establishment of the quality system registration. For an internationally recognized quality system registration it is evidently essential that the testing and measuring equipment of applying for QS registration should be based on international standards or at least meet the requirement of being traceable to international standards.

6.2 Implementation Organizations

6.2.1 Progress Monitoring for the Plan as a Whole

The following bodies should actively participate in the implementation of this project in order to lead this plan to a successful conclusion.

(1) Industrial standardization (national standardization and certification based thereon): INN

(2) Diffusion of quality control: training/teaching bodies on quality control such as INN and ASCAL

(3) Testing bodies: INTEC, CESMEC, CIMM, IDIC, IDIEM etc.

(4) Metrology - MINECOM, INN and metrology and calibration bodies such as CESMEC

(5) Technical Services: SERCOTEC, CORFO and testing/ inspection bodies and universities, etc.

(6) Tax and finance aid: CORFO, CIE, SENCE

(7) Information Service: SERNAC, PROCHILE, etc.

It will thus be desirable that INN should appoint a committee composed of representatives from the bodies considered particularly important to monitor the progress of the project and to promote its implementation.

implementation.

6.2.2 Implementation Organization for Each Plan

(1) Body in charge of plan execution and its role

It will be important that INN should assume the leading role as the plan promoter, even for those plans which are not directly under its competence. The bodies responsible for the execution of each program are listed in Fig. 6.2-1 which also includes the implementation organizations concerned and the bodies whose participation is considered most desirable.

(2) Use of foreign experts for plan execution

The areas in which foreign technical cooperation is considered particularly desirable and their qualification conditions are as stated below.

1) Introduction and diffusion of the unified certification system

Hosting body: INN

Areas of cooperation:

(a) Establishment of an accreditation system for the certification bodies (Incl. product and quality system certification)

(b) Establishment of auditors' registration system (Incl. training/teaching programs and preparation of curricula as well as preparation of implementation methods for qualification examination)

Programs	Executed by	Consulted with	Government	Inspection body	Teaching body	Industry body	Consumer	Expert
1. Introduction/Diffusion of Unified Certification System 1.1 Establishment of Laws and Regulations	MITECON (In fact INN)	Industrial Standardization Law Bill Examination Committee		(CESMEC)	(ASCAL)	(SOFOFA)	o	o
1.2 Establishment of Accreditation System for Certification Bodies	INN	Committee for Certification Establishment	MITECON	(CESMEC)		(SOFOFA) (ASEXMA)	o	o
1.3 Establishment of Certification System	Certification body (Body seeking INN accreditation)	Inquiry Committee for the Establishment for the Certification System	MITECON		(ASCAL)	(SOFOFA)	o	o
1.4 Establishment of Registration System for Auditors	INN	Committee for Establishment of Registration System for Auditors	MITECON	(CESMEC)	(ASCAL)	(SOFOFA) (ASEXMA)	o	o
1.5 Establishment of Training Systems for Inspectors	Teaching body (Body seeking INN approval)	Service Committee			(ASCAL)	(SOFOFA) (ASEXMA)	o	o
1.6 Diffusion of Unified Certification System	INN		MITECON	INTEC	ASCAL	(SOFOFA)	o	o
2. Diffusion/Promotion Plans for TQC and In-house Standardization 2.1 Technical Committee for Teaching System Reform and Establishment of Sub-Committees	INN	Establishing/ Preparation Committee	MITECON MEP	(DICTUC)	(ASCAL)	(SOFOFA)	-	o
2.2 Preparation of Programs for Teaching System Reform	INN	TC	MITECON MEP	(DICTUC)	(ASCAL)	(SOFOFA)	-	o
2.3 Training of Lecturers for Teaching under New Training System	INN	TC	MITECON MEP	(DICTUC)	ASCAL INN	(SOFOFA)	-	o
2.4 Teaching for Managers under the New Curriculum and Teaching for General Participants	INN	TC	MITECON MEP	(DICTUC)	ASCAL INN	(SOFOFA)	-	o
2.5 Diffusion on New Quality Control System in all Companies (Quality System Configuration)	INN	TC	MITECON MEP			(SOFOFA)	-	o
3. Establishment/Diffusion Plans for a Weights and Measures System 3.1 Establishment of Weights and Measures Laws/Regulations	MITECON	Weights and Measures Inspection Committee	MITECON		INN	(SOFOFA)	o	o
3.2 Establishment of Weights and Measures Research Center	MITECON	Weights and Measures Center Committee	MITECON		INN	(SOFOFA)		o
3.3 Establishment of Weights and Measures Inspectorate	MITECON INN	INN	MITECON		INN	(SOFOFA)	o	o
3.4 Establishment of Weights and Measures Calibration System	MITECON INN	INN	MITECON		INN	(SOFOFA)		o
3.5 Establishment of Conditions Required for Quality System Certification Body	INN	INN	MITECON		INN	(SOFOFA)		o

