and Tables 1 unit, Bore Gauges 4 kinds 2 sets, Dial Gauge Tester 1 unit, Precision Level 1 unit, Granite Comparator Stand 2 units, Edge Scale for measurement of parallelism of vernier calipers 2 units, Linear Scale 2 sets, Automatic Gauge Block Comparator 1 unit, Machine for calibration of length standards, steel rulers, etc. 1 unit, Special Gauge Block Set for vernier caliper with control ring for inner diameter and height calibration 1 set, Plate for tempering gauge blocks 2 units
D. Mass Calibration System	Weight Set E1 Class 2 sets, Weight Set E2 Class 2 sets, Weight Set F1 Class 1 set, Weight Set M1 Class 1 set, Electronic Digital Balance 3 kinds each 1 unit, Digital Balance Comparator 4 kinds each 1 unit, Apparatus for Measuring Density of Weights 1 unit, Apparatus for Measuring Magnetic Susceptibility of Weight 1 unit, Desiccator 1 unit, Humidity Controlled Cabinet 1 unit
E. Pressure Calibration System	Dead Weight Tester 1 set, Low, Medium and High Range Pressure Piston 1 set, Weight Set 1 set, Precision Pressure Gauge 2 units, Hydraulic Digital Pressure Calibrators (Fluid and Air) 1 set, Vacuum Pump 1 unit, Vacuum Meter 1 unit, Barometer 1 unit
F. Force Calibration System	Digital Force Read Out 2 units, Reference Standard Machine for Calibration of Load Cells 1 unit, Load Cell 6 kinds each 2 units, Torque Calibration System and Torque Transducer Calibration System 1 set

G. Volume & Density Calibration System	Weighing Machine 1 unit, Balance 1 unit, Standard Flask 10 kinds 1 set, Standard Pipette 10 kinds 1 set, Standard Burette 4 kinds 1 set, Standard Hydrometer 1 unit, Specific Gravity Meter 1 unit, Temperature Bath 1 unit, Water Distillation Apparatus 1 unit, Dry Oven 1 unit, Pycnometer 1 unit, Hydrometer 1 unit, Desiccator 1 unit
H. Flow Calibration System	Reference Standard and Working Flow Meters (Fluid) 3 kinds 2 units each, Reference Standard and Working Flow Meters (Air) 2 kinds each 2 units
I. Speed Calibration System	—
J. Light Calibration System	Reference Standard and Working Luxmeters 2 units, Reference Standard and working UV-meter 2 units

The flow of traceability of planned equipment and existing equipment in each field is shown in annex, "Calibration Traceability Chart."

2) Testing and Quality Control Division

Industries related to this unit in Jordan are manufacturing of household electric appliances (number of enterprises, 51; number of employees, 1,191; annual sales JD22,423,000), manufacturing of switchboards (number of enterprises, 10; number of employees, 187; annual sales, JD3,878,000; source for all: Department of Statistics), and manufacturing of lead acid starter batteries (number of enterprises, 5; as of 2004; source, hearings during the field survey).

In the subsector of manufacturing of household electric appliance and manufacturing of switchboards, there are many medium and small-sized enterprises. By sales amount, among the 81 subsectors of industrial sector, manufacturing of household electric appliance is in 37th place, manufacturing of switchboards is in 59th place, and in total the subsectors are in 32nd place that is a middle position in the industrial sector. And, about 1% employees of the industrial sector are working for the two subsectors. In the subsector of manufacturing of lead acid starter batteries, major manufacturers are large companies in which there has been capital participation by foreign companies, and their products are both sold in the Jordanian market and exported to surrounding countries (no statistical data are available for lead acid starter batteries alone). Products of the subsectors combined, namely manufacturing of household electric appliances, manufacturing of switchboards, and manufacturing of lead acid starter batteries, account for 2.9% of total exports from Jordan (source: Department of Statistics), so the sub-sectors are important for Jordan as a means of acquiring foreign currency.

Therefore, the fields of manufacturing of household electric appliance and manufacturing of switchboard are considered as target subsectors of the project for assistance to the medium and small-sized enterprises and for the third party test necessary for export and confirmation of safety. And, the field of manufacturing of lead acid starter batteries is considered as a target subsector of the project for the third party test necessary for export and confirmation of safety.

Requests from enterprises and others for testing services which have not been available using the existing equipment are as follows.

Table 2-7. ESTC-Testing and Quality Control Division - Unsatisfied Requests

Requested Services	Enterprises etc.	No. of request (2002, 2003)	Necessary Equipment
Test of audio-visual products (TV, video, satellite receiver, radio, etc.), Safety test of air-conditioners	All manufacturers of electronic and electric appliances in Jordan: -Middle East Complex for Electronic Industries -Abu Haltam Group for Electronic and Electric Industries Co. - Petra for engineering Industries, etc.	always	All requested items
IP test of electronic and electric products	All manufacturers of electronic and electric appliances in Jordan	always	
Test of household appliances, refrigerators	All manufacturers of electronic and electric appliances in Jordan: - Abu Haltam Group for Electronic and Electric Industries Co. - Al-Hafiz Group Co. - Middle East Complex for Electronic Industries - Wafa lighting industries, etc.	always	
Test of circuit breakers, switches, plugs, sockets	All manufacturers of electronic and electric appliances in Jordan: - Arab Electrical Industries Co.	always	
Test of lead acid starter batteries	All manufacturers of lead acid starter batteries in Jordan: - International Storage Battery Co. Ltd. "Hoppecke" - United Industries Corporation. "Super", etc.	always	
(Source: Answers to questionnaires to the Royal Scientific Society)			

In addition, research on demand was conducted with questionnaires to enterprises during the field survey. Data in the answers to the questionnaires are arranged in the following table.

Table 2-8. ESTC-Testing and Quality Control Division - Demands on Testing Services (Answer to the Questionnaire)

Requested Services	Enterprises etc.	Expected Frequency	Necessary Equipment
Safety test of household electric appliances	Abu Haltam for Electronic and Electric Industries Corp.	many	Requested items 1-1 - 1-29
Quality test of circuit breakers, switches, plugs, sockets	Arab Electrical Industries PLC.	many	Requested items 3-1 - 3-35
Quality test of refrigerators, freezers, bottle coolers	Abu Haltam Group for Electronic and Electric Industries Co.	many	Requested items 4-1 - 4-6
Quality test of lead acid starter batteries	International Storage Battery Co.	several times per year	Requested items 5-1 - 5-5
Quality test of TV sets	Abu Haltam Group for Electronic and Electric Industries Co.	many	Requested items 6-1 - 6-51
Quality test of circuit breakers	Arab Electrical Industries PLC.	many	Requested items 7-1 - 7-7

Moreover, in addition to the questionnaire survey, demand was confirmed by visiting enterprises during the field survey. Data acquired by this means are arranged in the following table.

