

# Annual Report 1997



**Institute of Occupational Safety and Health**

**Council of Labor Affairs. Executive Yuan**

**Republic of China**

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## **INTRODUCTION**

### **I. Summary**

The Institute of Occupational Safety and Health was established in August, 1992, over five years ago. From the beginning, the planning committee has clearly defined goals and directions of the Institute in its organizational regulation, which include:

1. Provide the theoretical basis for occupational safety and health strategies and administrative measures.
2. Provide solutions to important occupational health and safety problems.
3. Provide references for revisions of important occupational safety and health regulatory standards and management systems.
4. Upgrade the technological standard in occupational safety and health and inspection activities.
5. Provide necessary information for training and consultation in occupational safety and health.

In keeping with the spirit from the past, through open discussions and careful reviews that incorporated recommendations from various parties, the Institute has developed *Research Strategy: 1997-2001* to guide future research, in response to changes in industrial structure and results of national survey of occupational hazardous exposures, and in accordance with administrative needs of Departments of Labor Safety and Health and Labor Inspection, and occupational safety and health standards issued by

or proposed in European Union, International Standards Organization and World Trade Organization. *Research Strategy* focuses on serial and interdisciplinary research, goal-oriented and comprehensive in nature, in survey of work environment and work conditions, evaluation and prevention of occupational injuries and diseases, and technology for occupational safety and health management and personal protective equipment, in order to improve safety and health in domestic work environment, awaken workers' awareness of occupational safety and health, decrease occupational injuries and prevent occupational diseases, for the ultimate end of creating safe, healthful, and comfortable work environment for the nine-million-plus workers in Taiwan.

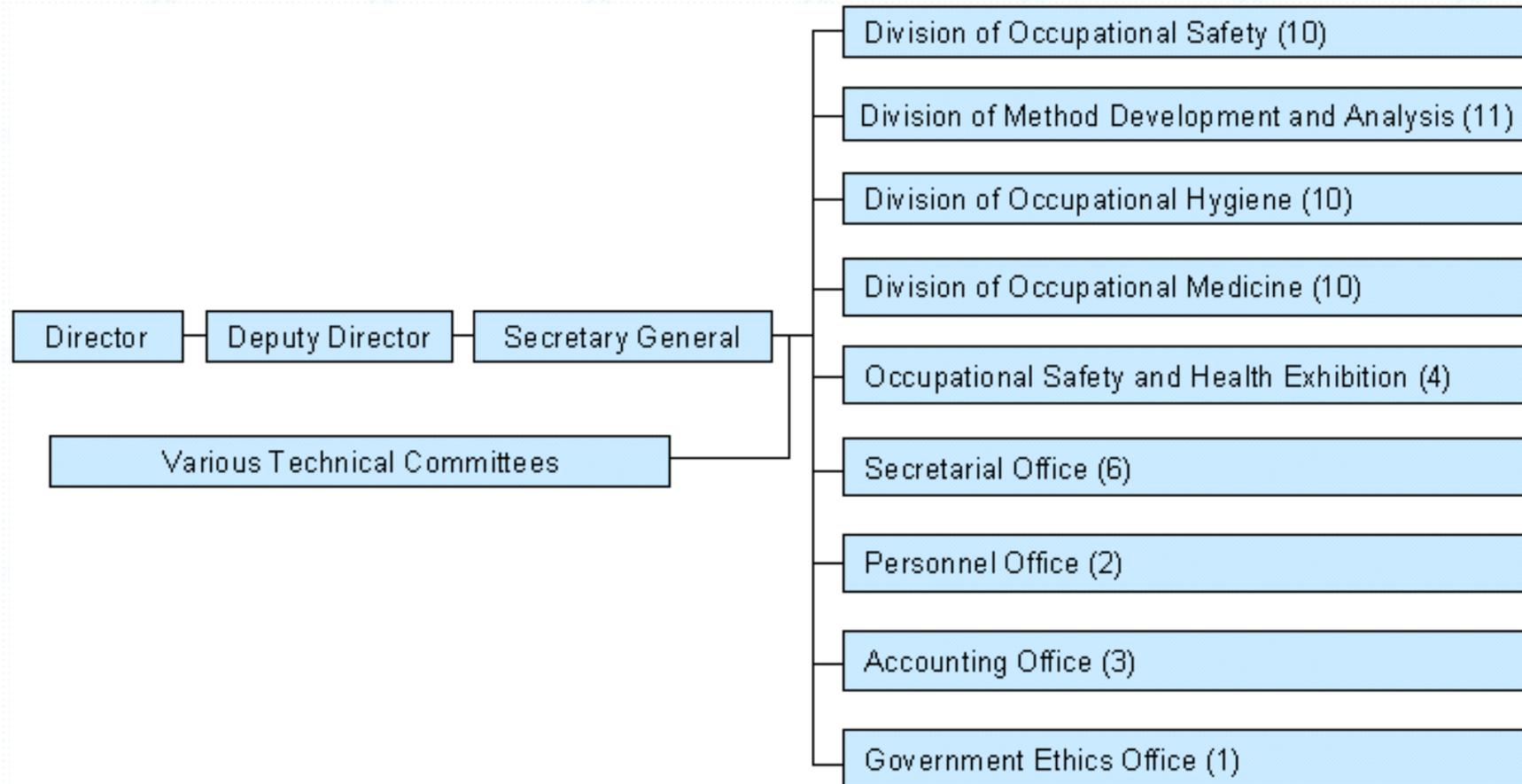
This annual report covers research activities from January 1 to December 31 of 1997, with the completion of 86 projects for fiscal year 1997, and the initiation of 89 projects for fiscal year 1998. All results are disseminated externally through 88 publications (over 40,000 copies issued), presentations (25 in journals and 65 in academic conferences), 2 exhibits, 19 conferences and on-line searches. 4 projects won awards from the Executive Yuan and the National Science Council, and 8 patents are obtained or pending. The Institute also assisted with investigations in incidences of occupational injuries and diseases, as well as provided calibration services for inspection agencies.

## **II. Organization and Personnel**

The Institute is headed by a Director, a Deputy Director and a Secretary-General. It is divided into five divisions: the Division of Occupational Safety, the Division of Occupational Hygiene, the Division of Method Development and Analysis, the Division of Occupational Medicine, and Occupational Safety and Health Exhibition Branch. For administrative support, it has a Secretarial

Office, an Accounting Office, a Personnel Office and a Government Ethics Office.

## 1. Organization



Note: Number in parentheses indicates the number of staff.

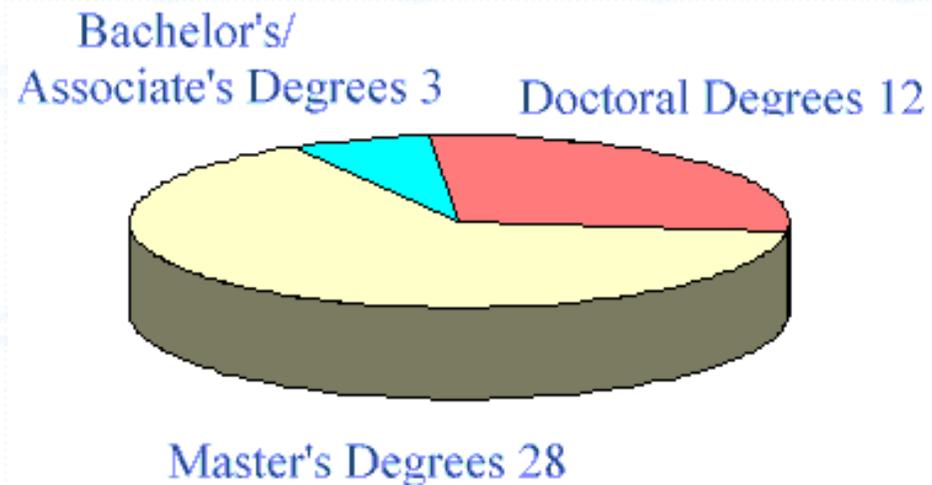
Figure 1 Organizational Structure.

## 2. Analysis of Research Positions

Table 1 Analysis of Research Positions.

Position	Researchers	Associate Researchers	Assistant Researchers
Number of Employees	16	18	11

## 3. Analysis of Level of Education of Current Research Personnel



Note: Currently, 5 are undertaking doctorate studies and 2 assistant researcher positions are open.

Figure 2 Analysis of Level of Education of Current Research Personnel.

### III. Research Expenditures

#### 1. Budget for Fiscal Years 1997 and 1998

Table 2 Budget for Fiscal Years 1997 and 1998( Unit: in Thousand).

Subject	Budget for FY1997	Budget for FY1998
Occupational Safety and Health Research	130,339	129,187
Occupational Safety	26,432	31,627
Method Development and Analysis	23,829	27,349
Occupational Hygiene	23,685	27,710
Occupational Medicine	21,853	27,364
Occupational Safety and Health Exhibition	15,740	15,137
Major Technology Development Projects	18,800	--

## 2. Analysis of Research Budgets over the Years

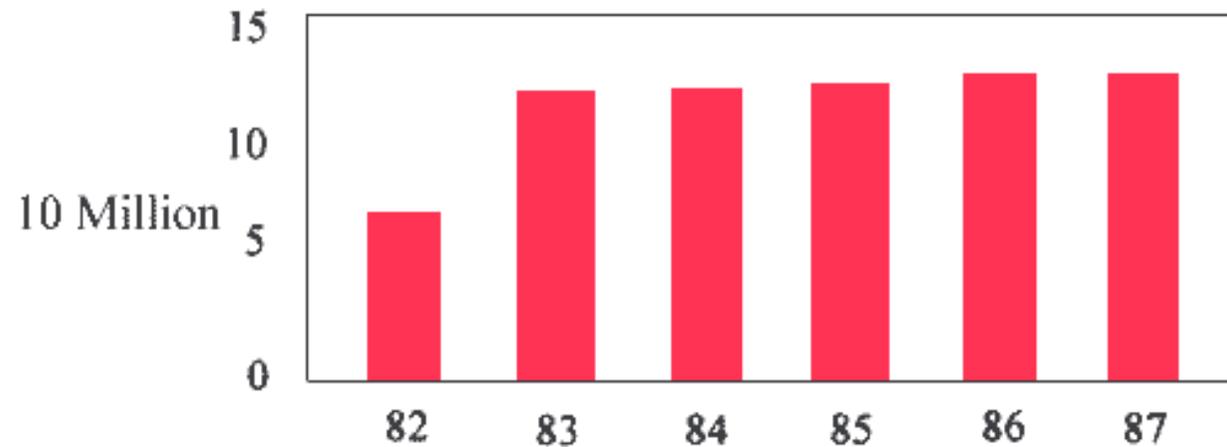


Figure 3 Budget for Fiscal Years 1993-1998

## IV. Research Laboratory Construction Project

### 1. Construction Plans

(1) Immediately after its establishment on August 1, 1992, the Institute has embarked on a plan to construct a laboratory building. After visiting numerous sites, the Institute requested for 8.6 hectares of land located in Hsi Chih, Taipei County, from the National Property Bureau, which was subsequently approved by the Executive Yuan.

(2) Because the land is a hilly area 1. Organization with conservation zoning designation, any development must be reviewed by the local government in accordance with "Regulations on Development and Construction on Hilly Terrain". Permission will be

issued in three stages: first a permit for development on hilly terrain, second a license for miscellaneous projects (including a license for their use and an application to change the zoning in non-urban areas), third a building license (including a building permit).

(3)An engineering consulting firm was commissioned to obtain permission for development in March, 1993. In July of the same year, all necessary documents were submitted to Taipei County Government, which issued a permit for development a year later in July, 1994. Designs for miscellaneous projects were prepared three months later for the application of a license, which was obtained in April, 1995. These projects were contracted immediately thereafter, and was completed in October, 1996, despite a delay due to weather, moving of ancient graves and public protest. The Institute obtained a note certifying that no public property was damaged during the construction from Hsi Chih Government, and applied for a permit to use the miscellaneous facilities and for zoning change to "land for special-purpose enterprises". These administrative procedures were completed in July, 1997.

(4)Architectural design for the laboratory building was completed in September, 1996. However, because the process in obtaining the permission for development in the second stage was so lengthy and "Technical Regulations on Construction" was revised in the meantime, the design was modified accordingly. The Institute applied for a building license in August, 1997. Building construction will be completed before June, 2000 according to the current schedule.

## **2.Contents of Construction**

(1) Miscellaneous projects:

A. entry/exit roadways.

B. sewage pipelines.

C. conservation of soil and water (drainage, retaining walls, landscape slopes).

D. common pipelines.

(2) Main buildings: total area 24,581.16 m<sup>2</sup>, including:

A. research and administrative offices 1893.21 m<sup>2</sup>.

B. laboratories 13249.07 m<sup>2</sup>, including 8 for occupational safety, 9 for method development and analysis, 9 for occupational hygiene, and 6 for occupational medicine.

C. exhibition hall and library 2678.8 m<sup>2</sup>.

D. education and training 5157.5 m<sup>2</sup>, including an auditorium, lecture halls, conference rooms, dormitory and recreational areas.

E. underground parking garage 1602.61 m<sup>2</sup>.

### **3.Expenditures**

(1)Miscellaneous projects: NT\$ 46 million.

(2)Main buildings and landscape architecture: NT\$ 590 million.

(3)Instruments and equipment: approved by the Executive Yuan and budgeted yearly in accordance with construction progress.

## **FOCUS OF RESEARCH**

### **I.Research on Occupational Safety**

Based on the operation guidelines of the Institute, occupational safety research include projects on safety management policy, mechanical safety, chemical safety, electrical safety, construction safety, and personal protective equipment, etc.

Occupational safety research is primarily oriented towards survey and evaluation of safety hazards in the work environment, study of improvement measures, establishment of hazard monitoring and warning systems, development of hazard control and intrinsic safety technologies, certification and testing of functions of personal safety equipment, with design for comfort.

Focus of the various research projects of occupational safety are as follows:

## **1. Occupational safety management and policies**

Focus of research is primarily on analysis of trends of occupational hazards, review of regulations, evaluation of organizational functions, preventive measures to respond to potential occupational hazards. New indicators for occupational hazards, and new management technologies were developed, in order to elevate safety consciousness of employers and employees. Trends of types of occupational injuries, geographical distribution, and personal factors were reported, to effectively support the enactment of policies. Feasibility of regulations (amendments), evaluation of safety management policies and organizations, and studies of the effectiveness of labor inspection were conducted, in order to strengthen functions of safety management.

## **2. Mechanical safety**

Analysis showed that struck by object, caught in or compressed by equipment, cuts and abrasions were the major types of injuries, which for the most part were due to unsafe machinery. Research therefore focuses on cranes, lifts, boilers and pressurized containers that often result in serious injuries, and construction machinery and process machinery that often result in caught in or compressed by equipment and cuts and abrasions. In 1997 research emphasized (1) warning technology for robots, process machinery and construction machinery; (2) inspection of dangerous machinery and equipment; (3) modeling and training system for operating dangerous machinery and equipment.