Note: (1) Bodies given in parentheses ( ) are quoted as examples.

(2) Circle "o" indicates that participation is desirable.

Fig. 6.2-1 Bodies Responsible for Implementation - Execution Organization and Related Bodies

Qualification conditions of experts:

. Experts should have specialist knowledge on international standards in the quality assurance field. He should also have specialist knowledge of product certification and quality system registration, plus adequate experience in the field. In addition expert should have specialist knowledge of teaching/training, qualification examination, and registration for auditors, plus adequate experience in the field.

2) Diffusion of comapnywide quality control and in-house standardization

Hosting body: INN

Areas of cooperation:

(a) Cooperation in the drafting of quality control/TQC teaching/training system reform programs and development of new teaching materials and curricula relating to this.

(b) Cooperation in the diffusion of new quality control system in companies (restablishment of quality system)

Qualification conditions of experts:

. Experts should have specialist knowledge and experience of quality system configuration and system operation. He should also have special experience in teaching/training (for high-level executives and engineers). Further, experts should have experience in guiding companies on quality system, in addition to the above qualifications.

3) Establishment and diffusion of a metrology system

Hosting body: INN

Areas of cooperation:

(a) Establishment of metrological law, regulations and administrative ordinances and decrees related to the law (establishment of legal frameowrk).

(b) Provision of the technical prerequisites and technical guidance for metrology verification bodies, type certification bodies, and metrology verification methods etc.

Qualification conditions of experts:

. Experts should have special experience directly concerned with metrology administration and knowledge of metrology legislations, with preference given to candidates with a wide knowledge of metrology systems of the various countries. In addition, they should be experts in the metrological technology field with adequate knowledge of metrology administration.

6.3 Expected Role of the Government

For the implementation of this plan, significant roles are placed on the government. The following areas of government involvement are considered of particular importance.

6.3.1 Assistance in Strengthening INN

INN is responsible for the nation's industrial standardization as a non-profit private organization. Compared with other countries whose economy is comparable in scale to that of Chile, INN is a rather weak organization both in terms of its staffing level and its financial position.

In the implementation of this plan, the government should give urgent consideration to the provision of financial assistance to INN so that INN can secure and recruit the staff necessary for the implementation of this plan.

It is hoped that the following staff members will be appointed for the implementation of this plan.

(1) Establishment of industrial standardization law and related regulations: 2 persons

(2) Establishment of accreditation system: 4 persons

(3) Establishment of registration system for auditors: 3 persons

(4) Diffusion of certification system: 2 persons

(5) Diffusion of quality control/TQC: 3 persons

(6) Establishments of metrological law and related regulations: 3 persons

(7) Assistance for metrological organizations: 3 persons

Total: 20 persons

6.3.2 Assistance at the Initial Stage of Implementation of the Unified Certification System

Without assistance from the government to meet the gap in revenue in the initial stage, it will be difficult to promote the diffusion of the certification system. INN's revenue, in particular, will come only from the accreditation of the certification bodies and the registration of auditors. It is likely that INN will not have a sufficient income so that aid plans will be required for make up the gap.

6.3.3 Establishment of Industrial Standardization Law

To ensure national standardization in Chile as a major national issue, it will be an urgent tasks to provide the corresponding legal framework.