Table 2-9. ESTC-Testing and Quality Control Division - Demands on Testing Services
(Visiting Research)

Enterprises	Requested Services	Expected Frequency	Necessary Equipment
Abu Haltam for Electronic and Electric Industries Corp.	Quality test and safety test of TV sets	30-40 kinds test per 1 model per half year as the 3rd party test	Requested items 1-1 - 1-29, 6-1 - 6-51
	Quality test and safety test of refrigerators		Requested items 1-1 - 1-29 4-1 - 4-6
	Safety test of washing machines, air-conditioners, satellite receivers		Requested items 1-1 - 1-29
Jordan Universal Gas Cookers & Washing Machines	Safety test of washing machines	several times per 1 year as the 3rd party test	Requested item 1-1 - 1-29
	Quality test and safety test of refrigerators		Requested items 1-1 - 1-29 4-1 - 4-6

Demands for testing items are increasing, which existing equipment cannot be applied due to progress of technology and standards. Especially, Saudi Arabia which is one of major destination of exports of household electric appliances recently revised its standards (SASO), resulting in a significant increase in testing items required for exporting to that country. Manufacturers in Jordan are making haste to acquire the capability to meet the requirements, and the need for the Royal Scientific Society to have available testing equipment to satisfy the new requirements is great.

The expected frequency of the testing service is twice or several times per model per year, but because quality tests and safety tests are required for a large number of products (models), it is judged that there is sufficient demand in the subsectors to justify equipping the division.

To meet the abovementioned demands, equipment has been requested for the following seven fields of testing.

1. Equipment for testing safety of Home Use Electronic Appliance
2. Equipment for testing of Electric Irons
3. Equipment for testing of Switches, Plugs and Sockets
4. Equipment for testing of Refrigerators, Freezers, and Bottle Coolers
5. Equipment for testing of Lead Acid Starter Batteries
6. Equipment for testing of Television Receivers
7. Equipment for testing of Circuit Breakers

The first on this list is equipment for testing the safety of household electronic and electric appliances. The second to seventh are testing equipment for tests peculiar to the six kinds of

industrial product.

As the Equipment for testing safety of Home Use Electronic Appliances, in accordance with the applicable standards (IEC60335-1, IEC921, EN1081), equipment for electrical safety tests, physical safety tests, and fire resistance and heat resistance tests are required. The major piece of equipment used for the electrical safety test is Proof tracking test apparatus, and it is used particularly for the test to prevent fire due to electric leakage from plugs. The major piece of equipment for the physical safety test is IP Rating Test equipment, and it is used for the test of protection of shell of motors etc. Major equipment for the fire resistance and the heat resistance tests are the Hot winding ohmmeter and Test corner, and those are used for high temperature tests, heat tests, etc. In addition, for refrigerators, microwave ovens, lamps, and electric cables, in accordance with the applicable standards (IEC60335-2-7, IEC60335-2-25, IEC60335-1 and IEC60598-1, IEC227 and IEC228), water pressure test, high voltage test, door endurance tester for microwave ovens, torque resistance test, resistance test are required, for which Water pressure apparatus, a Voltage tester, a Torque tester for lamps, and an RCL Meter are necessary.

As the Equipment for testing of Electric Irons, in accordance with the applicable standards (IEC60311, IEC60335-2-3), equipment for physical strength test, thermal performance test, and steam performance test is necessary. For the tests, respectively, a Circular blade crosscut tester, a Digital Thermometer with recording option, and a Steam pressure measuring apparatus are necessary.

As the Equipment for testing of Switches, Plugs and Sockets, in accordance with the applicable standards (IEC60884-1, IEC6-669-1, UEC60112), equipment for physical strength tests and for electric tests for those products is necessary. Major pieces of equipment for the physical strength test of plugs and sockets are Tumbling barrel, Apparatus for cord retention testing, Apparatus for socket-outlets breaking capacity and normal operation test, and Apparatus for flexing test. Major equipment for the physical strength test of switches is Test apparatus for making and breaking capacity for switches. Major equipment for the electric test is Conductor damage test set, AC current source, Inductive Loads. All of them are for measuring limits of capacities to bear physical or electrical loads.

As the Equipment for testing of Refrigerators, Freezers, and Bottle Coolers, in accordance with the applicable standards (ISO8187, IEC60335-2-24), equipment for thermal performance tests and electric consumption tests is necessary. Major equipment for the thermal performance test is a 50/60 Hz Frequency Converter and Temperature and a Humidity Chamber. The 50/60 Hz Frequency Converter is used to test export products on the same conditions as used in destination countries. The Temperature and Humidity Chamber is used for testing of export products for use where ambient conditions are high temperature and high humidity, which is important for exporting to Gulf countries. For the electric consumption test of products, a Digital kWh Meter is necessary.

As the Equipment for testing of Lead Acid Starter Batteries, in accordance with the applicable standard (IEC60095-1), equipment for performance tests and vibration tests is necessary. Major equipment for the performance test comprises a Temperature Chamber, a High Rate Discharge Tester, a Universal Battery Tester, and a Water Bath. The Temperature Chamber is used for performance tests of lead acid starter batteries under various temperature conditions, especially in low temperatures. The High Rate Discharge Tester is used for testing of performance of lead acid starter batteries when they are discharged. The Universal Battery Tester is used for measuring of capacities, voltage drop, maximum current, recharging time, etc. The Water Bath is used to maintain a constant temperature at the time of testing. The necessary equipment for vibration tests is the Vibration Tester. It is used for testing of strength and solution leakage against vibrations. There is among the existing equipment a vibration tester, but 25 years have passed since it was purchased and it is not available for the testing required by the applicable standard.

As the Equipment for testing of Television Receivers, in accordance with the applicable standards (IEC60065, IEC60107-1), equipment for noise tests, temperature tests, physical and electrical safety tests, display tests, and signal tests is necessary. The major equipment used for the noise test is the Oscilloscope and Surge test generator. Inputting of noise signals is done with the Surge test generator, and measuring with the Oscilloscope. The major equipment for the temperature test is the Softening temperature-testing equipment. It is used for testing of softening of TV set cases when subjected to high temperature. Equipment for the physical and electrical safety test includes Test fingers, Dielectric strength tester, etc. Equipment for the display test is the Microscope, Luminance meter and colorimeter with telescopic lens. The Microscope is used for inspection of defects of scanning lines, etc. with magnifications of displays of TV sets. This is one of test items for picture tubes used in TV sets, which is done by cathode-ray tube manufacturers. However, in Jordan, the test is included in test items for completely assembled TV sets, and this division has used an existing microscope as much as possible. But, the existing microscope is an old type and its magnification ratio is not sufficient, so that this division cannot fulfill the requirement of the standard. The Luminance meter and colorimeter with telescopic lens are used for testing of blightness and color of displays to confirm supply of normal power and signals to the displays. Major equipment for the signal test is the Video test signal generator, the Audio test signal generator, the Spectrum analyzer with digital frequency counting function, the Video noise meter, and the Television test modulator. Inputting signals is done with the Video test signal generator, and measuring and checking shapes of the signals and noise in TV sets with the Spectrum analyzer with digital frequency counting function and Video noise meter. The Television test modulator is used for testing of modulation of video and audio signals. What is mentioned above includes test items for which manufacturers' own tests are sufficient as final testing in

case of large-sized enterprises. However, most TV manufacturers in Jordan are medium and small-sized enterprises, and their own tests are not sufficient, so third-party tests are necessary for export products.

As the Equipment for testing of Circuit Breaker, in accordance with the applicable standard (IEC60898), equipment for electrical tests and physical tests is necessary. Major equipment for electrical tests is Short circuit current test set. This is one of safety tests considering the situations of short circuit. Major equipment for physical tests is the Glow wire test apparatus. Performance of fire-resistance and other tests is done by putting the heated wire (glow wire) on casing materials of circuit breakers.