## **3. Electrical safety**

Occupational electrocution incidents are the second leading cause of serious occupational injuries. Technical guidelines for explosion-proof electrical apparatus are also lacking. Short-term objectives for prevention of electrocution include developing and improving warning and protective devices, and establishing technical guidelines for choosing protective devices. Short-term objectives for explosion-proof electrical apparatus research include technologies for classification of hazardous areas with combustible gases and vapors for explosion-proof purpose, analysis of structural specifications for explosion-proof electrical apparatus and appropriate choice of apparatus, so that plants will install suitable explosion-proof electrical apparatus and decrease the occurrence of fires and explosions.

#### **4. Construction safety**

At the present stage, construction safety is one of the most important issues of the Council of Labor Affairs in terms of prevention of occupational injuries. Emphasis of research in construction safety is not only focused on surveys of current conditions, safety management and evaluation of construction safety, but also on prevention of construction hazards, and technologies of construction safety equipments and construction methods, in order to minimize occupational hazards in the construction industries. Studies encompassed technology to prevent collapse during open excavation, technology to prevent collapse of scaffolds and platform support, means to include construction safety considerations into planning and design; management system suitable for local conditions to incorporate safety during construction stages, and establishment of a database for construction safety. Research in 1997 included devices to prevent collapse during excavations for pipelines and sewage

systems, devices for safety of workers climbing on steel structures, means for incorporating safety considerations in planning and design, and a manual for construction safety.

## **5. Chemical safety**

Focus of research includes safety and risk assessment of chemical production processes, and safety in semiconductor manufacturing plants. Research included surveys of hazards in semiconductor manufacturing and chemical industries, control of run-away reactions, fire prevention in semiconductor manufacturing, development of risk assessment technology, models and characterization of explosive properties of chemical substances and related control technologies.

## **6. Safety protection equipment**

The provision of appropriate safety protection equipment is the last means to prevent injuries. Emphasis of research is on functional evaluations, comfort design and development of new safety protection equipment. A new type of helmet suitable for use both in construction sites and while riding a motorcycle was developed, in order to provide adequate protection for workers. In addition, comparison of standards for functions and fit of safety goggles was conducted, with the development of a computerized system to support the choice of appropriate eye protection for workers, to combat the current lack of understanding in personal protection.

To unify research in the Division, meet current demands for occupational safety, and satisfy expectations of the public, research

focuses on multi-disciplinary, high risk, future-oriented project series, which include fire prevention in semiconductor manufacturing, explosion prevention of mobile pressurized containers, monitoring and warning technologies for collapses during construction, overturn of construction machinery and incidences of electrocution, and comfortable design of safety protection equipment, while ensuring protective functions of the equipment. The effectiveness of safety research is maximized through optimization of research resources and integration of various academic fields.

## **II. Research on Method Development and Analysis**

Researches on Method Development and Analysis are focused on the development of monitoring methods for chemical hazards in the work environment, quality assurance and quality control programs in laboratories, development of certification for laboratories, and study of evaluation technologies for occupational exposures and health hazards. Orientation of research are as follows:

1. Develop easy-to-promote and practical sampling and analytical techniques for the environment.
2. Develop sampling media and analytical protocols applicable to local work environment.
3. Investigate actual exposure conditions for workers in high-risk industries.
4. Establish a database for the sampling and analytical methods and provide services to interested parties.

## 5. Conduct technology transfer of sampling and analytical methods.

The functions of the Division of Method Development and Analysis, according to the operational guidelines of the Institute, are to establish sampling and analytical methods for environmental monitoring and biological monitoring methods, to assist in identifying occupational diseases through exposure assessment, and to evaluate the performance of the commercially available sampling equipment with the goals of improvement and development. Currently, emphases of research are as follows:

### **1. Survey on chemical exposure**

There are still cases of occupational diseases caused by different chemical hazardous factors present in the working environment today. The government has adopted various positive strategies to seek improvement measures to express its concern on this matter. However, there is no way to understand actual occupational exposures, since no comprehensive survey on exposures to various highly dangerous chemicals in the work environment has been undertaken. The lack of reference information has created difficulties in the formulation of labor policies and the amendment of regulatory standards. To solve this shortcoming, there is a need to design and implement a series of organized researches on occupational exposures, and to integrate these results with other exposure monitoring data and the surveillance systems for occupational diseases. These will allow for the formulation of more thorough and feasible policies and regulations. The Institute shall continue to conduct in-depth studies of highly hazardous substances used in large quantities in industries, with large numbers of exposed workers or high incidence of occupational diseases, which are also focus of labor inspection and subjects for the setting of regulatory standards.

In 1997, silicon content of crystalline free silica was studied.

## **2.Development of sampling and analysis techniques for hazardous substances in the work environment**

The Council of Labor Affairs amended the "Permissible Exposure Limits of Hazardous Substances in the Work Environment" in 1995. More than 200 different kinds of hazardous materials were included and permissible exposure Limits were substantially lowered. In conjunction with these amendments, the Institute is actively developing standards for sampling and analysis of the newly included hazardous materials. Taking into account the special environmental conditions, and analytical techniques employed in developed foreign countries, methods for local sampling and analysis have already been established over the years. An Environmental Assessment Technical Committee was also convened to review various validated analytical methods, before submission to the Council of Labor Affairs for promulgation. Emphasis of research for this fiscal year shall continue to focus on the establishment of techniques for sampling and analysis of various hazardous materials, as well as further studies on newly developed sampling and analysis technology such as thermal desorption. The establishment of a database for method development and analysis will provide inquiry services to governmental agencies, academic research institutes, and enterprises to conduct various hazard surveys, and to obtain information on local occupational exposures and health hazards.

## **3.Development and evaluation of samplers and sampling media**

Currently, most of the sampling equipment used in method analysis are imported from foreign countries. Not only are these equipment expensive, but also not necessarily suitable for work environment in Taiwan characterized by high temperature and high humidity. Developing local samplers and sampling media that are more economical, more convenient, and more accurate, is needed. An aluminum respirable dust personal sampler was developed this year, to eliminate problems associated with dust loading of size separation cyclone and static interference while meeting ACGIH standards. The sampler will be field tested after trial production. A sampler for mist and small-diameter aerosol with sponge medium was also developed, ready for further studies on its characteristics.

#### **4. Development of biological monitoring techniques**

It is essential to develop biological monitoring techniques to supplement environmental monitoring, since environmental monitoring only considers inhalation exposures. Many industrial raw materials or process intermediates may also enter the human body through dermal contact and ingestion. In addition, differences in personal hygiene and inter-individual variability in skin absorption also increase the need for biological monitoring. Biological monitoring is the direct acquisition of a biological specimen from the human body, such as blood or urine, to test for the internal dose of hazardous substances or their metabolites. It also takes into account factors such as skin absorption, ingestion, work load, physical conditions, personal hygiene habits, and use of protection equipment to evaluate occupational health hazards. In recent years, research on occupational health technologies has caught the attention of developed countries in the world. In light of the above, the Institute invited scholars from various disciplines to form a Biological Monitoring Technical Committee, which determined that priority

should be given to blood lead required in current occupational health examination regulations, and biological monitoring of eight organic solvents required by Japanese government. In 1997 research focuses on automation of blood lead analysis, biological monitoring of toluene, xylene, aniline, butanol, and n-hexane, non-invasive methods for biological monitoring and kinetics of skin absorption of ethylene glycol monomethyl ether.

### **5. Development of real-time gas monitors**

Due to difficulties in using current sampling and analytical methods for certain substances in certain industries, this Division of Method Development and Analysis studies functions of direct reading monitors, in order to establish principles for evaluating direct reading monitors, so that appropriate equipment can be used if necessary.

Recently, Fourier transform infrared spectroscopy has become common for real-time gas monitoring. The Division is evaluating this particular instrument for its application in industrial hygiene, and has found that it is very effective in exposure assessment in semiconductor manufacturing. Further studies are planned.

### **III. Research on Occupational Hygiene**

Occupational hygiene studies means for understanding and controlling risk factors in the work environment. According to operation guidelines of the Institute, the Division of Occupational Hygiene is responsible for research relating to occupational health management policies, surveys and prevention of chemical, physical, biological and ergonomic hazards, and measuring

instruments and protection equipment related to occupational health. At this stage, the Division of Occupational Hygiene is oriented toward prevention of occupational diseases. In line with these guidelines, it has formulated four basic concepts and research objectives: 1. Understand occupational exposure levels in the work environment, 2. Study control measures to resolve occupational health problems in enterprises, 3. Obtain important local data on occupational hygiene, and 4. Cooperate in establishing regulations and policies in occupational hygiene. Research is directed to: 1. Study the work environment in which occupational diseases have occurred, in order to understand occupational exposure levels of various risk factors, and to develop control measures; 2. Support and promote systems necessary for the establishment of occupational safety and health regulatory system, and assist enterprises in finding solutions to difficulties encountered; 3. Obtain important local data in occupational hygiene, to provide references for regulatory amendments and improvements in the work environment; 4. Introduce technologies to prevent possible occurrence of major occupational diseases; 5. Provide research results to the Council of Labor Affairs, to serve as a reference for amendment of regulations.

Due to limited manpower and fund, the Division of Occupational Hygiene, combining domestic and Institute research resources, focuses on exposure assessment, risk prevention and management policies of important occupational hazards. Considering specialties of research personnel and availability of local resources, the Division of Occupational Hygiene focuses research as follows: 1. Survey of exposure to occupational hazards; 2. Prediction models and control of hazardous substances and noise; 3. Occupational health protection equipment and measuring apparatus; 4. Evaluation and control of ergonomic hazards; 5. Control of occupational musculoskeletal injuries. Objectives and methods are described as follows:

## **1.Survey of exposure to occupational hazards**

With rapid economic development and diversification of industrial operations, risk factors in the work environment are more complex and difficult to understand than ever. In order to decrease occupational injuries and to protect workers' health, there is a need to study hazardous exposure conditions and levels, and numbers of workers exposed, so that regulatory priority for chemical substances and industries can be determined for the formulation of strategies in occupational safety and health and in labor inspections.

## **2.Prediction models and control of hazardous substances and noise**

Results from a study on status of safety and health conditions in the work environment among workers in the Taiwan Area, conducted by the Institute of Occupational Safety and Health in 1995, showed that workers believed that improvement was most needed for pollution of hazardous substances and noise in the work environment. To lessen air pollution in the work environment, ventilation equipment is commonly adopted. However, with the complicated nature of air flow, improper ventilation design may at times produce exactly the opposite effect. Noise has a very significant effect on health and work efficiency of workers.

Emphasis of research lies in the development of control technologies for airborne hazardous substances and noise, in order to improve the work environment, and of relevant estimation models, to be validated in the field by labor inspectors and industrial hygienists, in order to understand possible effects of engineering control measures, so as to avoid making mistakes in installation, and to increase incentives to enterprises to improve the work environment. Research results can also be used to

construct theories on controlling airborne contaminants and noise in specific industries.

### **3.Occupational health protection equipment and measuring apparatus**

Occupational health protection equipment is the last line of defense in a workplace. Deficient or inappropriate use of health protection equipment will harm health and life of workers. Environmental assessment and control of conditions and hazard factors in the work environment are dependent on accuracy and quality of measuring apparatus. Studies focus on standards and technologies for testing of protection equipment, as well as their appropriate use and necessary education, and calibration of measuring apparatus (including photometers, noise meters, and anemometers). Effects of high humidity, high temperature, and facial shapes on protective effect and willingness to use are also important to consider.

### **4.Evaluation and control of ergonomic hazards**

Ergonomics is an applied science aimed at understanding the interaction between human abilities and environmental factors. Its objectives lie in the promotion of safety and health, efficiency and comfort at work. The lack of proper safety and man-machine interface design in machinery and equipment, and poor work environment can easily cause occupational injuries. Studies on causes of occupational injuries showed the lack of overall coordination between work methods, equipment, environment and "the worker". At the present stage, ergonomic research emphasizes applications of anthropometric data, assessment of manual material handling, introduction and dissemination of international ergonomic checklists, prevention of ergonomic injuries in the

workplace, and adaptation of heat environmental models to local conditions. Hopefully through the application of ergonomic principles, occupational safety and health problems may be resolved, as well as elevating work efficiency and comfort of the work environment.

### **5.Control of occupational musculoskeletal injuries**

In recent years, with changing industrial structure, increasing repetitiveness of work, and using machinery not matching physical dimensions of local workers, occupational musculoskeletal injuries are becoming more serious. According to a survey on safety and health conditions in the work environment in Taiwan in 1991, 51.8% of workers complained of awkward work posture. In a similar survey conducted by the Institute in 1994, 38 out of 100 workers reported muscular pain and soreness, of which 79% believed it was work-related, revealing that preventing musculoskeletal injuries is an important research topic.

At this stage, research emphasizes safety and health guidelines for designing man-machine interface, preventive strategy for repetitive injuries, physiological measurements related to biomechanics and support devices to prevent musculoskeletal injuries, so that occurrence of occupational musculoskeletal injuries will decrease.

### **IV.Research on Occupational Medicine**

Research in occupational medicine is closely related to workers' health. Nowadays labor rights and workplace safety and health receive much attention from employers and employees alike in enterprises. With scientific advancement and introduction of new

materials and machinery, occupational diseases have become diverse. The goal of research in occupational medicine is to understand clearly effects of various risk factors in the work environment on worker's health as a theoretical basis for safety and health regulations, to establish basic safety and health technologies, and to analyze locally available databases as a basis for management of workers' health.

At present, occupational safety and health has become a common focus among nations. Industrially advanced countries including Europe, U.S. and Japan are all devoted to implementing policies and planning research in occupational safety and health. Even so, cases of occupational diseases are on the rise. Comparing statistics on occupational diseases from several countries, Japan had 9,600 cases and Singapore 900 cases in 1993. Ontario, Canada had 5,600 cases in 1990. Even Finland, with a population of 5 million, had 9,000 cases in 1989. In Taiwan labor insurance statistics showed only 561 cases of occupational disease compensation between 1987 and 1996, obviously underestimated.

Research in occupational medicine involve: 1. Epidemiological studies and research into diagnoses, pathological mechanisms, and prevention of frequently occurring and serious occupational diseases and injuries, 2. Studies of new occupational health problems in step with contemporary demands, 3. Research necessary for safety and health regulations and policies, such as investigations to clarify cause-effect relationship between risk factors and occupational diseases, and studies of special working populations such as aging workers and disabled workers.

Research emphasizes: 1. Studies of occupational diseases; 2. Health of special working populations; 3. Occupational

epidemiology; 4. Theories and technologies related to diagnosis of occupational diseases.

### **1. Studies of occupational diseases**

The goal for studies of occupational diseases is to promptly identify cases of occupational diseases, so that preventive measures can be developed to control further occurrence.

Several surveillance systems are being established in the Council, including those for occupational burns, occupational skin diseases, occupational musculoskeletal disorders, and occupational cancers. National Quarantine Service of the Department of Health also periodically announce the results of reporting systems for blood lead and suspected cases of occupationally related diseases. Centers for Occupational Disease Prevention and certain regional hospitals have their own surveillance systems.

Because such information is scattered in different agencies and lacks coordination, the Council is currently studying ways to integrate them. In the past two years, the Council has completed a list of occupational disease, adding 4 categories with over 90 diseases to the 8 existing major categories. Labor insurance has added a column for noting occupational diseases on outpatient clinical records, so that information on occupational diseases can be effectively gathered from these records as well.