6.3.4 Assistance for the Diffusion of the Unified Certification System

In the initial phase of introducing the certification system, it will be of paramount importance, in the interest of the diffusion of the Unified Certification System, to have the reassurance of government assistance. A particularly effective propagator of the Unified Certification System will be a "Government or Government Body Procurement System Giving Priority to Products Identified with the Certification Mark of Conformity with the Unified Certification System." The advantage of this system is that is gives companies a tangible notion of the merits of the system.

6.3.5 Aid for the Diffusion of TQC

Aid schemes other than those described above may include a system offering finance and tax advantages and low-cost consultancy services so that medium and small companies can avail themselves of consultancy services for the introduction of quality control.

CHAPTER 7 EFFECTS LIKELY TO ARISE FROM THE IMPLEMENTATION OF THIS PLAN

7.1 Introduction

According to the ISO (International Organization for Standardization), standardization has six objectives:

(1) Fitness for purpose
(2) Compatibility and interchangeability
(3) Variety control
(4) Safety
(5) Protection of environment
(6) Product protection

The main benefits likely to arise from standardization will differ according to the standpoint of the pursuer of standardization. In the case of manufacturers, however, the main benefits expected from company standardization may include an improvement in product quality, an upgrading of production efficiency, a reduction in production costs, technical development, and an upgrading of the level of technology. In contrast, standardization from the standpoint of the national standardization organization serves the development of the nation's industry, the strengthening of the nation's technical potential, and the improvement of the level of technology through the promotion that comes from standardization of the manufacturers as the main agents in the implementation of standardization. In addition to these purposes, it also serves the wider purposes of enhancing public health, protecting life and wealth, preserving the environment, simplifying and facilitating fair transactions, and rationalizing consumption of goods. Ultimately therefore, standardization by the national standardization organization may be expected to increase the welfare and well-being of the nation.

Various studies have so far been conducted on the methods of evaluating the level of success of standardization, and the results have been published.

Various evaluation methods have been proposed or are being studied. The result of these efforts show that no appropriate method has yet been established for evaluating the economic effect of

standardization with practical accuracy.

It should be noted that effects by standardization include qualitative area and often its effect is substantial.

7.2 Effects That Can Be Expected at the Company Level

7.2.1 Effects of the Introduction of a Unified Certification System and the Diffusion of Quality Control

The companies in the country will treat the national standards as their own, in-house standards and create a quality control systems to manufacture in a stable and reliable manner products of a quality complying with the standards concerned. The implementation of this system is one of the primary objectives of the certification system. A certification system is the most effective means of ensuring the dissemination of quality control to the companies.

Investigations which were conducted in Japan produced to following results:

(1) Broken down by individual industry sector, in-house standardization has been found to produce significant results in industries such as the electrical, mechanical engineering, metals and metallurgy industry, and the chemical sectors. The effects are particularly significant in the assembly type industries.

(2) Broken down by the types of activities of the various departments within companies, it can be seen that there is a general tendency for the benefits of standardization decrease in the following order: design, procurement, inspection, manufacture, equipment maintenance, control, and management areas, in other words, the benefit is the greatest for the design department.

(3) A breakdown of the areas in which the benefits of standardization are high shows that the following industries stand to gain particularly from standardization bringing the following merits:

1) In the machinery sector (general machinery and equipment, transport machines and implements, precision machines and equipment): increased efficiency of design work, reduced variety of products and parts in the design, and improved inspection performance of inspectors

2) In the electrical industry: increased efficiency of design work, reduced variety of products and parts in the design, and improved inspection performance of inspectors

3) In the chemical industry (chemical products and petrochemical products): fewer inspection errors, enhanced level of production control, and reduced waiting time for materials

4) In the textile industry (fiber, textile fiber products): reduced variety of products or materials to be purchased, enhanced level of production control, and reduced waiting time for materials

5) Other areas in the secondary sector (metal products, printing and publishing, leather, leather goods, wood, wood/timber products, furniture, food products, etc.): reduced number of rejects/down-grade products, fewer inspection errors, and improved efficiency of design work

According to the results obtained by the Study Team in Chile, it became clear form the questionnaire survey responses that some of the respondents (firms) had achieved very favorable results from their in-house standardization efforts in terms of:

1) better product quality
2) more uniform product quality
3) greater savings of materials and raw materials/feedstock
4) reduced reject rate for finished production
5) reduced delivery time
6) fewer complaints
7) increased sales.