Expected frequency of use is shown in the list below. Occupancy rate means percentage of periods of use per eight hours a day. It is expected that the major equipment will be frequently used.

Table 2-10. ESTC-Testing and Quality Control Division - Expected Frequency of Use

No.	Major Equipment	Frequency of Use		
		Times/day	Hours /time	Occupancy rate
ESTC- 1-8	Proof tracking test apparatus	10	0.5	62.5%
ESTC- 1-9	IP Rating Test equipment	10	0.5	62.5%
ESTC- 1-14	Door endurance tester for microwave ovens	1	8	100.0%
ESTC- 1-15	Hot winding ohmmeter	3	2	75.0%
ESTC- 1-19	Torque tester for lamps	4	0.5	25.0%
ESTC- 1-20	Life cycling tester for lamps	1	8	100.0%
ESTC- 1-29	Test corner	5	1	62.5%
ESTC- 3-1	Tumbling barrel	4	1	50.0%
ESTC- 3-5	Apparatus for cord retention testing	4	0.25	12.5%
ESTC- 3-12	Apparatus for socket-outlets breaking capacity and normal operation test	1	8	100.0%
ESTC- 3-13	Apparatus for flexing test	1	8	100.0%
ESTC- 3-24	Test apparatus for making and breaking capacity for switches	1	8	100.0%
ESTC- 3-25	Conductor damage test set	4	0.5	25.0%
ESTC- 3-33	AC current source	5	1	62.5%
ESTC- 3-34	Inductive Loads	4	1	50.0%
ESTC- 4-3	Temperature and Humidity Chamber	1	8	100.0%
ESTC- 4-5	Temperature and Humidity Chamber	1	8	100.0%
ESTC- 5-1	Temperature Chamber	1	8	100.0%
ESTC- 5-2	Vibration Tester	1	8	100.0%
ESTC- 5-3	High Rate Discharge Tester	1	8	100.0%
ESTC- 5-4	Universal Battery Tester	1	8	100.0%
ESTC- 5-5	Water Bath	1	8	100.0%
ESTC- 6-7	Oscilloscope	4	1	50.0%
ESTC- 6-8	Softening temperature-testing equipment	4	0.5	25.0%
ESTC- 6-19	Surge test generator	4	1	50.0%
ESTC- 6-28	Full draught oven	2	1	25.0%
ESTC- 6-37	Video test signal generator	4	1	50.0%
ESTC- 6-38	Audio test signal generator	2	1	25.0%
ESTC- 6-41	Spectrum analyzer with digital frequency counting function	4	1	50.0%
ESTC- 6-43	Video noise meter	4	0.25	12.5%
ESTC- 6-47	Television test modulator	4	1	50.0%
ESTC- 7-1	Short circuit current test set with all standard accessories	2	2	50.0%
ESTC- 7-3	Glow wire test apparatus	4	0.5	25.0%

Based on the above-mentioned study, the following equipment is planned for this division.

Table 2-11. ESTC-Testing and Quality Control Division - Planned Equipment

Field / Purpose of Use	Planned Equipment	Applicable Standard
1-1. Equipment for testing safety of Home Use Electronic Appliance		
Electrical safety test	Insulation and breakdown tester 1 unit, Leakage current meter 2 units, Proof tracking test apparatus 1 unit, Creepage Gauge set 1 set, Digital Power Meter 1 unit, Variable transformers 1 unit, Resistance Battery 1 unit, Surface resistivity meter 1 unit	IEC60335-1, IEC921, EN1081
Physical safety test	Spring operated impact hammer 2 units, IP Rating Test equipment 1 unit, Rigid Test finger 1 set	IEC60335-1
Fire resistance and heat resistance test	Ball pressure test set 1 set, Needle flame test apparatus 1 unit, Heating cabinet 1 unit, Hot winding ohmmeter 1 unit, Test corner 1 unit	IEC60335-1
Test of refrigerators	Water pressure apparatus 1 unit	IEC60335-2-7
Test of microwave ovens	Voltage tester 1 unit, Door endurance tester for microwave ovens 1 unit	IEC60335-2-25
Test of lamps	Torque tester for lamps 1 unit, Life cycling tester for lamps 1 unit	IEC60335-1, IEC60598-1
Test of electric cables	RCL Meter 1 unit	IEC227, 228
1-2. Equipment for testing of Electric Irons		
Physical strength test	Circular blade crosscut tester 1 unit	IEC60311
Thermal performance test	Apparatus for measuring temperature drop under load 1 unit, Test apparatus for total steaming time 1 unit, Digital Thermometer with recording option 2 units	IEC60311
Steam performance test	Steam pressure measuring apparatus 1 unit	IEC60335-2-3
1-3. Equipment for testing of Switches, Plugs and Sockets		
Physical strength test of plugs and sockets	Tumbling barrel 1 unit, Pendulum impact test apparatus-mechanism 1 unit, Apparatus for checking the withdrawal force 1 unit, Apparatus for cord retention testing 1 unit, Impact Weight Apparatus 1 unit, Apparatus for socket-outlets breaking capacity and normal operation test 1 unit, Apparatus for flexing test 1 unit, Device for testing non-solid pins 1 unit, Apparatus for plug pin abrasion test 1 unit, Device for checking the resistance to lateral strain 1 unit	IEC60884-1
Physical strength test of switches	4-step double programmable timer 1 unit, Programmable off switching counter 1 unit, Pneumatic drive unit 2 units, Test apparatus for making and breaking capacity for switches 1 unit	IEC60669-1
Electric test	Conductor damage test set 1 set, AC current source 1 unit, Inductive Loads 1 unit	IEC60884-1, IEC60112
1-4. Equipment for testing of Refrigerators, Freezers, and Bottle Coolers		
Thermal performance test	Multi-Channel Temperature Logger 2 units, 50/60 Hz Frequency Converter 1 unit, Temperature and Humidity Chamber 1 unit, Water Evaporation Apparatus 1 unit	ISO8187, IEC60335-2-24
Electric consumption test	Digital kWh Meter 2 units	ISO8187
1-5. Equipment for testing of Lead Acid Starter Batteries		
Performance test	Temperature Chamber 1 unit, High Rate Discharge Tester 1 unit, Universal Battery Tester 1 unit, Water Bath 1 unit	IEC60095-1
Vibration test	Vibration Tester 1 unit	IEC60095-1
1-6. Equipment for testing of Television Receivers		
Noise test	Oscilloscope 1 unit, Discharge meter 1 unit, Surge test generator 1 unit, Dielectric strength for sheet material test instrument 1 unit	IEC60065
Temperature test	Temperature recorder (multi-channel) with thermocouples 2 units, Softening temperature-testing equipment 1 unit, Full draught oven 1 unit	IEC60065
Physical and electrical safety test	Several special equipment for laser classification 1 unit, Test finger 1 pc, Test pin 1 set, Straight test probe 1 set, Test hook 1 pc, Rigid test finger 1 pc, Test tool 1 pc, Dielectric strength tester 1 unit	IEC60065
Display test	Microscope 1 unit, Luminance meter and colorimeter with telescopic lens 1 unit	IEC60065

Signal test	Video test signal generator 2 units, Audio test signal generator 1 unit, RF signal generator 1 unit, Spectrum analyzer with digital frequency counting function 1 unit, Video noise meter 1 unit, Vectorscope 1 unit, Audio level/distortion meter 1 unit, Passive devices 1 unit, Television test modulator 1 unit	IEC60107-1
1-7. Equipment for testing of Circuit Breakers		
Electrical	Short circuit current test set with all standard accessories 1 unit	IEC60898
Physical test	Mechanical shock test apparatus 1 unit, Glow wire test apparatus 1 unit	IEC60898

(2) Mechanical Design and Technology Center (MDTC)

1) Plastics & Rubber Unit

Industries related to this unit in Jordan are manufacturing of plastic products (number of enterprises 220; number of employees, 4,529; annual sales, JD103,585,000), production of plastic and rubber materials (number of enterprises, 10; number of employees, 605; annual sales, JD10,339,000), manufacturing and reclaiming rubber tires (number of enterprises, 14; number of employees, 117; annual sales, JD1,724,000), manufacturing of the other rubber products (number of enterprises, 12; number of employees, 116; annual sales, JD1,156,000; source for all: Department of Statistics).