Labor insurance compensation and occupational health examination data, as well as records of outpatient services rendered by medical specialists, are all used to track the occurrence of occupational diseases.

### **2. Health of special working populations**

The relationship between risk factors and occupational injuries for special working population is often elusive. Workers often do not use proper personal protective equipment because of a lack of awareness. In the past, the Institute has completed health effect studies among workers in special work environments, such as those with high noise, high temperature, abnormal atmospheric pressure and shift work.

Occupational health promotion aims toward both physical and psychological health of workers. Nutrition and shift work, psychological stress and its measurement, physiological demands in specific jobs were some of the topics studied.

### **3.Occupational epidemiology**

Occupational epidemiology, through exposure assessment and cohort follow-up, focuses on occupational diseases among workers exposed to certain risk factors. Internationally the relationships between occupation and reproductive functions, cancers, and skin diseases, as well as individual variation among workers, have received much attention.

The Institute has conducted cohort

studies of vinyl chloride workers and mine workers, and investigated workers in manufacturing industries for lung diseases and those in electronic industries for skin and musculoskeletal diseases. In the future research will concentrate on cohort and case-control studies among workers exposed to important hazardous substances, in addition to occupational epidemiological studies

of respiratory and circulatory systems.

#### **4.Theories and technologies related to diagnosis of occupational diseases**

In November 1995 the Council of Labor Affairs established a "Occupational Disease Review Committee, in order to resolve disputes regarding occupational diseases between employers and employees. After nearly two years in operation, it is found that cause-effect relationships are difficult to establish because further research is required. Such understanding is also needed in establish diagnostic criteria for occupational diseases.

## **RESEARCH AND RESULTS**

### **I.Occupational Safety**

Since its establishment August 1, 1992, the Division of Occupational Safety has actively considered and repeatedly modified its research directions, integrating results of discussions on "Development of Occupational Safety and Health Technologies" in the Scientific and Technology Consultative Meetings in fiscal years 1993 to 1995. As recommended by Consultative Committees, research projects for fiscal year 1997 were conducted in areas concerning mechanical safety, chemical safety, electrical safety, construction safety, safety protection equipment and safety management and policies.



Figure 4 Virtual Reality Simulation

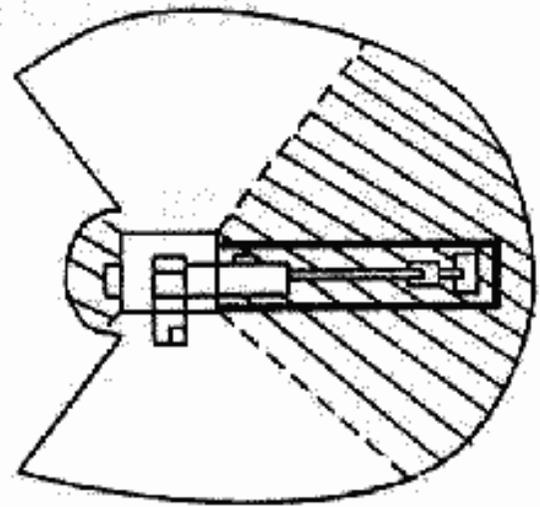
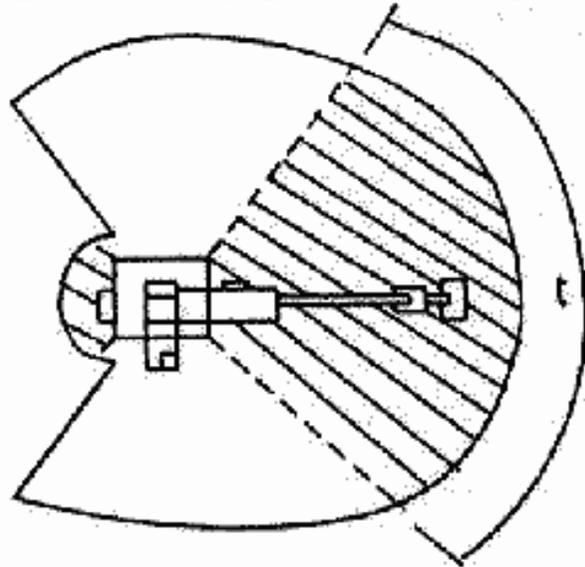
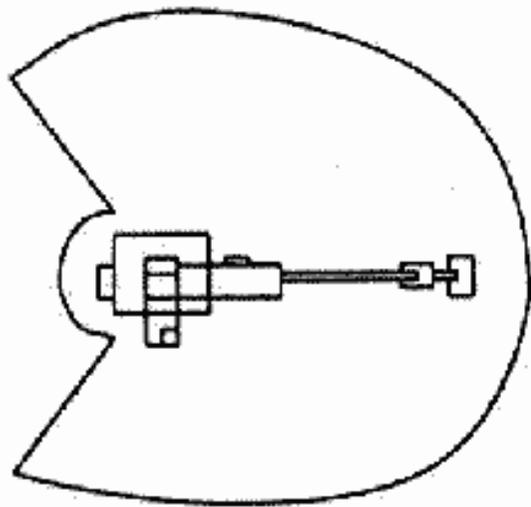
## 1. Mechanical safety

Completed "Development of Simulation Systems for Training for Dangerous Machinery and Equipment"(Figure 4): Through analysis of structural stability and strength, modeling of motions, and application of virtual reality technology, a simulation system of control panel and pedals in a trolley car for a crane, combined with image, sound, and vibration, was created for training and testing purposes.

Completed "Development of Safety Technology for Hydraulic Brake System in Construction Trucks": Friction coefficient for brake lining was shown to decrease as temperature increased, leading to the loss of braking capability. A miniature warning device for such condition was created, as well as a database for indicators of brake failure.

Completed "A Study on Monitor and Control of Robotics-Active Hazard Prevention Equipment" (Figure 5): Motions of U-type industrial robots were analyzed to develop the theoretical basis for safety monitoring system and hazard prevention. With the application of virtual reality technology, an interactive man-machine interface was created, which could be connected to a centralized monitoring system.

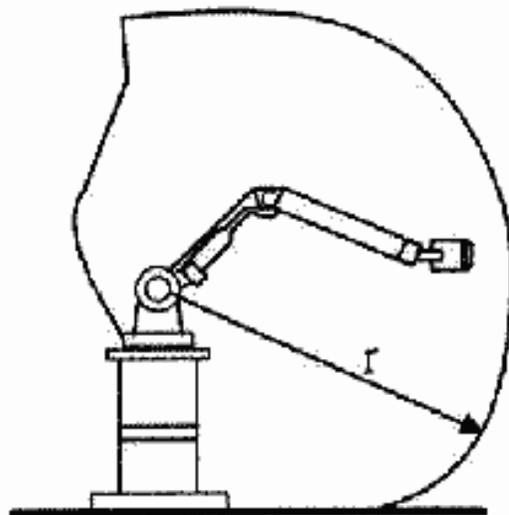
Completed "Development of Hazard-preventive Techniques for Major Hydraulic Machinery-Fan, Compressor and Pump": Neural network, fuzzy theory and neural-fuzzy algorithm were studied to determine mechanical failures. A database of parameters of failures of fans, pumps, and compressors was created through actual testing, forming the basis for signaling and modeling in a diagnosis system.



Maximum Encompassing Range

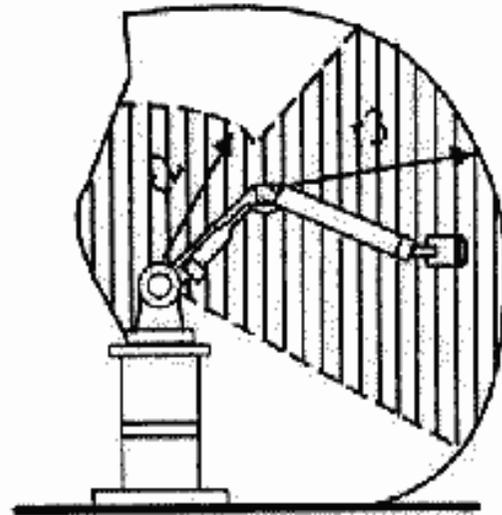
Reachable Range

Activity Range



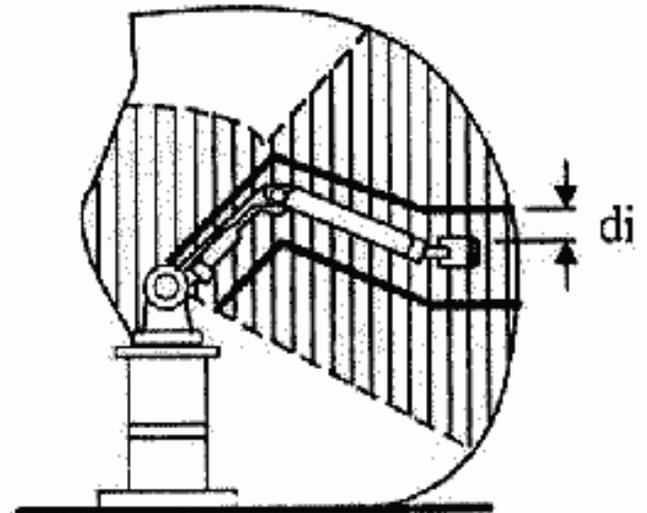
First Class

maximum radius  $< r$



Second Class

fan angle  $< t$   
radius of each arm  $< r_i$



Third Class

safety distance for each arm =  $d_i$

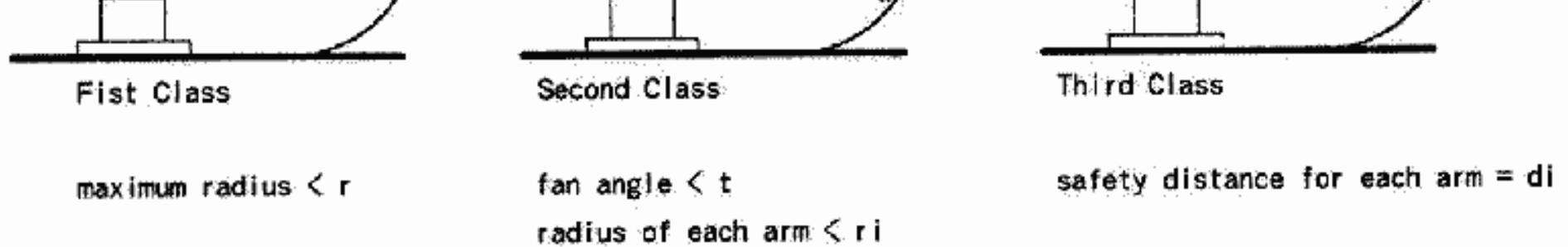


Figure 5 Safety Protection for Robots: Classification and Parameters

Completed "Study and Analysis of Intrinsic Safety Feature for Tower Crane": A process for calculating strength and a model for finite element analysis of tower cranes were established, which could be used in training labor inspectors.

Completed "Design and Analysis of Sway Warning (monitoring) System for cranes-tower crane": Mathematical model and computerized simulation of crane lifting were established, so that swaying could be measured continuously as a basis for adjusting the length of the arm and the motion of the trolley.

Completed "Detailed Design and Technology Transfer of an Overturn Warning Device for Forklifts": A model for the dynamics leading to overturn was established, in order to create a warning device.

Completed "The Study of Safety Techniques for Construction Elevators(I)": Domestic and international regulations, standards, inspection criteria for construction elevators were collected. A survey was also conducted on the use of construction elevators in Taiwan. Recommendation for regulation, enforcement, management and use were also made.

Completed "Detailed Design, Manufacturing and Technology Transfer of Over-winding Cutoff Device for Truck Cranes": A new type of over-winding cutoff device was tested for its reliability, usability, durability and applicability in different environmental

conditions. It allowed operations in the safe range, yet incorporating an automatic hazard prevention control that would not result in a deadlock. A patent application has been filed.

## **2. Chemical safety**

Completed "Study of Safety Relief Valve Design Standard": Regulations in Japan, U.K., U.S. and Taiwan were compared.

Thermal decomposition of hydrogen peroxide was assessed, to determine the area of release for a safety relief valve.

Recommendations for revision of related regulations were offered.

Completed "Improving Chlorine Sensor": Platinum doped with solid state polymer electrolyte and poly-aniline conductive polymer were used as electrodes to determine chlorine concentration in the air, showing its superiority in terms of current stability, reproducibility, sensitivity and analytical capability compared with the presently available methods.

Completed "The Design of Computer-aided Program for Fault Tree Analysis and the Setup of Failure Rate Data": A Chinese version of fault tree analysis software was developed, with capability to draw, analyze and diagnose a process, as well as to determine its smallest grouping and quantify its probability of failure.

Completed "Storage Safety Research of Cellulose Nitrite Factories": Heat release for cellulose nitrite in a barrel was simulated in order to determine the dynamics of its chemical reaction, so that storage hazard prevention strategy could be developed.

Completed "BLEVE Model for LPG Storage Tank and Its Control Strategies": A BLEVE model for LPG storage tank was developed to determine safe distance, cooling effect of water spray and the effect of the fire on the tank. Regulations on gas stations from different countries were compared.

### **3. Construction safety**

Completed "Techniques to Prevent Trench Cave-in Fatalities": The distribution of soil pressure was studied to understand stresses on a shielding device designed to protect workers during a cave-in.

Completed "The Study on the Draft of Testing and Standard for Safety Nets": Performance specification and testing standard for safety net were developed by reviews of codes from other countries, and by experiments, so that those appropriate for conditions in Taiwan would be available for reference for users and manufacturers alike.

Completed "Safety Inspection Technique and Evaluation Criteria for Construction Formwork Shoring System": A manual on inspection techniques and evaluation criteria for formwork shoring system was written, so that enforcement would be effective in preventing injuries resulting from its collapse.

Completed "The Design and Verification of Energy-dissipated Devices of Pumping Pipes": Through measuring dynamic responses of formwork and applying theories of base isolation and energy dissipation, a device to decrease energies transferred by vibration of concrete pumping pipes to formwork was developed, which was shown effective in field tests.

Completed "Construction Safety Assessment Research for Soil Retaining Methods": Construction procedures, machinery and hazards in the work environment for various soil retaining methods were studied, which were further validated by cases of occupational injuries. Recommendations on how to eliminate these hazards were proposed.

#### **4. Electrical safety**

Completed "Design of the Alarm System for Preventing Mobile Cranes from Accidentally Touching Overhead Power Lines(II)": Digital system to give warning upon approaching the danger zone was developed, with a detection component that measured vertical electrical field strength on the surface of the arm of the crane, and a warning component that would give sound and light alarms if the crane entered the preset danger area.

Completed "Analysis of the Codes for Flameproof Enclosures and Increased Safety of Electrical Apparatus in Explosive Gas Atmosphere": Structural specifications on increased safety and flame proof of electrical apparatus in IEC, EN, JS, and CNS standards were reviewed, which would serve as a reference in purchasing such apparatus and in revising related regulations.

#### **5. Safety protective equipment**

Completed "Detailed Design, Manufacturing and Technology Transfer of a Safety Helmet used both as an Industrial and a Motorcycle Helmet": Prototype for dual-use helmet built last year was modified in terms of weight, strap adjustment mechanism,

mechanism for switching between modes of use, ventilation, and water proof.