It is hoped that through the implementation of the plan, the large firms (workforce of 300 employees or more) and the medium firms (workforce of 200 - 300 employees) will establish the kind of quality system presented in ISO9002 and carry out quality control activities in accordance with ISO9004. The consistent implementation of in-house standardization and quality control will enable them to supply and deliver products or render services in good time (timely delivery) at an effective costs, with the products and services being of a quality satisfying the user and consumer thereof. Once this level has been reached, the companies concerned will be in a position to intensify their corporate activities even further by being more effective in collecting market information, reinforcing product plans, upgrading their level of technology, innovating their plant, improving the quality of their products, lowering their costs and developing a bigger or new market for their products.

As a result, Chile's companies will achieve a major leap forward in improving their competitiveness and are bound to improve their export performance. Product of a high quality can be sold at a high price, while, at the same time, production costs will not go up in proportion to the increase in quality because of the consistent implementation of quality control. The result will therefore be an increase in profitability and prosperity for the company.

7.2.2 Benefits of Introducing a Metrology System

In the manufacturing industries, metrological control is an absolutely essential factor in all processes, including product development, design, material purchasing, production control, quality control, production process technology, delivery and sales. There is at present no method for calculating and quantifying the benefits arising from the metrological control to the national economy, and it is also unavoidably true to say that it is strictly impossible to calculate the benefits by concentrating only on one particular model

for the calculation of the very diversified commercial activities.

However, the following example on ball bearings will demonstrate how big the economic effect of accurate calibration for ball bearing production is.

The economic loss (L) due to measurement errors is given as being proportional to the square of the size (magnitude) of the error, according to the theory of quality control. Generally, however, it is found that the economic loss (L) can be expressed by the equation $L = K\sigma^2$, because the average "error distribution σ^2" of the square of the error is used, when a measurement is repeated several times, rather than the square of the magnitude of the error. Here, K is a proportionality constant. It is expressed by the values obtained by dividing the loss (harm) in price terms A associated with the repair of the down-graded product or the scrapping thereof by the square of the permissible error tolerance [Δ], that is, the magnitude of the permissible error (i.e., $K = A/\Delta^2$). From this definition of the proportionality constant K, we can now express the economic harm or loss (L) due to measurement error as:

$$L = A\sigma^2/\Delta^2$$

Let's use an example to make this clear:

Suppose the dimensional errors that must be strictly adhered to in the production of ball bearings are:

- inner diameter error (tolerance) [Δ] 30mm $\pm$ 5 μm
- each instance of deviation from this tolerance causes a loss of due to scrapping (Loss A) 400 yen/each
- error distribution for measuring equipment [σ^2] 1 μm
- with an annual production output 1 million bearings

The loss due to inner diameters deviations associated with

measurement errors is:

$L = 400/5^2 \times 1^2 \times 100$ million = 16 million yen

Let us next consider the loss L' which arises when the measuring instrument has a poorer accuracy because it has not been calibrated and is used in this condition because no information has been given saying that the error distribution has doubled. This loss L' is four times the value of the loss L, that is, 64 million yen.

This demonstrates that the loss taken as the loss L is 4% if the value of annual output is 400 million yen but the loss L' is 16%.

The initial error distribution 1 m of the measuring equipment is appropriate in this case, but it will eventually lead to the above economic loss, when this equipment becomes less accurate with the frequency and duration of use and when used in this condition without calibration and checking. Yet, if it is calibrated at regular intervals of appropriate length, this loss can be prevented, thereby making a substantial contribution to improving production efficiency and lowering production costs. But this is not all. It will also help the manufacturer establish a reputation for product reliability and thus open up a potential for market expansion.

7.3 Benefits Expected at the National Level

(1) Benefit of standardization as making a contribution to Chile's economic development

The manufacturing industry is the leading sector in the development of the national economy. On both the demand (because of the high resilience of demand depending on income, it follows that the demand for industrial products will increase with increase in national income) and supply (the effect on the other industrial sectors is significant and the proportion of added value is high) sides, there is a significant correlation with economic development. For this reason, the proportion of the

manufacturing industry's output in the gross national product can be considered as one of the most important factors indication the economic development of the country. In Chile, the manufacturing industry has a roughly 20% share in the nation's gross national product. This share has tended to stagnate for the last ten years.