In terms of sales, among the 81 subsectors of the industrial sector, manufacturing of plastic products is in 10th place, production of plastic and rubber materials is in 44th place, manufacturing and reclaiming rubber tires is in 70th place, manufacturing of the other rubber products is in 76th place, and total of the subsectors is in 8th place overall. And, about 4.2% employees of the industrial sector are working for the subsectors, which are very important fields. In the subsectors, major manufacturers are medium and small-sized enterprises. Products of the subsectors account for 1.9% of total exports from Jordan (source: Department of Statistics), and the subsectors are important for Jordan for acquisition of foreign currency.

Therefore, the fields are considered as target subsectors of the project, and testing equipment is planned for the products, i.e., plastic and rubber products and their materials. Categories of the tests are: tensile tests, viscosity tests, hydro-pressure tests, and aging tests.

Requests from enterprises etc. for testing services which have not been satisfied by use of the existing equipment are as follows.

Table 2-12. MDTC-Plastics & Rubber Unit - Unsatisfied Requests

Requested Services	Enterprises etc.	No. of request (2002, 2003)	Necessary Equipment
Tensile test of plastic materials and films	Manufacturers of plastic films, sheets, bottled drink	always	Requested items 1-1, 1-6
Hydro-pressure test of large diameter pipes	JISM	always	Requested item 1-11
Tensile test of plastic materials	JISM	always	Requested item 1-1
Tensile test of plastic films	JISM	always	Requested item 1-6
(Source: Answers to questionnaires to the Royal Scientific Society)			

In addition, research on testing requirements was conducted by use of questionnaires to enterprises during the field survey. Data in the answers to the questionnaires are arranged in the following table.

Table 2-13. MDTC-Plastics & Rubber Unit- Demands on Testing Services

(Answer to the Questionnaire)

Requested Services	Enterprises etc.	Expected Frequency	Necessary Equipment
Tensile test of plastic materials	International Plastic Company Ltd., Arabian Steel Piping Manufacturing Co.	75-125 /year 20 /year	Requested items 1-1, 1-6
Measurement of viscosity	International Plastic Company Ltd., Arabian Steel Piping Manufacturing Co.	120-200 /year 20 /year	Requested item 1-2
Aging test	International Plastic Company Ltd., Arabian Steel Piping Manufacturing Co.	50-100 /year 20 /year	Requested item 1-4

Every item of the testing services is expected to be used frequently, and there are many enterprises in the subsectors. Hence, it is judged that there is sufficient demand in the subsectors to equip the unit as planned.

For the tensile test, the necessary major equipment is a Universal testing machine and a Computerized tensile film tester. The Universal testing machine is necessary for measuring of tensile strength of plastics in accordance with the applicable standards (ASTM D638M, ISO6259, ISO527). The existing universal testing machine which was made in 1974 is an old type, its capacity is up to 500N, and it is not usable for meeting recent demand, which is for up to about 15,000N. The Computerized tensile film tester is necessary for measuring tensile strength of plastic films in accordance with the applicable standards (ASTM D2103, ISO527, 4593).

For the measurement of viscosity, the necessary equipment is the Melt flow indexer. It is necessary for the measurement of plastics etc. in accordance with the applicable standards (ISO1133, ASTM D1238). The existing melt flow indexer which was made in 1979 is too old, and it is not applicable for tests with accuracies required by the standards.

In addition, a Sample preparation machine is necessary for preparation of plastic samples for the each test.

Expected frequency of use is shown on the list below. It is expected that the major equipment will be frequently used.

Table 2-14. MDTC-Plastics & Rubber Unit - Expected Frequency of Use

No.	Major Equipment	Frequency of Use		
		Times/day	Hours/time	Occupancy rate
MDTC- 1-1	Universal testing machine	1	7	87.5%
MDTC- 1-2	Melt flow indexer	1	6	75.0%
MDTC- 1-6	Computerized tensile film tester	1	5	62.5%
MDTC- 1-7	Sample preparation machine	1	2.5	31.3%

For the above-mentioned demands, the following equipment is planned for the project.

Table 2-15. MDTC-Plastics & Rubber Unit - Planned Equipment

Purpose of Use	Planned Equipment
Tensile test	Universal testing machine 1 unit, Computerized tensile film tester 1 unit
Measurement of viscosity	Melt flow indexer 1 unit
Sample preparation	Analytical balance 1 unit, Sample preparation machine 1 unit, Punch dies for plastic tensile samples 1 set

For the hydro-pressure test, an existing hydro-pressure testing device is used together with requested end caps for pressure testing. Therefore, it is planned that the end caps for pressure testing of large diameter of pipes shall be provided by the Jordanian side.

For the aging test, a forced circulation oven is necessary in accordance with the applicable standards (ISO2505, DIN8061, 8075, 16892), and it is planned that an existing forced circulation oven will continue to be used for the tests.

2) Strength of Materials Unit

Jordan‘s industries related to this unit are manufacturing of steel (number of enterprises, 24; number of employees, 1,560; annual sales, JD106,022,900), manufacturing of metal goods (number of enterprises, 737; number of employees, 3,025; annual sales, JD57,261,000), manufacturing of non-ferrous metals (number of enterprises, 6; number of employees, 657; annual sales, JD25,366,000; source for all: Department of Statistics).

In terms of sales, among the 81 subsectors of the industrial sector, manufacturing of steel is in 9th place, manufacturing of metal goods is in 23rd place, manufacturing of non-ferrous metals is in 33rd place, and total of the subsectors is in 6th place, a high rank. And, about 3.8% of all employees of the industrial sector are working for these subsectors, which are very important fields. In the subsectors, major manufacturers are large enterprises, but there are many medium and small-sized enterprises too. Products of the subsectors account for 3.5% of total exports from Jordan (source: Department of Statistics), so the subsectors are important for Jordan for acquisition of foreign currency.

Therefore, the categories are considered as suitable target subsectors of the project, and testing equipment is planned for measurement of the strength of ferrous and non-ferrous materials of the products. Categories of the tests are tensile and compression, impact, and hydro-pressure.

Requests from enterprises etc. for testing services which have not been available by means of use of

the existing equipment are as follows:

Table 2-16. MDTC-Strength of Materials Unit - Unsatisfied Requests

Requested Services	Enterprises etc.	No. of request (2002, 2003)	Necessary Equipment
Tensile and compression test	General companies	100	Requested item 2-1
Impact test for pipes	Water Authority	200	Requested item 2-6
Impact test	Jordan Petroleum Refinery	30	Requested items 2-2, 2-4
Hydro pressure test	JISM	6	Requested item 2-6
(Source: Answers to questionnaires to the Royal Scientific Society)			

In addition, research on needs was conducted by use of questionnaires collected from enterprises during the field survey. Data in the answers to the questionnaires are arranged in the following table.