Completed "A Comparison Study of Commercially Available Personal Safety Goggles and Development of a Computer Software for Personal Eye Protection Selection": Three data bases with information on selecting eye protection were established using hypertext format , so that employers and the public can access the information on line.

## **6.Safety management and policy**

Completed "The Feasibility Study on the Implementation of BS8800 in ROC": A survey of safety and health management in 358 enterprises was conducted, to evaluate the feasibility of implementing British Standard 8800 in Taiwan and to recommend means for responding to such international trend.

Completed "Safety Assessment Techniques in Construction Engineering": Construction safety assessment system in advanced countries were studied. "Preliminary Hazard Analysis" using a checklist was proposed to identify intrinsic hazards at the earliest stage, so that construction planning could consider how to manage them. In general, special features of research projects in fiscal year 1997 were as follows: active development of hazard monitoring and warning technologies, proposal of new studies to respond to safety problems brought by automation as industrial structure changes, emphasis on development and comfort design of safety protection equipment. In addition to these projects, other activities to promote occupational safety in fiscal year 1997 included: participating in investigations of cases of major occupational injuries with inspection agencies, cooperating with local and foreign academic organizations, convening conferences on research results and other safety issues, calibrating safety

measurement instruments used by labor inspection agencies, and planning for the laboratory building.

Research projects in occupational safety for fiscal year 1998 will support administrative demands of the labor inspection agencies, Department of Labor Safety and Health, and the Department of Labor Inspection. In accordance with short-term, mid-term and long-term goals recommended by consultative committees, research will build on those conducted in the past five years, in mechanical safety, chemical safety, electrical safety, construction safety, safety protection equipment, and safety management policies.

**1.Mechanical safety:** focuses on development of monitoring and warning devices, hazard analysis of dangerous machinery and equipment, and development of simulation systems for training and includes "Development of Simulation Systems for Training for Dangerous Machinery and Equipment", "Detecting Hazards in Major Components of Hydraulic Machinery", "Risk Assessment and Prevention for Cranes", "Safety Protective Systems for Remote-control and Integrated Robots and Preliminary Study for Technology Transfer", "Design of Overloading Prevention Device for Mobile Cranes and Preliminary Study for Technology Transfer", "Inspection Method and Interval for Installations Containing Highly Pressurized Gases-Liquid Nitrogen and Liquid Oxygen Low Temperature Storage Tanks", "Structural Analysis and Safety Standard for Aerial Lift", "A Study of Safety Technology for Construction Elevators", "A Study of International Standards for Cranes", "Establishing a Technical Manual for Safe Operation of Gondolas", "Current Status of Measures Taken to Prevent Pipeline Leakage in Domestic Petrochemical Industry", "Designing and Manufacturing a Commercial Model of a Overturn Warning Device for Forklifts".

**2. Chemical safety:** focuses on developing and managing chemical safety technologies and includes "Guidelines for Managing Special Highly Pressurized Gases", "Manufacturing Electrochemical Chlorine Sensors", "Performance Evaluation of Flame Arresters for Vehicles", "Technology for Storing Peroxides".

**3. Construction safety:** focuses on developing safety protection devices and writing safety operations manuals, and includes "Safety Device for Erecting and Climbing Steel Structures", "Design and Manufacturing of Devices to Prevent Trench Cave-in Fatalities", "Safety Considerations to be Included in Building Engineering Planning and Design", "Guidelines for Safety Net and Lanyard", "Technical Handbook for Construction Safety".

**4. Electrical safety:** focuses on preventing electrocution and developing explosion-proof electrical apparatus, and includes "Improvement of Electric Shock Prevention Devices for Arc Welding Machines", "A Guide for Selection and Installation of Earth Leakage Circuit Breaker to Prevent Electric Shock", "Classification of Hazardous Areas in Ignitable Gas and Vapor Atmosphere", "Selection and Installation of Flameproof Enclosures and Increased Safety of Electrical Apparatus for Explosive Gas Atmospheres".

**5. Safety protection equipment:** focuses on designing and improving personal protective equipment, and includes "Commercial Design of Industrial Helmet and Motorcycle Helmet", "Designing Comfortable Protective Glasses", "A Study to Develop Protective Equipment for Preventing Falling Stones in Gravel and Pebble Area".

**6. Safety management and policies:** includes "Establishment and Evaluation of Coordination Organizations in Construction

Industry" and "Research of Strategies to Prevent Workers from Traffic Accidents".

## **II.Method Development and Analysis**

In order to prevent occupational diseases, as well as to upgrade productivity and quality of the work environment, the objectives of research for method development and analysis are to establish evaluation methods for hazardous substances found in the work environment, to develop quality assurance/control and certification of laboratories, and to evaluate hazardous exposures among workers.

Researches for method development and analysis for fiscal year 1997 included: (1) Chemical exposures assessment, (2) Sampling and analytical techniques for hazardous substances in the work environment, (3) Development and evaluation of samplers and sampling media, (4) Development of occupational biological monitoring techniques, (5) Development of infrared real-time gas monitoring technology as well as, (6) Application of thermal desorption in sampling and analysis. In summary, projects for fiscal year 1997 were conducted in accordance with the Institute's short-term, medium-term and long-term plans and policy directives, in coordination with the Institute's research personnel and facilities. Chemical exposure in highly dangerous industries and operations among workers were studied, as well as more economical, convenient, sensitive, fast, automated, easy to promote, and practical sampling and analytical techniques. Sampling and analytical equipment and sampling media suitable for local conditions were developed to upgrade the technical level of industrial hygiene.

Significant methods and research results for fiscal year 1997 were as follows:

### **1. Chemical exposure surveys**

Completed "Crystalline Free Silica Analysis of Raw Materials Used in Industries": Free silica concentration was highest in raw materials used for sandblast, porcelain and pottery, which would require environmental control and use of personal protective equipment. There are differences between free silica concentrations in raw materials and in air samples. Furthermore, raw materials labeling 60-80% silicon dioxide concentration might have only 2% free silica concentration. It was recommended that crystalline free silica in the raw material, analyzed by X ray diffraction instead of infrared spectroscopy to decrease interference, for exposure assessment.

### **2. Development of sampling and analytical technologies for hazardous substances in the work environment**

Completed "Method Evaluation Of Thermodesorption/Gas Chromatography for the Measurement of Tetrachloroethylene in Dry Cleaning Industry": Thermal desorption/ gas chromatography was used to analyze tetrachloroethylene in dry cleaning industry, showing high capture using Tenax TA as the absorbant, high recovery(close to 100% at desorption temperature of 240°C), storage stability (good for 15 days at room temperature), and high breakthrough volume.

Completed "The Development of Thermal Desorption/GC Method for Analysis of Petrochemical Pollutants (Dichloroethane, Trichloroethylene, Ethyl Acetate and Methyl Butyl Ketone)": 60-80 mesh Tenax-TA absorption tubes were used to take samples

from sampling bags simulating environmental concentration. After 6 minutes of desorption at 200°C, recovery rate ranged between 94.8-101.2% for all the substances named above. All the samples showed storage stability with or without refrigeration.

Completed "The Effects of Temperature and Humidity on Analysis of Organic Solvents in the Workplace": At high temperature and high humidity, organic vapor sampling recovery was affected more by temperature than humidity. In order to avoid underestimating the level of exposure, special care should be taken when sampling organic vapors at high temperature.

Completed "Validation of Analytical Methods for 25 Hazardous Substances(I)": Laboratories certified by the Council of Labor Affairs, participated in the validation of analytical methods from other countries for use in Taiwan. 25 regulated substances without standard analytical methods in Taiwan were included.

Completed "Establish a Toluene Passive Sampling and Thermal Desorption Method": ATD stainless sampling tubes, filled either with Tenax-TA or Carbopack B, were used as passive samplers for known concentrations of toluene generated in the laboratory. Sampling rate with Tenax-TA was  $1.85 \pm 0.13$  ng/ppm/min, and with Carbopack B,  $2.18 \pm 0.06$  ng/ppm/min. Sampling rate was not affected by directionality or by surface wind velocity between 0.10 to 0.41. Sampling concentrations using active and passive methods approximated each other, but still showed statistical significance.

### **3.Evaluation and development of samplers and sampling media**

Completed "Research and Development of a Personal Respirable Dust Sampler" (Figure 6): A new aluminum-made size

separator was tested using Marple size separator for comparison. For respirable dust at various wind velocities, average ratios

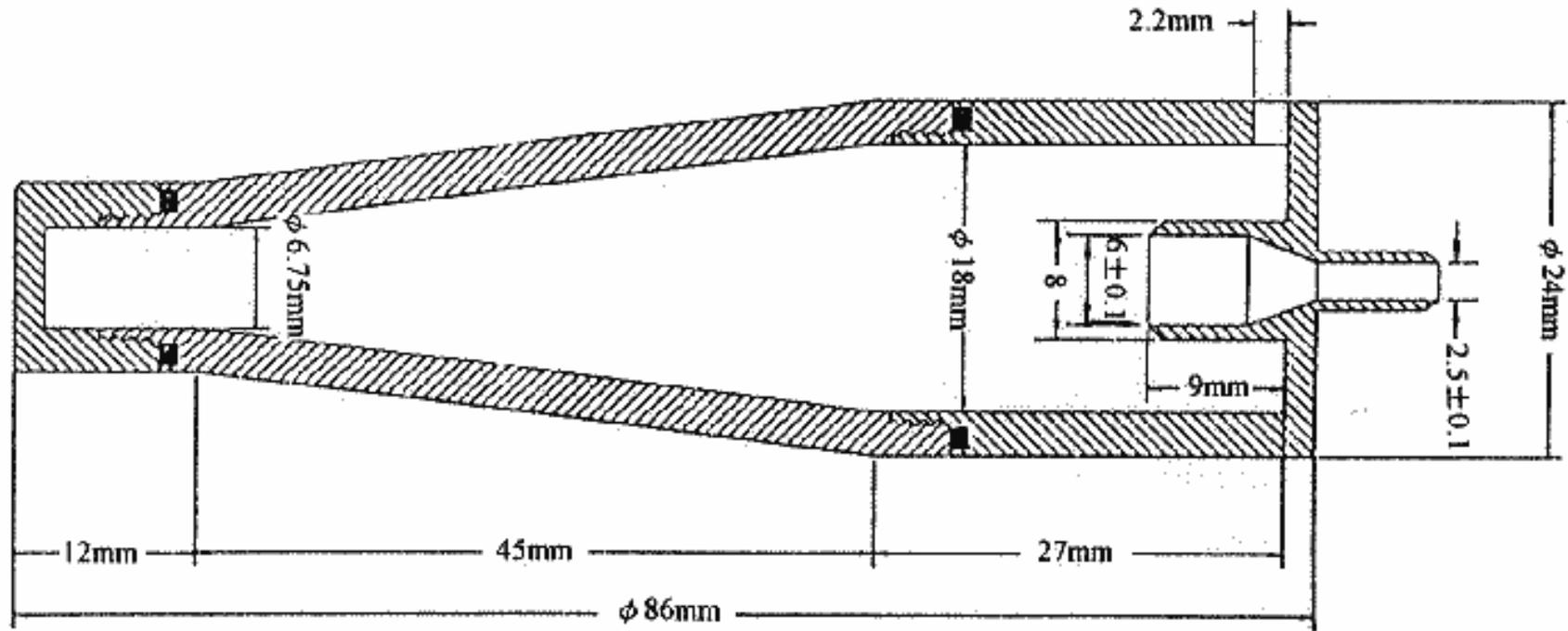


Figure 6 Dimensions of Newly Designed Separator

between the two means of measurement were 1.045 in porcelain glazing factories and 0.965 in lead powder factories, compared with 1.133 and 1.069 respectively for nylon-made size separator. As dust loading increased from 0 to 3 mg, optimal sampling flow rate decreased from 1.8-2 L/min to 1.6-1.7 L/min.

Completed "Performance Comparison of Size-selective Samplers" (Figure 7): Sponges, made with different materials with various thickness and pore size, were used in conjunction with 25mm-diameter asbestos sampling tube for size separation of aerosol. For capture efficiency, only one sponge sampler did not meet international standard. However, at a total sampling flow rate of 8.0 L/min., two serial sponge samplers, with pore size of 100ppi and 10ppi, thickness of 18mm and 15mm, diameter of 25mm and 13mm respectively, could achieve near uniformity with separation curve for respirable dust.

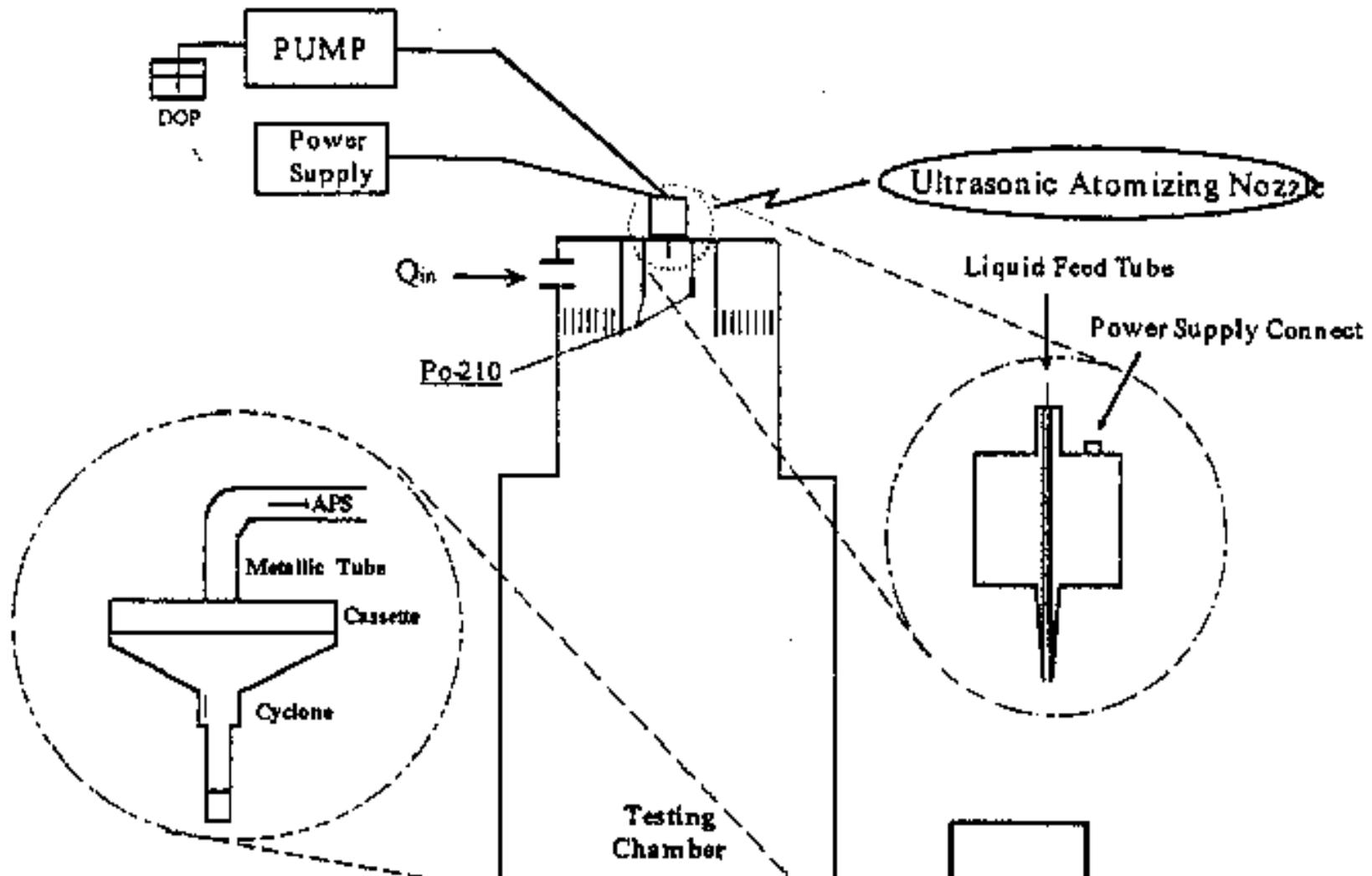
#### **4. Development of biological monitoring techniques for workers**

Completed "Application of Automated Biological Monitoring Method for the Determination of Lead in Blood Samples"(Figure 8): Optimal operating conditions for automated analysis were studied, including cleaning conditions for digestive chambers, pH stability of digestive liquid, stability of concentration efficiency of chelating resin, and stability of the system. Using blood lead as the example, standard operating procedures were written for the purpose of techniques transfer.