For the development of Chile's industry, however, it is essential to look for foreign markets since the domestic market is rather small (with a population of only approximately 13 million people). By product category, it is clear that the major export item is minerals, especially copper which account for a large share of Chile's exports. By contrast, manufactured products have a small share in the nation's exports. And even among these so called "manufactured products," it would be noted that agricultural, forestry, and fishery products such as food and paper/pulp account for the majority while the industrial products do not appear to expand their share position and are still at a rather low level. Generally, the trend has been for primary export items such as natural resources to cause the exchange rate to rise excessively while the nation's export competitiveness for industrial manufactured products is dropping. In Chile, this phenomenon is so marked that it may be diagnosed as the "Dutch malaise" visiting Chile, a trend seen in many developing countries. In the case of Chile, it remains to be analyzed to judge whether this is true of Chile or not, but it should be clear in any event that the excessive reliance on raw materials/natural resources exports with their enormous price volatility is not desirable from the viewpoint of achieving stable economic growth. Rather than raw materials exports, the essential task will be to diversify and upgrade exports. The Chilean government fully recognizes the essential need for diversifying the range of export products and in particular expanding the export of high value-added products. Towards this end, the government operates official incentive schemes, including reimbursements for exports of non-traditional products.

It is more important, however, to increase the competitiveness for

manufactured products in a more radical manner. This necessitates the promotion of industrial standardization as the essential prerequisite. There is much hope for the present plan also on the part of the Chilean government. Thus, the interviews with the leading personalities of the MINECOM have demonstrated that while the share of manufactured industrial products, that is, products excepting the industrial products in the former sense of the export statistics -- namely products from the agricultural, forestry and fishery sector --, accounts for a mere 18% at present, the government is most anxious to increase this share and believes that industrial standardization may make a significant contribution toward this objective.

To foster the development of a high value-added industry and enhance its level, it is only too logical that the prerequisite condition for achieving these objectives will be to establish a system of national standards for metrology and diffuse this to the industrial sector through the calibration of their measuring equipment.

In section 7.2, we have already dealt with the role of standardization as a contributory factor to the development of individual companies. The role of standardization in contributing to the development of the national economy is even greater, because the companies are the main bearers of a nation's economy. Especially in a country like Chile which aims for a basic policy of a private sector-led style free market economic policy, the development of the national economy can be interpreted as the projection of the development of the nation's companies. National standardization has a much greater impact than the in-house standardization of individual companies because it adjusts and coordinates the borders between the individual companies and industries. This demonstrates all the more how much national standardization can contribute to economic development.

(2) Benefits in terms of enhancing health for the people of Chile and contributing to the protection of life and welfare as well as to the conservation of the environment

Improved health, hygiene, the protection of life and property, and the conservation of the natural environment are all issues arousing worldwide interest. Products of a quality not fulfilling these benefits will not be welcomed by the market and, more than this, will even do great damage to the image of Chile's exports in general. Consequently, the increased export of products with the quality features required to ensure that these problems will not arise, will be essential since it will be the basis for the nation's economic development. This underscores the importance of promoting national standardization.

(3) Benefit in terms of the contribution made by metrology system to fair trade

Correct measurement are the basis for fair and correct trading. This goes for the general consumer as much as for companies. It is therefore most relevant also for the nation to attempt to establish a national metrology system as part of the commitment shown toward policy measures such as industrial development, consumer protection, environmental conservation, and a fair tax system.

(4) Benefit in terms of the contribution made by metrology system to research and development in the science and technology domain

In the research and development area in all technical fields spanning the natural sciences and their application sectors, facts and observation are taken in their pure scientific, objective context to create the basis for proving theories. The establishment of a metrology system and the provision of standards of high accuracy will ultimately reduce the elements of uncertainty surrounding the application of new techniques. It can also make a contribution to the promotion of modernization for production equipment and the development of products using new techniques.