Table 2-17. MDTC-Strength of Materials Unit - Demands on Testing Services
(Answer to the Questionnaire)

Requested Services	Enterprises etc.	Expected Frequency	Necessary Equipment
Tensile and compression test	United Iron & Steel Manufacturing Co., Al Ittihad Foundry, A1 Engineering Manufacturing Group	50 /year 100/ year 150 /year	Requested item 2-1
Impact test	Al Ittihad Foundry, Jordan Petroleum Refinery Co. Ltd.	150 /year 5 /year	Requested item 2-4
Hydro pressure test	A1 Engineering Manufacturing Group, Jordan Pipes Manufacturing Co.	150 /year 4 /year	Requested item 2-6

Though there are differences with regard to the expected frequency of testing among the enterprises, every one of the relevant testing services is expected to be used frequently, and there are many enterprises in the subsectors. Hence it is judged that there is sufficient demand in the subsectors to justify equipping the unit with the equipment planned.

For the tensile and compression tests, the necessary equipment is an Automated Universal tensile/compression testing machine. It is used for measurement of tensile strength and compression strength of steel bars etc. in accordance with the applicable standard (EN10002, ASTM370). The existing universal tensile/compression testing machine is too old and its functions and the number of types of test it can perform are limited, so it is not always applicable to satisfy demand.

For the impact test, necessary equipment is impact testing machine. It is used for measurement of strength of steel bars, plates etc. against impact in accordance with the applicable standard (ASTM E23,

etc.). An existing impact testing machine does not conform to applicable standard, ASTM. Then, then it is not applicable to the testing according to the standard.

Expected frequency of use is shown on the list below. It is expected that the major equipment will be frequently used.

Table 2-18. MDTC-Strength of Materials Unit - Expected Frequency of Use

No.	Major Equipment	Frequency of Use		
		Times/day	Hours/time	Occupancy rate
MDTC- 2-1	Automated Universal tensile/compression testing machine	1	9	112.5%
MDTC- 2-4	Impact testing machine	0.2	10	25.0%

For the above-mentioned demand, the following equipment is planned for the project.

Table 2-19. MDTC-Strength of Materials Unit - Planned Equipment

Purpose of Use	Planned Equipment
Tensile and compression test	Automated Universal tensile/compression testing machine 1 unit
Impact test	Impact testing machine 1 unit
Sample preparation	Analytical balance 1 unit, Thermocouple 1 unit

3) Measurement & Calibration Unit

This unit measures length, height, thickness, weight etc. of test samples. This unit supplies such services to the other units and laboratories of the Royal Scientific Society. Provision of equipment for such measurement in this unit for common use will be more effective than provision of such equipment in each unit or laboratory.

The requested equipment consists of small items, but they are necessary for the measurement of samples. With deletion of items which can be substituted by use of existing equipment or other measures, the following equipment is planned for the project.

Table 2-20. MDTC-Measurement & Calibration Unit - Planned Equipment

Purpose of Use	Planned Equipment
Measurement of length, height etc.	Digital height master 1 unit, Calibrated steel balls 1 set, Ultrasonic thickness gauge 1 unit, Coating and oxidation thickness gauge 1 unit
Measurement of weight	Digital balance (5kg) 1 unit, Digital balance (50kg) 1 unit, Digital balance (100kg) 1 unit

4) Metallography & Heat Treatment Unit

Industries related to this unit in Jordan are manufacturing of steel (number of enterprises 24, number of employees, 1,560; annual sales, JD106,022,900), manufacturing of metal goods (number of enterprises, 737; number of employees, 3,025; annual sales, JD57,261,000), manufacturing of non-ferrous metals (number of enterprises, 6; number of employees, 657; annual sales, JD25,366,000; source for all: Department of Statistics), and those are same as the above mentioned target subsectors for the Strength of Materials Unit. While the Strength of Materials Unit measures physical strength of metals, this unit tests compositions and characteristics of metals.

In this unit too, the fields are considered as target subsectors of the project, and testing equipment, is planned for the test of compositions and characteristics of metals. Categories of testing are chemical analysis (micro structures and elemental analysis), measurement of hardness, heat treatment, rust resistance, and thickness test of internal coating of cans for canning industry.

Requests from enterprises etc. of testing services which have not been met by use of the existing equipment are as follows:

Table 2-21. MDTC-Metallography & Heat Treatment Unit - Unsatisfied Requests

Requested Services	Enterprises etc.	No. of request (2002, 2003)	Necessary Equipment
Thickness test of internal coating of cans	National Canning Co./Zarqa Best Food / Giza, etc.	20	Requested item 4-14
Measurement of C, S, N in metals	Jordan Petroleum Refinery Co. – Zarqa	6	Requested items 4-1-2, 4-6
Measurement of hardness	Food canning industry Jordan Petroleum Refinery Jordan Phosphate Mines Co.	10	Requested items 4-4-1, 4-4-2
Thickness test of internal coating of cans	JISM	always	Requested item 4-14
Measurement of C, S, N in metals	JISM	always	Requested items 4-1-2, 4-6
Measurement of hardness	JISM	always	Requested items 4-4-1, 4-4-2
(Source: Answers to questionnaires to the Royal Scientific Society)			

In addition, research on demand was conducted by use of questionnaires recovered from enterprises during the field survey. Data in the answers to the questionnaires are arranged in the following table.

Table 2-22. MDTC-Metallography & Heat Treatment Unit - Demands on Testing Services
(Answer to the Questionnaire)

Requested Services	Enterprises etc.	Expected Frequency	Necessary Equipment
Chemical analysis of metallic products and materials	Al Ittihad Foundry, A1 Engineering Manufacturing Group, Jordan Steel	50 /year 150 /year 12 /year	Requested items 4-1-1, 4-1-2, 4-5
Measurement of hardness	Jordan Steel	12 /year	Requested item 4-4-1, 4-4-2
Heat treatment test	Jordan Steel	12 /year	Requested item 4-9
Rust resistance	Jordan Steel	12 /year	Requested item 4-10

There are differences regarding the expected frequency of testing among the enterprises, anyhow, there are many enterprises in the subsectors, and hence it is judged that there is sufficient demand in the sub-sectors to equip the unit.

For the chemical analysis of metallic products and materials, testing methods are specified in relative standards, and they consist of microstructure and elemental analysis, carbon and sulphur analysis using combustion methods, and elemental analysis of solutions. For the microstructure and elemental analysis, in accordance with the applicable standards (WI 321/02, FQA, etc.), a Scanning Electron Microscope with X-ray Analyzer is necessary. The existing scanning electron microscope with x-ray analyzer which was made in 1987 is too old, and replacement is required as it is not internationally accredited due to low accuracy. As an accessory, wavelength despersive x-ray analyzer (WDX) has been requested. The sensitivity of the energy despersive x-ray analyzer (EDX) is low (about 0.1%), and WDX has an advantage that its sensitivity is higher (about 0.01～0.001%). However, EDX can analyze many elements simultaneously, but WDX can analyze only one element at a time and it takes a longer time to do so. Furthermore, WDX has a disadvantage that its measuring of data is uneven (low repeatability). Considering these matters, it is planned that the accessory is to be an EDX instead of a WDX. For the carbon and sulphur analysis using combustion methods (burning metal samples in high-frequency furnace or tubular electric furnace to oxidize carbon and sulphur in the sample, and measuring carbon and sulphur by means of infrared absorption) in metal, in accordance with the applicable standards (WI 321/03, FQA, etc.), a CS Analyzer is necessary. It is used for quantitative analysis with high accuracy of carbon measurement as carbon content affects mechanical properties and heat treatment characteristics, and of sulphur as one of impurities which affects strength. The existing CS analyzer which was made in 1984 is too old, and replacement is required. For the elemental analysis of solutions, in accordance with the applicable standards (JS 441, FQA, etc.), a Portable Spectrometer is necessary.