Completed "Biological Monitoring of Hazardous Occupational Exposure-the Development of Two Analytical Methods": Principles and standards (such as calibration curve, precision and recovery rate) for validation of biological monitoring methods were established. For biological monitoring of toluene and xylene, analytical methods NIOSH 8301 and NIOSH 8305 for hippuric acid

and methyl hippuric acid in urine respectively, were validated by four laboratories.

Completed "Method Development and Verification for Biological Monitoring of Exposure to Aniline": Colorimetry of p-aminophenol in urine showed that for its calibration curve, linear correlation coefficient reached 0.999, for exposures between 0.1 to 1.2 times of the limit set by BEI of ACGIH, with percent relative deviation less than 10%.



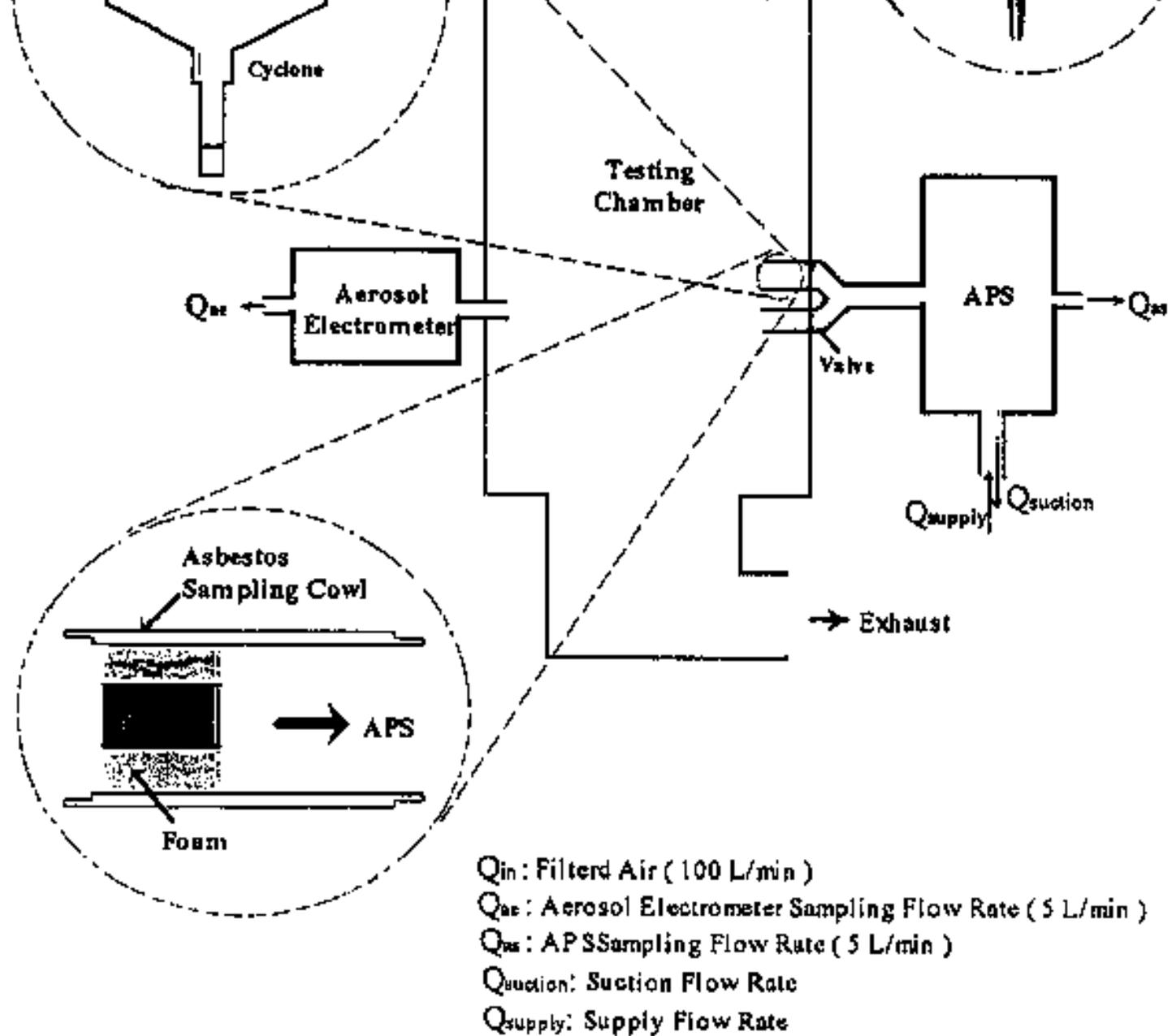
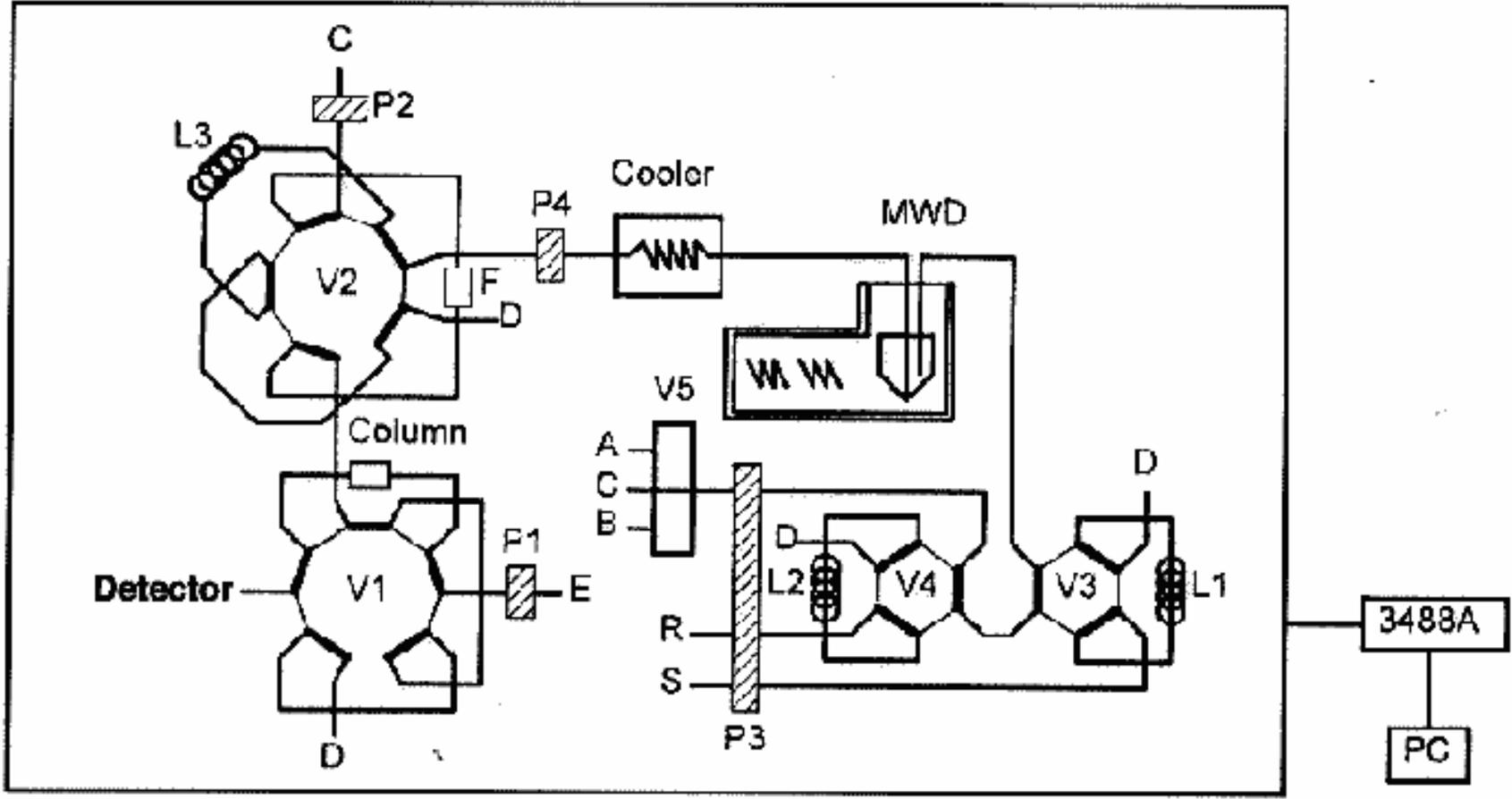


Figure 7 Experimental System for Aerosol Size Selective Sampler



P1 and P2: pump with set flow, P3 and P4: pump with continuous flow

V1~V5: electromagnetic gates

L1: sample channel, L2: reactant channel, L3: collection channel

MWD: microwave digestion chamber

A: air, B: buffer solvent, C: water, D: waste fluid, E: washing fluid, F: filter

R: digestive acid, S: sample, 3488A: signal switch/control unit

PC: computer

### Figure 8 Channel Connection System for Automated Biological Monitoring Method for the Determination of Lead in Blood Samples

For analysis of aniline in urine, reverse-phased HPLC was used, with results showing linear correlation coefficients of 0.999 and 0.997 without and with urine for concentrations between 1 to 5 ug/mL, detection limit at 0.2 ng and recovery rate at 74%.

Completed "Utilization of Non-invasive Biomarkers in Assessing Occupational Tetrachloroethylene Exposures": GC/FID was

used to measure trichloroethylene in exhaled breath of workers. For a sampling volume of 0.5L, the calibration curve ranged from 0.1 to 20 ppm, with a detection limit of 0.49 mg. The same method was also used for the measurement of tetrachloroethylene in urine, with a calibration curve ranging from 10 to 200 mg/L and a detection limit of 2.8 mg/L.

### **5. Development of real-time gas surveillance technique**

Completed "Establishment and Evaluation of Infrared Sensing Technology in Semiconductor Manufacturing": Fourier transform infrared spectroscopy was used for exposure assessment in clean room, yellow light area, etching area, and ion implant area of semiconductor manufacturing facilities. Results showed that most pollutants dispersed abruptly, with concentrations showing large variability over time, especially during maintenance.

Completed "Evaluating a Hydrogen Sulfide Sensor": Basic functions and influences of physical and chemical factors for hydrogen sulfide direct-reading instruments were studied. Results showed that all three detectors commercially available in Taiwan met the requirements for measurement.

Research projects on method development and analysis are conducted to support the work of the Department of Labor Health and Safety and the Department of Labor Inspection in the Council of Labor Affairs, formulated in accordance with the latest foreign technologies and urgent domestic needs (such as the frequency and severity of occupational injuries in recent years). In principle, research projects for fiscal year 1998 will build on the above, and taking into consideration the recommendations of the Scientific and Technical Advisory Group of the Executive Yuan and the Environmental and Biological Monitoring Technical Committee of the

Institute. It will continue upon the foundation of research studies in the previous three years, and will focus on chemical exposure surveys, development of sampling and analytical techniques for hazardous substances in the work environment, evaluation and development of samplers and sampling media, development of biological monitoring techniques for workers and development of real-time gas surveillance techniques:

**1. Chemical exposure surveys:** focus on in-depth studies of hazardous substances used in industries, and writing guidelines for sampling strategies and exposure assessment in high-risk industries, including "Workplace chemical exposure survey".

**2. Development of sampling and analytical techniques for hazardous substances in the work environment:** focuses on developing sampling and analytical methods for hazardous substances suitable for the local work environment, including "Sampling and Analysis of Airborne Toluene Diisocyanate(TDI)", "A Study of Gravimetric Method for the Analysis of Nuisance Dusts from the Workplace", "Study on Fume Composition from Stainless Steel Welding", "Study on Sampling and Analytical Method for Mercury Vapor from Workplace", "Measurement of Chloromethane and Vinylbromide in the Workplace by Using Thermodesorption/Gas Chromatography", "New Sampling and Analytical Methods for Acetonitrile", "Improving Air Sampling and Analytical Method for Carbon Disulfide", and "A Guideline for Drafting an Environmental Monitoring Program".

**3. Evaluation and development of samplers and sampling media:** focuses on developing a sampler for acidic mist that will simultaneously collect particles and gases, and guidelines for manufacturing and using direct reading instruments, including "Masking Effects on Asbestos Counting", "Research and Development of Personal Denuder Sampler", "Adsorption of 2-methoxy

ethanol Vapor on Working Clothes", "Development and Evaluation of Respirators Cartridges for Organic Vapors", "Detector Tube Selection and Measurement Technical Book", "Examination of the Validation System of Direct Reading Instruments", and "The Evaluation of Commercial Detector Tube Performance".

**4. Development of biological monitoring techniques for workers:** focuses on field validation of biological monitoring methods that have been developed, and quality management systems in laboratories, including "Mercury Speciation in Urine and Blood Among Workers", "Risk Assessment of Workers Exposed to Pesticides", "Survey on Analytical Performance of Blood Lead Testing in Taiwan" "Survey an Tetrachloro-ethylene Exposure in Hotel Dry Cleaning Operation", and "Study of Ethylene Oxide Health Hazard".

**5. Development of real-time gas surveillance technology:** focuses on using infrared spectroscopy to monitor concentrations of pollutants as well as to assess levels of occupational exposure, including "The Evaluation of Toxic Gases Leaking from Process Machines in Semiconductor Industry".

### **III. Occupational Hygiene**

Research on occupational hygiene focuses on prevention of occupational diseases caused by work environmental hazards, including their recognition, evaluation and control. The Institute submits research results to the Council of Labor Affairs, Executive Yuan, hoping that they will serve as references for the formulation of policies and occupational hygiene system, as well as for reviews and amendment of occupational hygiene regulations, in addition to providing occupational hygiene technology to

assist enterprises to effectively improve the work environment, so realizing the objective of protecting the health of workers.

Plans for occupational health research were aimed at protecting workers' health through recognition, evaluation and control of the work environment, concentrating on surveying, preventing and controlling chemical, physical, biological, and ergonomic hazards, as well as at establishing research strengths. Research projects for occupational hygiene for fiscal year 1997 expanded on those conducted in 1996. In addition to gathering information on risk factors and biomechanical data locally, applying anthropometry and engineering control methods in the work environment, emphasis was placed on recognition, control and protection in special operations.

A total of 20 research projects were completed in fiscal year 1997, including:

(1) Survey of exposure to occupational hazards, (2) Prediction models and control of hazardous substances and noise in the work environment, (3) Study of occupational hygiene protection equipment and measuring instruments, (4) Evaluation and control of ergonomic hazards, and (5) Control of occupational musculoskeletal diseases. A detailed account of research results is as follows:

### **1. Survey of exposure to occupational hazards**

Completed "Occupational Chemical Hazard Survey(I)": First year of a four-year survey of chemical exposure in industries covered by Labor Safety and Health Law, focused on leather goods manufacturing, printing, resin products manufacturing, plastic

products manufacturing, porcelain and pottery making, and basic steel industries. Walk through surveys and chemical exposure assessment were conducted in 602 factories.

Completed "Biohazards in the Air of Healthcare Facilities-*Legionella pneumophila*": Air samples were taken at the exhaust end of ventilation system and the effluent end of waste water collection system in medical facilities. Blood and sputum samples of cases prone to infection (including patients and health care professionals) were also taken for antibody-testing and microbial culture. Results showed while there were patients with Legionnaire's disease in medical facilities and *Legionella pneumophila* was found in the water tower, *Legionella pneumophila* was not found in the air samples and infected patients were not nosocomial cases. The route of infection would require further study.



Figure 9 Study of Occupational Hygiene Conditions in Medical Facilities

Completed "Survey on Occupational Health In Medical Facilities" (Figure 9): Biological, physical, chemical and ergonomic hazards, as well as implementation and difficulties in occupational safety and health in medical facilities, were studied by on-site interviews of health care workers. 400 questionnaires were completed to elucidate special hazards and numbers of exposed workers in hospitals.

Completed "Study of Domestic Workers!| Adjustment to Heat Environment using ISO-7933 Program": An attempt to develop a software for heat hazard assessment was made by measuring physiological responses to high temperature under various environmental conditions, in accordance with related ISO standards. 120 sets of data were collected, showing that ISO predictive model for amount of perspiration was congruent with experimental results, while that for skin temperature did not, indicating a

need to reevaluate relationships between factors influencing skin temperature. As for rest schedule, results showed the same trend as the recommended standard issued by ACGIH.

## **2.Prediction models and control of hazardous substances and noise in the work environment**

Completed "A Study on the Model of Airborne Contamination Control and Prediction": General ventilation when hazardous substances were evenly dispersed was studied, using dispersion model and flow network model developed previously. Predictive power of the models were evaluated by actual measurements before and after the improvement of temperature and humidity conditions at the workplace.

Completed "A Study on the Design of Local Exhaust Ventilation System": A Chinese version of the software for duct design of local exhaust ventilation system was developed, which was further validated in trial calculations, laboratories and field measurements. Pressure loss did not exceed the acceptable limit of 20%. Information on hood design, including shape, dimensions, suitable operations or processes, ventilation volume, pressure loss coefficient, and control velocity or concentration, was collected.

Completed "Prediction Model for Noise control-the Simulation of Sound Field in the Workplace(II)" : First year study focused on laboratory validation of simulation software. Results showed that in the sound room, total error was about 0.2% with average deviation less than 1 dB. In the meeting room, total error was about 0.6%, with 1.2% at 125 Hz and 0.2% at 4kHz. Application of sound field simulation in complex work environment (i.e. footwear and tape manufacturing) will be conducted, to see if such a

model is useful for qualitative evaluation of the effectiveness of proposed control measures.

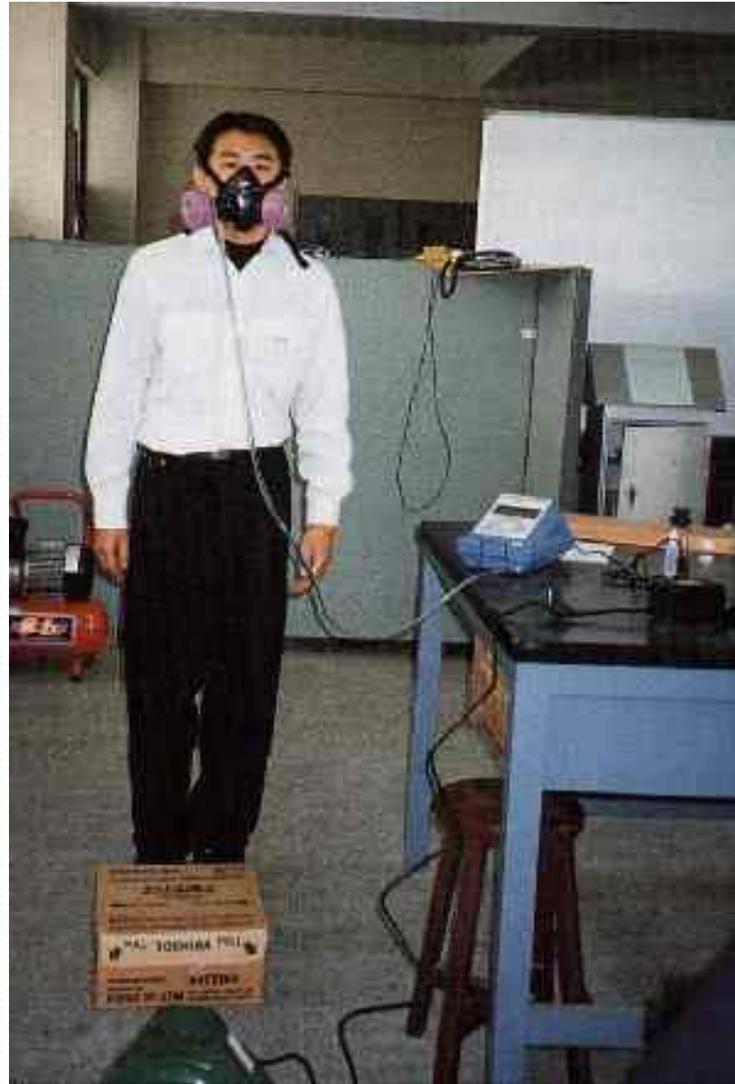
Completed "The Study on the Improvement of Safety, Health and Amenity in Electroplating Workplace": A team was formed to provide technical assistance to 23 electroplating factories participating in the study. Training materials were prepared with information gathered through field studies and 363 measurements of chromic acid concentrations in the work place, as well as literature review. 70 people attended the training program. The result showed 63% improvement in terms of chromic acid concentration before and after assistance.

Completed "A Study on the Control of Lead Stearate Aerosol Exposure": Environmental monitoring data were used to understand the differences in exposure for various operations. Environmental monitoring was conducted at 67 points in 4 factories, including 23 personal samples and 44 area samples. 78% of personal samples and 41% of area samples exceeded regulatory standards. Most serious exposure occurred in loading and packing, and in reaction operations. Control measures were collated and distributed in seminars for enterprises.

Completed "Survey on Dust Exposure in Masonry": Occupational musculo-skeletal injuries were more than respiratory disorders, there was a statistical relationship between respiratory disorders and smoking history. The dust concentration is below the level of Law except the commission of Taipei masonry, the low concentration of free silica in bulk samples and airborne samples which are primarily constituted of feldspar.

Completed "Review of Regulations on Airborne Contaminants in the Workplace": Regulations on air pollution in the work

environment from other countries were assembled in order to revise current regulations in Taiwan.



## Figure 10 Respirator Fit Test with Human Subject

### 3. Study of occupational hygiene protection equipment and measuring instruments

Completed "Fit Test Respirators"(Figure 10): 9 types of half-face respirators from 3 brands were tested for the fit to experimental subjects, in order to understand the influences of trial use, facial shape, mask dimensions and motions on the fit of respirators. Results showed that mask dimensions and facial shape affected the fit, and medium-small mask was most suitable for local subjects.

Completed "Breakthrough and Test Conditions for Organic Vapor Filters": 87 filters (29 types) was tested for breakthrough using the current national standard. Feasibility of using cyclohexane instead of carbon tetrachloride as test gas was evaluated. Results showed that domestic products did not provide sufficient protection and their performances were inferior compared with foreign products.

### 4. Evaluation and control of ergonomic hazards

Completed "The Design Guidelines on Safe and Healthy Man-machine Interface-Visual Display Terminal": Applying ergonomic principles, guidelines for VDT were developed through subjective questionnaires and measurements of workstations.

Contents included demands on job design, monitor, keyboard, work space, work environment, and health management. A checklist was also available for workers.

Completed "Establishing Manual Material Handling Regulations Locally": Using psychophysics, maximum acceptable weight limit (MAWL) for young men in Taiwan was determined to be 28 kgs. Referring to manual material handling guidelines overseas (including ISO, EN, and NIOSH documents), a handbook was written on acceptable weights, risk factors evaluation, and improvement measures.

Completed "The Study on Suitability of Ergonomic Checklist for Work Site": Two ergonomic checklists (BRIEF and MSDs) were evaluated locally. Questionnaires showed that in 8 enterprises in different industries, MSDs was more sensitive in uncovering potential musculoskeletal risk factors. Safety and health staff participating in the study indicated that the time for training on the use of either checklist should be lengthened, and MSDs were easier to use in evaluating work postures.

Completed "The Improvement of Simple Splint for Computer Word Processing Task": Through questionnaires and motion analyses, the effectiveness of a protective splint for word processing was evaluated. Its main function was shown to prevent wide-angle wrist motions.

### **5. Control of occupational musculoskeletal diseases**

Completed "The Investigation of Occupational Musculoskeletal Problems in Housing Construction": Applying ergonomic principles, musculoskeletal disorders among 531 construction workers were studied using questionnaires. 97% had

musculoskeletal pain or discomfort, of which 53% required some self-remedy or a clinical visit. Lower back(19%) was most commonly affected (except among painters), followed by right shoulder(9%) and right hand(5%).

Completed "The Investigation of Parameters for Biomechanical Model-the Establishment of Anthropometric Data of Musculoskeletal System(I)": Whole body MRI was used to measure mass, center of mass, momentum of inertia for external force model and cross section area, vector of action force, and vector of moment arm for internal force model of various sections of the body. 8 local subjects were studied, showing that except for upper arms, thighs and feet, the values were smaller when compared with Caucasian population, but the differences were within acceptable ranges.

Completed "Strategy in Repetitive Disorders Prevention-Field Assessment and Establishment of Hand Force Database(I)": A database on biomechanics of wrist motions was established through analysis of videotapes taken in 16 factories with operations involving hands, in order to classify basic motions resulting in hand force exertion. 300 workers will be selected for static measurement of hand dimensions, motion angles, and force. 15 workers will be selected according to body size for 8-hour power curves determined by psychophysics. An instrument for measuring hand force exertion was pilot tested with 15 subjects.

Completed "Application of Anthropometric Data to Workplace Environment Design": A database of static and dynamic anthropometry in Taiwan was developed, in order to establish reference values for work environment design, including working range, activity space, and sizes of equipment and tools. Research was conducted for (1)work bench height, conveyor belt height, vertical working area, comfortable lifting height, work space while standing, and (2)work bench height, seat, activity space for

legs, vertical working area, horizontal working area, conveyor belt height, and work space while sitting, (3) display terminal dimensions, and (4) computer workstation dimensions.

Research projects for 1998 supports administration demands of related organizations such as the Department of Occupational Safety and Health, the Department of Labor Inspection and various labor inspection agencies. Projects also take into consideration past research findings, such as problems arising from occupational hygiene, conditions of the work environment and difficulties in implementing improvements for occupational health. In accordance with research strategic plan, as well as reviewing and continuing research from the last five years, adjustments have been made for 22 research projects in 1998, hoping that the implementation of these projects will actually meet the basic needs in occupational hygiene. Emphasis of research is stated below:

**1.Survey of exposure to occupational hazards:** focuses on studying severity and number of exposed workers for various chemical hazards, and understand exposure conditions in domestic work environment (especially in industries newly covered by Occupational Safety and Health Act), including "Occupational Chemical Hazard Survey(II)", "Study on Occupational Health Issues of Health Care Facilities in Taiwan(II)", "A Study of Domestic Workers' Heat Hazard Evaluation Model".

**2.Prediction models and control of hazardous substances and noise in the work environment:** focuses on solving problems associated with airborne contaminants, through studies of engineering control technology (especially ventilation), and on assisting enterprises in applying it in highly hazardous workplace, including "Study and Health Improvement in Asbestos

Workplace", "The Performance of Air Supply and Exhaust System in Semi-enclosed Working Space", "A Study of Particulate Capture Efficiency by the Hood", "Study on the Condition and the Dispersion of Chromium Acid Mist in Electroplating Plants", "Study on Processes and Dust Exposure in Fire Brick Manufacturing", "A Study of the Relationship Between Occupational Exposure Dose And Sound Source".

**3.Study of occupational hygiene protection equipment and measuring instruments:** focuses on factors influencing effects of protective equipment, to serve as guidelines for selection, including "A Study on Establishing the Standard for Respirator Fit Testing-Variou Face Shapes And Respirator Valve", "Study on Valid Respirators for Harmful Materials"

**4.Evaluation and control of ergonomic hazards:** focuses on applying ergonomic technologies in occupational safety and health, to avoid injuries resulting from improper man-machine interface and work environment, and adopting measures such as workplace checklists, manual material handling assessment, and ergonomic injury prevention, including "Design Guidelines on Safe and Healthy Man-machine Interface-a Study of Computer Simulation on Human Modeling", "A Feasibility Study on Lifting Aids for Manual Handling Tasks", "The Study of Range of Motion of Upper Limbs in Machinery Safety Guidelines", "A Study of Occupational Safety and Health Hazards in Semiconductor Manufacturing Industry", "The Study of European Standards on Ergonomics", "Mechanisms of Supports of Back Belts in the Sitting Posture(I)", "A Study On Suitability of Ergonomic Checklist for Semiconductor Manufacturing Industry".

**5.Control of occupational musculoskeletal diseases:** focuses on establishing basic data for hand force exertion and

physiological measurements of musculoskeletal system, so that biomechanical principles can be applied to solve the problem with ever-increasing number of cases of occupational musculoskeletal injuries, including "Ergonomic Designs of Tools for Painters", "An Investigation of Parameters of the Biomechanical Model-The Establishment of the Anthropometric Data of Musculoskeletal System(II)", "Strategy for Repetitive Disorders Prevention-Field Study and Establishment of Hand Force Database(II)", "Analysis and Improvement of LBP Problems for Building Construction Workers".

#### **IV. Occupational Medicine**

In 1997 studies in occupational medicine were conducted in the following four areas: occupational epidemiology, surveys of occupational diseases and injuries, labor health promotion, and occupational biomedicine.