For the measurement of hardness of metallic products and materials, the necessary equipment is hardness testers. In accordance with the applicable standards (ISO 6506, 6507, 6508, WI 321/06), Brinel, Vickers, Rockwell, and mini-load hardness testers are necessary. A Digital Universal Hardness Tester which can be used for all the Brinel, Vickers, Rockwell hardness tests, and Mini-load hardness (Micro-hardness) tester for thin samples, have been requested. The existing universal hardness tester which was made in 1974 is too old to use, and replacement is required.

For the heat treatment test of metallic products and materials, in accordance with the applicable standards (ASTM F467, F468, etc.), an Electric Furnace is necessary. There are four existing electric furnaces which were made in 1974 or 1976. Those are too old, and those cannot satisfy requirement.

For the rust-resistance test of metallic products and materials, in accordance with the applicable standards (ASTM G85, 112), a Salt Spray Cabinet is necessary. The existing salt spray cabinet which was made in 1973 is too old, and is hardly usable.

For the thickness test of internal coating of cans, in accordance with the applicable standard (JS 372), a Lacquer Thickness Measurement is necessary.

In addition, for the preparation of samples, Cutting Machine, Grinding and polishing machines, and an Automatic Mounting Press Machine for Sample preparation are necessary. Cutting metals to fixed sizes is done by the Cutting Machine, grinding and polishing the surface by the Grinding and polishing machine. The Automatic Mounting Press Machine for Sample preparation is used to fix small samples in plastics. The existing cutting machine, grinding machine, and polishing machine which were made in 1973 are too old, and replacement is required.

Expected frequency of use is shown on the list below. It is expected that the major equipment will be frequently used.

Table 2-23. MDTC-Metallography & Heat Treatment Unit - Expected Frequency of Use

No.	Major Equipment	Frequency of Use		
		Times/day	Hours/time	Occupancy rate
MDTC- 4-1-1	Scanning Electron Microscope with X-ray Analyzer	0.8	8	80.0%
MDTC- 4-1-2	CS Analyzer	1	15	187.5%
MDTC- 4-2	Cutting Machine	1	7	87.5%
MDTC- 4-3	Grinding and polishing machines	1	10	125.0%
MDTC- 4-4-1	Digital Universal Hardness Tester	1	12.5	156.3%
MDTC- 4-4-2	Mini-load hardness (Micro-hardness) tester	1	7.5	93.8%
MDTC- 4-9	Electric Furnace	1	1	12.5%
MDTC- 4-10	Salt Spray Cabinet	0.025	500	156.3%
MDTC- 4-13	Automatic Mounting Press Machine for Sample preparation	1	10	125.0%

For the above-mentioned demands, the following equipment is planned for the project.

Table 2-24. MDTC-Metallography & Heat Treatment Unit - Planned Equipment

Purpose of Use	Planned Equipment
Chemical analysis of metallic products and materials	Scanning Electron Microscope with X-ray Analyzer 1 unit, CS Analyzer 1 unit, Portable Spectrometer 1 unit
Measurement of hardness	Digital Universal Hardness Tester 1 unit, Mini-load hardness (Micro-hardness) tester 1 unit, Universal Hardness Tester References Blocks 1 pc
Heat treatment test	Electric Furnace 1 unit
Rust-resistance test	Salt Spray Cabinet 1 unit
Thickness test of internal coating of cans	Lacquer Thickness Measurement 1 unit
Preparation of samples	Cutting Machine 1 unit, Grinding and polishing machines 1 set, Electronic Balance 1 unit, Automatic Mounting Press Machine for Sample preparation 1 unit

A Scanning Electron Microscope is one of the pieces of equipment that is comparatively difficult to operate and maintain, but an existing scanning electron microscope has been operated and maintained for a long time, and it is supposed that this item can continue to be used by the Royal Scientific Society.

For operation and maintenance of the Scanning Electron Microscope, one of the most frequent replaced parts is the filament for an electron gun. It is planned that the filament be of the wolfram type which is less expensive and replaceable by the user, so that the costs for operation and maintenance can be held down.

5) Thermal Testing Unit

Industries related to this unit in Jordan are manufacturing of radiator heaters (number of enterprises, 7; export 7,434JD/year), manufacturing of cookers (number of enterprises, 8; export 5,687,000JD/year, as of January 2004;, source: Amman Chamber of Industry). The number of the enterprises is not many, and beneficial effects are not large in case that the fields are considered as target subsectors of the project.

Requests from enterprises etc. of testing services which could not be met with the existing equipment are as follows.

Table 2-25. MDTC-Thermal Testing Unit - Unsatisfied Requests

Requested Services	Enterprises etc.	No. of request (2002, 2003)	Necessary Equipment
Testing of hot water radiator heaters	Middle East Est-for Heating Equipment, Al-Tayseer for Trade & Industrial Investment, General Engineering Industries	12	Requested item 5-1
Testing of boilers	Keilani Industrial Foundation, METALCO, Middle East Est-for Heating Equipment	18	Boiler testing equipment
Testing of cookers	Universal Gas Cookers, Rum Alladdin Industries Co. PIC.	38	Requested item 5-2
(Source: Answers to questionnaires to the Royal Scientific Society)			

In addition, research on requirements was conducted using questionnaires recovered from enterprises during the field survey. Data in the answers to the questionnaires are arranged in the following table.

Table 2-26. MDTC-Thermal Testing Unit - Demands on Testing Services (Answer to the Questionnaire)

Requested Services	Enterprises etc.	Expected Frequency	Necessary Equipment
Testing of hot water radiator heaters	General Engineering Industries	12 /year	Requested item 5-1
Testing of cookers	Universal Gas Cookers & Washing Machine, Rum Alladdin Industries Co.	12 /year 12 /year	Requested item 5-2

Moreover, in addition to the questionnaire survey, requirements were confirmed by visiting enterprises during the field survey. Data obtained from the visits are arranged in the following table.

Table 2-27. MDTC-Thermal Testing Unit - Demands on Testing Services (Visiting Research)

Enterprises	Requested Services	Expected Frequency	Necessary Equipment
Universal Gas Cookers & Washing Machine	testing of gas cookers	12 /year	Requested item 5-2

Expected frequency of the testing services is once a month for each enterprise.

For the above-mentioned demands, Establishing a facility (closed room) to test radiator and Establishing a facility to test domestic gas cookers have been requested.

Although the existing testing room for radiators is of the open type, not the closed type which is recommended by the applicable standard (EN442, DIN4704), it still can be used.