##### **1.Occupational epidemiology**

Completed "Cohort Study among Workers Exposed to VCM in Taiwan(II)": Environmental assessment showed that for most part occupational exposure did not exceed the regulatory limit of 10ppm for dichloroethylene, except for those working at maintenance, pollution control, unloading and driving. High exposure to VCM or EDC was related to abnormality of liver function, possibly leading to disorders such as cirrhosis. However, because of the small number of cases, further studies would be required to confirm the association.

Completed "A Preliminary Survey of Occupational Cancer in Taiwan": Labor insurance data was used to establish a database on

cancer patients, which showed that 8.45% of lung cancer, 6.73% of leukemia, and 4.13% of bladder cancer might be related to work. Cluster analysis revealed that some factories and enterprises had abnormal increases of cases, warranting further investigations of causes.

Completed "Epidemiological Study on Sudden Death Syndrome among Workers": 15 cases of sudden deaths among foreign workers were collected, of which 3 had confirmed causes after autopsy, with

unadjusted death rate at 5.1 per 100,000. The remaining 12 cases were mostly Thais (75%), working in manufacturing (83%), with 17% having family history of sudden death. They were all male, with average age of 31.8 years old.



Figure 11 Fires often occur from the main motor in the center of the fishing boat because of carelessness during maintenance or mechanical failure

Completed "Risk Analysis for Commercial Fishing Industry in Taiwan(I)"(Figure 11): Types of causes resulting in occupational injuries among fishermen were assessed. Recommendations for future inspections including personnel, machinery and equipment, and environment were made.

Completed "A Study of Physical Conditions among Workers Exposed to Lead":Health examination data of lead stereate workers for the past three years were analyzed, in order to compare blood lead levels through the years.

## **2.Surveys of occupational diseases and injuries**

Completed "Surveillance for Acute Occupational Injuries in Emergency Departments": 2089 cases of acute occupational injuries were collected, of which 1676 were males and 403 females.13.6% worked for construction industry, followed by 8.8% in metal product manufacturing, 7.9% in public administration, 7.8% in personal services and 6.1% in food product manufacturing. Most of the hospitalized cases worked for construction, metal product manufacturing and machinery industries. 61 workplace survey were also conducted.

Completed "Estimation of Economic Cost for Occupational Deaths in Taiwan": Occupational death incidence rates and types of causes for various industries were analyzed using labor insurance data. Families and employers for 150 cases were interviewed. 300 healthy workers were also selected to determine the cost of life using willingness-to-pay method. The loss in terms of human

resource was evaluated with economic theories and literature review.

Completed "Utilizing data from Health Examinations for Occupational Disease Prevention Sponsored by Labor Insurance Bureau-Lead Operations": Special health examination results for workers in lead operations were analyzed, showing that 2.54% had abnormal zinc protoporphyrin level, and 1.41% had abnormal blood lead level. Recommendations for establishing basic medical and work history before examination, unifying reported test units and diagnostic criteria, as well as letting occupational physicians review results, were made.

Completed "Occupational Exposure to Vibrations-Hands and Arms": Machinery producing greatest vibration (3-D weighted average vibration  $<10$  m/s) were handheld road drill, platform grinder, pneumatic lever, pneumatic compactor, electric drill, heavy postal motorcycle (125cc), concrete breaker and chain saw. 269 exposed workers were examined by medical specialists, with 44 showing clear symptoms according to Stockholm hand-arm vibration syndrome classification for a prevalence rate of 16.4%. 2 railroad workers occasionally had whitening of fingertips, possibly circulatory function impairment. In questionnaires for self-reported symptoms, aches of lower back, shoulders, and wrist, as well as stomach ache, ringing in the ears and difficulty in hearing were most common. As for recovery rate of finger skin temperature, automotive repairers were fastest, while rail drillers, masons, and construction workers were the slowest, indicating decline of peripheral circulatory functions among workers exposed to high level of vibration.

### **3.Labor health promotion**

Completed "Assessment of Nutritional and Physiological Status of Shift Workers(II)-Fixed Shift": Blood lipids and vitamins among shift and daytime workers were studied to understand their nutritional intakes.

Completed "A Study on Preventing Decompression Sickness among Workers under High Atmospheric Pressure": Preventive strategy, safe operations procedures and directions for regulatory amendments were proposed with consideration for current situations. Heat hazard in high atmospheric pressure workplaces was evaluated to see if workers should follow "High Temperature Operations Rest Schedule".

Completed "Follow-up Study on Work-hardening of Workers with Work-related Injuries": 109 cases completed work-hardening program, and return-to-work rate at the completion of the programs, and 1 month , 3 months afterwards, were 30.3%, 32.1% and 36.7% respectively. Factors influencing return-to-work included: whether the employer kept the job for the injured worker, which part of the body lost its functions, marital status, difference between physical demand of the job and physical capability of the case, ability to perform daily living activities, and functional mobility capability.

Completed "Validation of Procedures in pure-tone Audiometry-Hearing Loss and Intervals for Examination": Hearing thresholds and pure-tone hearing for males and females in different age groups between ages 15 to 65 were examined, which would be used as a basis for hearing loss assessment.

Completed "Establishment of Physical Capacity Norms for Aging Workers-Transport, Storage & Communication Industries, Food

Service And Hospitality Industries, Electricity, Gas & Water Industries, Environmental Health Services Industries": Body mass index and waist-hip ratio were shown to approach upper limits for workers tested. Muscle strength and endurance, joint range of motion and flexibility and balance and reaction declined as age increased. Male muscular strength and endurance decreased faster than females. Balance and reaction dropped faster after age 50. Females were more flexible than males in the same age group. Cardiopulmonary fitness was related to exercise habits.

Completed "Abnormal Mental Status Among Taiwanese Workers-An Application of Labor Insurance Data on Occupational Mental Health": Among cases of labor insurance cash compensation for 1993, 2012 were for mental disorders, accounting for 0.534% of all cases. 863 cases were for schizophrenia, 273 for emotional disturbance, 140 for alcohol addiction, accounting for 42.9%, 13.5% and 7.0% of all mental disorders cases. Claims were most often made by workers in construction, taxi, and inland fishing industries.

Completed "Intervention Strategies on High Job Stress Workers": Group tests were used to identify high stress workers, who subsequently were divided into experimental and control groups for 14-week intervention plan. Managers receiving stress management training were significantly better in the immediate effects of relaxation of job stress sensitivity.

Completed "Subjective Test Technology for Hearing Protectors(II)": Subjective testing environment and equipment for hearing protectors were established. Human subjects were also selected.

#### **4.Occupational biomedicine**

Completed "A Follow-Up Study on Effects of Lead on Immune Functions of Workers": Immune functions of 60 workers exposed to lead were tracked for 2 years, which showed lead exposure had long-term effects on humoral and cellular immune functions. A method for quantifying secretory antibodies in saliva was developed.

Completed "Detection of Infectious Agents in Hospitals": Field studies of medical facilities were conducted to understand ventilation conditions. Sampling methods for airborne infectious agents were compared and validated. Related preventive measures taken by medical facilities were evaluated.



Figure 12 Even if isocyanate is used in an enclosed system, respiratory protection is still necessary

Completed "Individual Characteristics and Allergic Responses among Workers--Isocyanates"(Figure 12): 135 workers in 6 factories using isocyanates were studied through questionnaires, physical examinations, lung functions tests, and blood samples.

Over 30% of workers had lung functions abnormalities. Over 30% had hypersensitivity, and MHC class I and II HLA were analyzed for relationship between the two.

Expanding upon research in 1997, research is planned for the following in 1998:

**1.Occupational epidemiology:** "Health Management Practices in the Workplace", "A Longitudinal Study of Respiratory Diseases among Coalminers in Taiwan", "The VCM Cohort Study in Taiwan(III)", "The Study of Long Term Health Effects among Sulfuric Acid Workers", "An Epidemiological Survey of Workers Exposed to Isocyanates(II)", "Analysis of Risk Factors for Occupational Cancers-Urinary and Bladder Cancers", "Analysis of Hazards in Commercial Fishing Industry in Taiwan(II)".

**2.Surveys of occupational diseases and injuries:** "A Study of Occupational

Bladder Cancer, Leukemia, Lymphoma and Skin Cancer in Taiwan", "A Study of Health Examination Data among Workers in Semiconductor Industry", "Analysis of Labor Insurance Compensation Data-Sanitary Services", "Medical Surveillance for Occupational Injuries in Emergency Rooms(II)", "Survey and Analysis of Cumulative Musculoskeletal Disorders among Transportation Employees", "An Estimation of Occupational Injuries and Illnesses from Hospitalized Data from Labor Insurance".

**3.Labor health promotion:** "Preliminary Study on the Energy Expenditure for Workers", "Evaluation on Work Fatigue and Physiological Effects among High Elevation Operators", "The Analysis Of Substance Abuse among Taiwanese Workers", "Subjective Test Technology for Hearing Protectors(III)", "Analysis of Psychological Disturbances among Taiwanese Workers from 1993-1996(II)", "Health Promotion Strategy among Aging Workers-Manufacturing", "A Model for the Establishment of Rehabilitation Network(III)", "Survey of Background Noise Level in Audiometric Rooms", "Assessment of Hearing Loss among Workers in Industries with High Noise Level-Automobile Manufacturing"

**4.Occupational biomedicine:** "Study of Biological Health Effect Index of Chromium Among Electroplating Factory Workers", "Survey of Dietary Pattern and Nutrition Status in Factories in Taiwan", "An Investigation of the Factors Related to Adverse Effects among Foam Resin Workers", "A Study of Glove Permeability".

## **RELATED ACTIVITIES**

### **I.Academic Activities**

Academic activities are primarily focused on presentations of research results, and local and foreign academic exchanges. For 1997, the Institute sponsored or jointly sponsored 19 academic conferences; presented 20 theses in local publications, 5 theses in foreign publications, 55 theses in local academic conferences, 10 theses in foreign academic conferences; and invited foreign experts to conduct 5 academic seminars. In addition, four of the Institute's research projects and six researchers have garnered

Outstanding Research Awards for fiscal year 1996 from the Executive Yuan and the National Science Council.

**1. Academic conferences (Table 3)**

Name of the Conference	Summary of Activities	Date
Presentation of Research results on Construction Safety from Fiscal Year 1996	Approximately 180 labor inspectors, safety and health professionals from industries, researchers in related fields participated; 6 papers and special lectures included.	97/1/24 97/1/30 97/4/21 97/4/23
1997 Conference on Industrial Hygiene	Approximately 500 labor inspectors, safety and health professionals from industries, researchers in related fields participated; 128 papers included.	97/4/6-8
1997 Presentation of Research results on Health Promotion	Presented research results from fiscal year 1996; approximately 200 people participated; 8 papers included.	97/4/11-12

Practicum on Computer Workstation and Ergonomics	Approximately 75 labor inspectors, and safety and health professionals participated in discussions on applying ergonomic principles and practices on computer workstations.	97/4/15-16
Conference on Mechanical Safety and Presentation of Research results on Mechanical Safety from Fiscal Year 1996	Approximately 180 labor inspectors, safety and health professionals from industries, researchers in related fields participated; 6 papers and special lectures included.	97/4/25!B 97/4/28!B 97/4/30

<b>Name of the Conference</b>	<b>Summary of Activities</b>	<b>Date</b>
Conference on Chemical Safety and Presentation of Research results on Chemical Safety from Fiscal Year 1996	Approximately 150 labor inspectors, safety and health professionals from industries, researchers in related fields participated; 5 papers and special lectures included.	97/5/29 97/6/5
The Ninth annual Conference of the International Society for Environmental Epidemiology	300 researchers in related fields from 38 countries participated; 10 plenary symposia and more than 200 papers included.	97/8/18-20

<p>Practicum on Guidelines for Occupational Hearing Protection Plan</p>	<p>Approximately 70 labor inspectors and safety and health professionals participated in the introduction and the promotion of Guidelines for Occupational Hearing Protection Plan by experts and scholars, to be use as a reference in industries.</p>	<p>97/9/18-19</p>
<p>1997 Conference on Exposure Assessment Technology</p>	<p>Approximately 200 labor inspectors, safety and health professionals from industries, researchers in related fields participated; 27 papers included.</p>	<p>97/10/1-2</p>
<p>1997 International Conference on Aerosol Technology, Environmental Monitoring and Control</p>	<p>Approximately 200 people participated; included special lectures by international experts, and 46 papers on aerosol technology, including hazards, control and sampling of aerosol.</p>	<p>97/10/1-2</p>
<p>Eighteenth Conference on Sino-Japanese Engineering Technology</p>	<p>Approximately 250 people participated in presentation of safety and health research results; 8 papers included.</p>	<p>97/11/5</p>
<p>1997 Presentation of Research results on Occupational Medicine</p>	<p>Approximately 250 people participated in presentation of occupational medicine research results; 10 papers included.</p>	<p>97/11/7-8</p>

Conference on Cross-Strait Exchange and Development of Occupational Medicine	Approximately 250 physicians, scholars and experts participated, 19 papers on occupational medicine from both sides of the Taiwan Strait included.	97/11/21-22
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## 2. Presentation of theses-Local publications(Table 4)

Title	Publication	Authors
Development of a Thermal Desorption Method for 1,3-Butadiene, Acrylonitrile and Styrene	Journal of Occupational Safety and Health, Vol. 5, No. 1	L-J. Wu*, S-N. Uang*, T-S. Shih*
Investigation of Cumulative Trauma Disorders in Semiconductor Manufacturing Industry	Journal of Occupational Safety and Health, Vol. 5, No. 1	K-W. Li, J-C. Chu, C-Y. Chen*, W-Y. Yeh*
The Maximum Acceptable Weights of Chinese Workers in Repetitive Lifting Tasks	Journal of Occupational Safety and Health, Vol. 5, No. 1	Y-H. Lee, C-Y. Chen*
Selenium Exposure and Health Effects Study of Rubber Production Process	Journal of Occupational Safety and Health, Vol. 5, No. 1	C-C. Wu, J-S. Lai, C-J. Chen*, Y-M. Chiung*
Establishment of a Guideline for Audiometry in Labor Health Examinations	Journal of Occupational Safety and Health, Vol. 5, No. 1	C-J. Chen*, C-H. Pan*, Y-K. Wu, Y-H. Young

Investigation and Design of Truck Cranes Overwinding Cut Out Devices	Journal of Occupational Safety and Health, Vol. 5, No. 2	W-C. Chou, J-Y. Wang, J-S. Yang, C-Y. Gau*
Effects of Particle Mass Loading and Electrostatics on Collection Efficiency of 10mm Nylon Cyclone	Journal of Occupational Safety and Health, Vol. 5, No. 2	C-J. Tsai, T-S. Shih*, H-G. Shiau, K-C. Lin
Development of Aerosol Size-Selective Devices	Journal of Occupational Safety and Health, Vol. 5, No. 2	C-J. Lai, C-C. Chen, T-S. Shih*, W-Y. Yeh*, C-Y. Chen*
An Occupational Disease Survey for Suspected Carbon Disulfide Intoxication in a Viscose Rayon Factory	Journal of Occupational Safety and Health, Vol. 5, No. 2	T-S. Shih*, L-J.Wu*, S-T. Kuo, C-C. Huang
A Follow-up Study on Manganese Exposure at Ferro-manganese Alloy Manufacturing Plants in Taiwan	Journal of Occupational Safety and Health, Vol. 5, No. 3	T-S. Shih*, T.J. Smith, C-C. Huang, R-I. Cheng*, W-Y. Yeh*, C-Y. Chen*
The Sampling and Analysis Method of Ethylene Oxide by Thermal Desorption	Journal of Occupational Safety and Health, Vol. 5, No. 3	S-N. Uang*, C-C. J. Chan. L-T. Chang
Evaluation of Hydrogen Disulfide Gas Monitors	Journal of Occupational Safety and Health, Vol. 5, No. 3	S-Y. Yan, S-W. Wong, D-T. Tang*