A piece of existing testing equipment for boilers that has been diverted for testing of gas cookers, is not applicable to all testing items required by the applicable standard (JS510, 511) and testing items

necessary for export of the products. The manufacturers have requested testing institutes in India and elsewhere to conduct testing of their export products. It is inconvenient, but such other institutes can be available for the testing of exporting products in future too.

Due to the above considerations, it is decided that these fields are not target subsectors, and the requested equipment is not included in the planned equipment.

6) Non-Destructive Testing Unit

Jordan's industries related to this unit are manufacturing of steel construction materials (number of enterprises, 2,801; number of employees, 6,888; annual sales, JD57,193,000), steel tanks and vessels (number of enterprises, 153; number of employees, 398; annual sales, JD1,647,000), casting (number of enterprises, 12; number of employees, 299; annual sales, JD7,680,000; source: Department of Statistics).

In terms of sales, among the 81 subsectors of the industrial sector, manufacturing of steel construction materials is in 21st place, steel tanks and vessels is in 71st place, casting is in 52nd place, and the total of the subsectors is in 18th place, a moderately high rank. And, about 5.4% of all employees of the industrial sector are working for these subsectors, which are important fields in this respect. In the subsectors, major manufacturers are large enterprises, but there are many medium and small-sized enterprises too. Products of the sub-sectors account for 1.9% of total exports from Jordan (source: Department of Statistics), the subsectors thus are important for Jordan for acquisition of foreign currency.

Therefore, the fields are considered as target subsectors of the project, and testing equipment is planned for checking welded parts and inside the casting of the products. Categories of testing are x-ray, ultrasonic, and ultrasonic thickness measurement.

Requests from enterprises etc. for testing services which have not been met with the existing equipment are as follows:

Table 2-28. MDTC-Non-Destructive Testing Unit - Unsatisfied Requests

Requested Services	Enterprises etc.	No. of request (2002, 2003)	Necessary Equipment
X-ray test	JPRC, METALCO	10	Requested item 6-1
Ultrasonic test	JPRC	4	Requested item 6-3
Ultrasonic thickness measurement	JPRC, METALCO	15	Requested item 6-4
(Source: Answers to questionnaires to the Royal Scientific Society)			

In addition, research on requirements was conducted using questionnaires recovered from enterprises during the field survey. Data in the answers to the questionnaires are arranged in the following table.

Table 2-29. MDTC-Non-Destructive Testing Unit - Demands on Testing Services
(Answer to the Questionnaire)

Requested Services	Enterprises etc.	Expected Frequency	Necessary Equipment
X-ray test	Metal Industrial Co., NEGEMCO for Engineering & Contracting, Jordan Petroleum Refinery Co. Ltd., General Engineering Industries	all boilers 3 /year 5 /year all products	Requested item 6-1
Ultrasonic test			Requested item 6-3
Ultrasonic thickness measurement			Requested item 6-4

There are differences of expected frequency of testing among the enterprises, but moreover, there are many enterprises in the subsectors, and it is judged that there is sufficient demand in the subsectors to equip the unit.

For the x-ray test, the necessary equipment is a Directional X-Ray Machine for industrial radiography. The existing directional x-ray machine is too old and too inaccurate and low in reliability, and it cannot be calibrated. For such testing in factories etc., a portable type has been requested.

For the ultrasonic test, the necessary equipment is Digital Ultrasonic Flow Detectors with probes. There are three existing ultrasonic flow detectors, but all of them are too old and low in accuracy, and cannot satisfy the requirements.

For the ultrasonic thickness measurement, the necessary equipment is Digital Ultrasonic Thickness Gauge. It is used for measuring of welded parts of large metallic tanks and vessels.

The expected frequency of use is shown on the list below. It is expected that the major equipment will be frequently used.

Table 2-30. MDTC-Non-Destructive Testing Unit - Expected Frequency of Use

No.	Major Equipment	Frequency of Use		
		Times/day	Hours/time	Occupancy rate
MDTC- 6-1	Directional X-Ray Machine for industrial radiography	0.4	6	30.0%
MDTC- 6-3	Digital Ultrasonic Thickness Gauge	0.2	40	100.0%

For the above-mentioned demands, the following equipment is planned for the project.

Table 2-31. MDTC-Non-Destructive Testing Unit - Planned Equipment

Purpose of Use	Planned Equipment
X-ray test	Directional X-Ray Machine for industrial radiography 1 unit
Ultrasonic test	Digital Ultrasonic Flow Detectors with probes 2 units
Ultrasonic thickness measurement	Digital Ultrasonic Thickness Gauge 1 unit

7) Radiation Measurement and Calibration Laboratory

Jordan's industries related to this unit produce non-alcoholic beverages (number of enterprises, 31; number of employees, 2,884; annual sales, JD76,598,800), flour milling (number of enterprises, 197; number of employees, 924; annual sales, JD73,327,300), production of alcoholic beverages (number of enterprises, 8; number of employees, 463; annual sales, JD21,298,000), fruit and vegetable processing (number of enterprises, 19; number of employees, 853; annual sales, JD12,004,000; source: Department of Statistics).

In terms of sales, among the 81 subsectors of the industrial sector, production of non-alcoholic beverages is in 17th place, flour milling is in 16th place, production of alcoholic beverages is in 38th place, fruit and vegetable processing is in 43rd place, and total of the subsectors is in 6th place, a high rank. And, about 3.5% of all employees of the industrial sector are working for the subsectors, which are very important fields. In the subsectors, major manufacturers are large enterprises, but there are many medium and small-sized enterprises too. Products of the subsectors account for 1.7% of total exports from Jordan (source: Department of Statistics).

Therefore, the fields are considered as target subsectors of the project, and testing equipment is planned for checking radioactive contamination of the products such as foods and beverages. Categories of the tests are Gamma spectroscopy, and gross Alpha / Beta count.

Requests from enterprises and others for testing services which could not be satisfied using the existing equipment are as follows.

Table 2-32. MDTC-Radiation Measurement and Calibration Laboratory - Unsatisfied Requests

Requested Services	Enterprises etc.	No. of request (2002, 2003)	Necessary Equipment
Alpha/Beta ray test	Mineral Water Industries (via ERC)	10	Requested item 7-5
Neutron dose/ dose rate test	Road Construction Companies	8	Requested item 7-6
Neutron dose/ dose rate test	National Center for Agriculture Research	8	Requested item 7-6
(Source: Answers to questionnaires to the Royal Scientific Society)			

In addition, research on requirements was conducted using recovered questionnaires from enterprises during the field survey. Data in the answers to the questionnaires are arranged in the following table.

Table 2-33. MDTC-Radiation Measurement and Calibration Laboratory
- Demands on Testing Services (Answer to the Questionnaire)

Requested Services	Enterprises etc.	Expected Frequency	Necessary Equipment
Gamma spectroscopy test	Nutu-Das	all products	Requested items 7-2, 7-3
Radon/Radon daughter test	Nutu-Das	all products	Requested item 7-4

For the enterprises engaged in food processing and beverage production, it is necessary to certify that there is no radioactive contamination of their products for export. Therefore, it is judged that there is sufficient demand in the subsectors to equip the laboratory.

For the Gamma spectroscopy test, in accordance with the applicable standard (ASTM E181), the necessary equipment is Low level Gamma Spectroscopy System or Portable Gamma Spectroscopy System, and Gamma–Ray Spectroscopy Analysis Software. The Low level Gamma Spectroscopy System is used for measurement in the laboratory of radioactive contamination in foods, potassium, salt, fertilizer, feed, etc. The purpose of use of the Portable Gamma Spectroscopy System is the same as t his, but it is used in sites such as freighters etc., and both items were requested. With all respect to the request, it is planned that the Portable Gamma Spectroscopy System is to be used in the both laboratory and outside sites, and the Low level Gamma Spectroscopy System for the testing exclusively in the laboratory only is not included in the planned equipment. The Gamma–Ray Spectroscopy Analysis Software is used for processing and analyzing the data from the Portable Gamma Spectroscopy System and calculating the levels of radiation, concentration of radioactivity, etc.

For the gross Alpha / Beta count, in accordance with the applicable standard (JS 286, 1214, 200), the

necessary equipment is a Gross Alpha / Beta Counter. It is used for checking of radioactive contamination in foods, beverages, etc.

Expected frequency of use is shown on the list below. It is expected that the major equipment will be frequently used.

Table 2-34. MDTC-Radiation Measurement and Calibration Laboratory - Expected Frequency of Use

No.	Major Equipment	Frequency of Use		
		Times/day	Hours/time	Occupancy Rate
MDTC- 7-2	Gamma–Ray Spectroscopy Analysis Software	1	8	100.0%
MDTC- 7-3	Portable Gamma Spectroscopy System	0.4	8	40.0%
MDTC- 7-5	Gross Alpha / Beta Counter	0.4	8	40.0%

For the above-mentioned requirements, the following equipment is planned for the project.

Table 2-35. MDTC-Radiation Measurement and Calibration Laboratory - Planned Equipment

Purpose of Use	Planned Equipment
Gamma spectroscopy test	Portable Gamma Spectroscopy System 1 unit, Gamma–Ray Spectroscopy Analysis Software 1 set
Gross Alpha / Beta Count	Gross Alpha / Beta Counter 1 unit

Purposes of the Neutron dose/ dose rate test in the above "Unsatisfied Requests" are checking for radioactive contamination in raw materials or the working environment. Then, it is considered that these are not closely related to the improving the quality of Jordanian industrial products, and equipment for those tests are not included in the planned equipment.

8) Casting Technology Unit

An industry related to this unit in Jordan is casting (number of enterprises, 12; number of employees, 299, annual sales, JD7,680,000; source: Department of Statistics). In addition, the category of manufacturing of sand for casting is included.

In terms of sales, among the 81 subsectors of the industrial sector, casting is in 52nd place, a middle rank. And, about 0.2% employees of the industrial sector are working for the subsector. In the subsector, major manufacturers are medium and small-sized enterprises. The scale of the subsector is not large, but it is one of fundamental industries for the other industrial fields, i.e., making parts of machines, cars, trains, molds for plastic injection, etc., and it is a very important field for development

of industry.

Therefore, the field is considered as a target subsector of the project, and testing equipment is planned for testing of casting and sand for casting. Categories of the tests are hardness testing of castings, sand test for castings, and casting test.

Requests from enterprises and others for testing services which could¥ not be provided with the existing equipment are as follows:

Table 2-36. MDTC-Casting Technology Unit - Unsatisfied Requests

Requested Services	Enterprises etc.	No. of request (2002, 2003)	Necessary Equipment
Chemical analysis, hardness test and sand test in site of casting	every foundry in Jordan	many and always	Requested items 9-1, 9-3, 9-4
(Source: Answers to questionnaires to the Royal Scientific Society)			

In addition, research on requirements was conducted using questionnaires recovered from enterprises during the field survey. Data in the answers to the questionnaires are arranged in the following table.

Table 2-37. MDTC-Casting Technology Unit - Demands on Testing Services
(Answer to the Questionnaire)

Requested Services	Enterprises etc.	Expected Frequency	Necessary Equipment
Hardness test of casting	Al Ittihad Foundry, A1 Engineering Manufacturing Group	150 /year 150 /year	Requested item 9-1
Sand test for casting	Al Ittihad Foundry, A1 Engineering Manufacturing Group	15 /year 15 /year	Requested items 9-3, 9-4

Moreover, in addition to the questionnaire survey, requirements were confirmed by visits to enterprises during the field survey. Data from the visits are arranged in the following table.

Table 2-38. MDTC-Casting Technology Unit - Demands on Testing Services (Visiting Research)

Enterprises	Requested Services	Expected Frequency	Necessary Equipment
Al Ittihad Foundry (Union Foundry Establishment)	Hardness test of casting (manhole covers, etc.)	150 /year	Requested item 9-1
	Sand test for casting	15 /year	Requested items 9-3, 9-4
	Casting test (brake shoes for train, etc.)	15 /year	Requested item 9-2
Middle East Foundry (MD Foundry)	Hardness test of casting (brake drums, etc.)	150 /year	Requested item 9-1
	Sand test for casting	15 /year	Requested items 9-3, 9-4
	Casting test (machine parts, etc.)	15 /year	Requested item 9-2
A.1 Engineering Manufacturing Group	Hardness test of casting (water valve, etc.)	150 /year	Requested item 9-1
	Sand test for casting	15 /year	Requested items 9-3, 9-4
	Casting test (valves, joints, etc.)	15 /year	Requested item 9-2

The hardness test services are expected to be frequent. For the sand test and casting test, the expected frequency is about 15 times per year per company. But, those are comparatively large-scale tests and take long periods, hence it is supposed that the expected frequency is high and there is sufficient demand in the subsectors to justify equipping the unit.

For the hardness test of casting, in accordance with the applicable standard (ISO 6507), a Hardness Tester is necessary. To conduct such tests in foundries, a portable hardness tester has been requested.

For the sand test for casting, in accordance with the applicable standard (AFS), a particle size tester, sand washer, sand mixer, sand sample composer, compression tester, etc. are needed. It is necessary to test sand for casting just before the casting is done, i.e., on the same conditions as the molds. Therefore, it is planned that the particle size tester, sand washer, sand mixer, sand sample composer, and compression tester are such as to be capable of being loaded in a vehicle as a Mobile Sand Testing Laboratory for the foundry industry.

For the casting test, in accordance with the applicable standard (AFS), an Induction Furnace is necessary. An existing induction furnace is used for cast iron, and another induction furnace is requested for copper and aluminum alloy. Ordinarily, it is not possible to one furnace for different metals, therefore, another furnace is necessary. One Induction Furnace with two crucibles for copper and aluminum alloy is planned. Induction Furnace can be utilized not only for casting test but also for technology development and technical assistance to the enterprises, it is very much useful to improve casting technology and price competitiveness.

Expected frequency of use is shown on the list below. It is expected that the major equipment will be frequently used.

Table 2-39. MDTC-Casting Technology Unit - Expected Frequency of Use

No.	Major Equipment	Frequency of Use		
		Times/day	Hours/time	Occupancy Rate
MDTC- 9-2	Induction Furnace	0.4	6	60.0%
MDTC- 9-3	Mobile Sand Testing Laboratory for foundry industry	0.05	80	75.0%

For the above-mentioned requirements, the following equipment is planned for the project.

Table 2-40. MDTC-Casting Technology Unit - Planned Equipment

Purpose of Use	Planned Equipment
Hardness test of casting	Portable Hardness Tester 1 unit
Sand test for casting	Mobile Sand Testing Laboratory for foundry industry 1 unit
Casting test	Induction Furnace 1 set