Title	Publication	Authors
Exposure of Bioaerosols and Coexisting Contaminants in Swine Feed Buildings	Journal of Occupational Safety and Health, Vol. 5, No. 3	C-W. Chang*, H. Chung, C-S. Huang, J. Su
Investigation of In Vitro Binding Reaction between Cobalt/Chromium Particles and Human Serum Albumin	Journal of Occupational Safety and Health, Vol. 5, No. 3	T-W. Chiou, R-L. Su, H-S. Liu, Y-M. Chiung*, C-D. Hsiao
Sampling and Thermal Desorption Method for Toluene Vapor	Journal of Occupational Safety and Health, Vol. 5, No. 4A Passive	L-J. Wu*
Analysis of Phenol in Workplace Air Using Thermal Desorption Gas Chromatographic Technique	Journal of Occupational Safety and Health, Vol. 5, No. 4	S-N. Uang*, T-S. Chang, F-Y. Fung
Method Development and Validation for Biological Monitoring of Occupational Exposure to Dimethylformamide	Journal of Occupational Safety and Health, Vol. 5, No. 4	S-N. Uang*, M. J. W. Chang, L-J. Wu, Y-C. Chen, H-J. Yang, J-D. Lin*
A Theoretical Study on the Control Velocity of Flanged Circular Hoods	Journal of Occupational Safety and Health, Vol. 5, No. 4	Y-K. Chen*, W-Y. Yeh*, C-W. Chen*

Evaluation of Control Methods for Chromium Mist Exposure in Chromium Electroplating Tanks	Journal of Occupational Safety and Health, Vol. 5, No. 4	C-W. Chen*, W-Y. Yeh*, Y-K. Chen*
Utilizing Data from Health Examinations Sponsored by the Labor Insurance Bureau-Lead Operations	Journal of Occupational Safety and Health, Vol. 5, No. 4	H-L. Lai*, C-L. Du*, C-J. Chen*

Note:\*IOSH Research Staff

### 3. Presentation of theses-Foreign publications(Table 5)

Title	Publication	Authors
Artifact Interference in Vinyl Chloride Analysis by Thermal Desorption Gas Chromatography	Journal of Chromatographic Science, Vol. 35, 151-155, 1997	I-F. Hung, C-K. Hung, K-C Huang, T-S Shih*, S-N Uang*
Characteristics of Lead Aerosols in Different Work Environment	American Industrial Hygiene Association Journal, Vol. 58, pp. 650-656, 1997	C-J. Tsai, T-S. Shih*, R-N. Sheu*

Automated On-line Sample Pretreatment System for the Determination of Trace Metals in Biological Samples by Inductively Coupled Plasma Mass Spectrometry	Analytical Chemistry, Vol. 69, pp. 3930-3939, 1997	C-C. Huang, M-H. Yang, T-S. Shih*
A Three-Dimensional Mathematical Model for Predicting Spinal Joint Force Distribution during Manual Lifting	Clinical Biomechanics of Sup. (accepted)	C-K. Cheng, H-H. Chen, H-H. Kuo, C-L. Lee , W-J. Chen, C-L. Liu
Deposition Modeling of Fibrous Particles in Rats: Comparisons with Available Experimental Data	Aerosol Science and Technology Vol.26,No.2	J-Y. Ding, C-P. Yu, L. Zhang, Y-K. Chen*

Note:\*IOSH Research Staff

#### 4. Presentation of theses-Local academic conferences(Table 6)

Topic	Conference	Date	Presenters

Survey on Hazards Related to Abnormal Atmospheric Pressure in Taiwan	Conference on Technology to Prevent Hazards Related to Atmospheric Pressure in Taiwan	97/3/20	C-C. Ho*
Cancer Surveillance among VCM Workers	1997 Conference on Biological Monitoring Technology	97/3/20-21	C-L. Du*
Field Performance Evaluation of the Passive Sampler for Ethylene Glycol Monomethyl Ether in the Field	1997 Conference on Industrial Hygiene	97/4/6-8	T-S. Shih*, C-Y. Chen*, R-I. Cheng*, L-J. Wu*, T-J. Smith
Performance Comparison of Size-Selective Samplers	1997 Conference on Industrial Hygiene	97/4/6-8	S-H. Chen, C-Y. Lai, T-S. Yu, C-C. Chen, W-Y. Yeh*, T-S. Shih*, C-Y. Chen*
Heavy Metal Concentrations in Domestic Cement	1997 Conference on Industrial Hygiene	97/4/6-8	T-S. Shih*, C-M. Hsieh*, C-H. Pan*, C-J. Chen*, W-Y. Yeh*, K-C. Yeh*, Y-L. Kuo
Development of an Analytical Method for Methoxyacetic Acid in Urine	1997 Conference on Industrial Hygiene	97/4/6-8	T-S. Shih*, J-S. Chou, C-Y. Chen*, T.J. Smith , C-Y. Chen*

Using Induced Coupled Plasma Mass Spectroscopy to Study the Mechanism of Magnesium Nitrate Based Modifier in Manganese Analysis	1997 Conference on Industrial Hygiene	97/4/6-8	H-Y. Lin*, C-C. Huang, M-H. Yang, T-S. Shih*
Control Technology for Lead Stearate Aerosol	1997 Conference on Industrial Hygiene	97/4/6-8	C-W. Chen*, J-P. Chang*, W-Y. Yeh*, M-H. Lin*, C-Y. Chen*
Occupational Manganese Exposure in Steel Plants	1997 Conference on Industrial Hygiene	97/4/6-8	T-S. Shih*, T. J. Smith, W-Y. Yeh *, R-I. Cheng*, C-C. Huang, C-Y. Chen*
Survey of Exposure to Carbon Disulfide in Man-made Fiber Manufacturing	1997 Conference on Industrial Hygiene	97/4/6-8	T-S. Shih*, L-J. Wu*, C-T. Kuo, C-C. Huang
Prevalence of Occupational Skin Diseases in Taiwan	1997 Conference on Industrial Hygiene	97/4/6-8	Y-L. Kuo, L-I. Lin, W-Y. Yeh*, C-W. Chen*
A Theoretical Study on the Control Velocity of Flanged Circular Hoods	1997 Conference on Industrial Hygiene	97/4/6-8	Y-K. Chen*, W-Y. Yeh*, C-W. Chen*

Establishing a Model for Estimating Exposure Index and Exposure Rate for Chemical Hazardous Factors	1997 Conference on Industrial Hygiene	97/4/6-8	W-Y. Yeh*, P-J. Tsai
Occupational Hygiene Conditions in Medical Care Facilities	1997 Conference on Industrial Hygiene	97/4/6-8	T-H. Hsieh, L-H. Hung, C-W. Chang*, M-H. Lin*, W-Y. Yeh*, Y-K. Wu, Y-H. Huang
Classification System for Respiratory Protectors	1997 Conference on Industrial Hygiene	97/4/6-8	Y-K. Chen*, W-Y. Yeh*, C-W. Chen*
Evaluation and Control of Vibration due to Crushers Operated by Railroad Workers	1997 Conference on Industrial Hygiene	97/4/6-8	W-Y. Yeh*, Y-W. Liu, H-T. Ho, S-H. Lin*, W-I. Chen*
Hazardous Work Environment Exposure in Swine Farms	1997 Conference on Industrial Hygiene	97/4/6-8	C-W. Chang*, H. Chung*, C-S. Huang, J. Su
Anthropometry and Musculo-skeletal Disorders in Computer Operations	1997 Conference on Industrial Hygiene	97/4/6-8	C-Y. Chen*, W-Y. Yeh*, C-L. Lee*
Respirator Fit Test with Mannequin Heads and Human Subjects	1997 Conference on Industrial Hygiene	97/4/6-8	C-W. Chen*, W-Y. Yeh*, Y-K. Chen*

Lumbar Force Model for Occupational Low Back Injuries	1997 Conference on Industrial Hygiene	97/4/6-8	C-L. Lee*, C-K. Cheng, H-H. Kuo, C-Y. Chen*
Lifting Weights for Repetitive Lifting Operations	1997 Conference on Industrial Hygiene	97/4/6-8	Y-H. Li, C-Y. Chen*
Assessment of Work Environment in VDT Operations	1997 Conference on Industrial Hygiene	97/4/7-8	I-F. Mao, J-W. Huang*, C-J. Chen*, M-L. Chen, S-F. Cheng, M-H. Tsai
Establishment of Guidelines for Conducting Hearing Test in Labor Health Examinations	1997 Conference on Industrial Hygiene	97/4/7-8	C-J. Chen*, C-H. Pan*, Y-K. Wu, I-H. Yang
Reconstruction of Occupational Exposure Dose- the Example of VCM	1997 Conference on Industrial Hygiene	97/4/7-8	C-L. Du*, C-C. Chan, J-D. Wang
Sudden Death Syndrome among Workers	1997 Conference on Industrial Hygiene	97/4/7-8	M-C. Li, T-P. Shih, C-L. Du*, C-J. Chen*
Physiological Status of Shift Workers-Fixed Shift	1997 Presentation of Research Results on Health Promotion	97/4/11-12	J-W. Huang*, T-L. Hsu, C-F. Liu, H-P. Hu

Fatigue and Physiological Status of VDT Operators	1997 Presentation of Research Results on Health Promotion	97/4/11-12	I-F. Mao, J-W. Huang*, C-J. Chen*, M-L. Chen, M-H. Tsai, S-F. Cheng
Research on Guidelines for Conducting Hearing Test in Labor Health Examinations	1997 Presentation of Research Results on Health Promotion	97/4/11-12	C-J. Chen*, C-H. Pan*, Y-K. Wu, I-H. Yang
Estimating Economic Cost for Disabilities Resulting from Occupational Accidents	1997 Presentation of Research Results on Health Promotion	97/4/11-12	C-C. Ho*
Food Consumption and Nutritional Status of Fixed-Shift Workers	Nineteenth Meeting of the Society of Nutrition	97/5/17	J-W. Huang*, T-L. Hsu, C-F. Liu, H-P. Hu
An Improved Method to Measure Urinary Alkoxy Acetic Acids	The Ninth annual Conference of the International Society for Environmental Epidemiology	97/8/17	T-S. Shih*, J-S. Chou*, T.J. Smith
Exposure Assessment of 2-methoxy ethanol	The Ninth annual Conference of the International Society for Environmental Epidemiology	97/8/17	T-S. Shih*, S-H. Liu, C-Y. Chen*, J-S. Chou*, T.J. Smith

Thermal Desorption/Gas Chromatography for the Measurement of Tetrachloroethylene in Dry Cleaning	1997 Conference on Exposure Assessment Technology	97/10/1-2	K-L. Yang, S-C. Ho, C-K. Luo, S-N. Uang*
Development of a Organic Vapor Passive Sampler	1997 Conference on Exposure Assessment Technology	97/10/1-2	R-I Cheng*, T-S. Shih*, C-H. Wang, S-C. Lai
Establishing a Toluene Passive Sampling and Thermal Desorption Method	1997 Conference on Exposure Assessment Technology	97/10/1-2	L-J. Wu*
Crystalline Free Silica Analysis of Raw Materials Used in Industries	1997 Conference on Exposure Assessment Technology	97/10/1-2	D-T. Tang*, H-Y. Lin*, P-P Hong*
Analytical Methods for Metabolites of 2,5-Cyclohexandione in Urine	1997 Conference on Exposure Assessment Technology	97/10/1-2	C-T. Kuo, T-S. Shih*, J-S. Chou*, I-C. Tseng, C-L. Chen
Assessing Tetrachloroethylene in Exhaled Breath	1997 Conference on Exposure Assessment Technology	97/10/1-2	Y-C. Chien*, T-S. Shih*
Confounding Factors in Asbestos Microscopy	1997 Conference on Exposure Assessment Technology	97/10/1-2	T-S. Yu, C-C. Chen, C-H. Huang, T-S. Shih*

Environmental Assessment and Engineering Improvement	1997 Conference on Exposure Assessment Technology	97/10/1-2	W-Y. Yeh*, Y-K. Chen*
Monitoring the Effect of Mist Control in Chromium Electroplating	1997 Conference on Exposure Assessment Technology	97/10/1-2	C-W. Chen*, C-H. Lin, I-C. Lin, W-Y. Yeh*, Y-K. Chen*
From Evaluation of Lead Concentration to Demand for Control Technologies	1997 Conference on Exposure Assessment Technology	97/10/1-2	C-W. Chen*, W-Y. Yeh*
Airborne Asbestos Concentration in Brake Lining Operations	1997 Conference on Exposure Assessment Technology	97/10/1-2	J-P. Yu, S-C. Lin, C-W. Chen*, W-Y. Yeh*, I-C. Lin, C-J. Su
Mist Suppressants Used in Chromium Electroplating	1997 International Conference on Aerosol Technology, Environmental Monitoring and Control	97/10/1-2	C-W. Chen*, C-H. Lin, I-C. Lin, W-Y. Yeh*, Y-K. Chen*
Needlestick Injuries in Health Care Facilities in Taiwan	1997 National Safety and Health Conference	97/11/3-4	C-W. Chang*, W-Y. Yeh*, T-H. Hsieh, Y-H. Huang
Guidelines for Hearing Protection	1997 National Safety and Health Conference	97/11/3-4	W-Y. Yeh*, S-H. Lin*

Establishing Anthropometric Normative Values for Limbs with MRI	1997 Conference of the Society for Orthopedic Research/ Joint Meeting with Society of Biomechanics	97/11/5	C-K. Cheng, H-H. Chen, C-L. Lee*
Control Methods for Chromium Electroplating	Conference on Labor Health Inspection	97/12/2-4	C-W. Chen*, W-Y. Yeh*
Guidelines for Hearing Protection	Conference on Labor Health Inspection	97/12/2-4	W-Y. Yeh*, S-H. Lin*
Noise Prediction in Industrial Setting	Tenth Conference of the Society of Acoustics	97/12/13	T-C. Wang, W-L. Chang, W-Y. Yeh*, S-H. Lin*
Modeling Sound Fields for Decreasing Noise of Machinery	Tenth Conference of the Society of Acoustics	97/12/13	W-Y. Yeh*, S-H. Lin*, T-C. Wang, W-L. Chang
Occupational Health Regulation for Use of Ethylene Oxide in Hospitals	Conference on Caring for Nursing Professionals	97/12/17	C-W. Chang*, W-Y. Yeh*
Hearing Test Facilities and Hearing Loss Thresholds for Labor Health Examinations	1997 National Safety and Health Conference	97/11/4	C-H. Pan*

Hearing Thresholds for People in Taiwan	Tenth Conference of the Society of Acoustics	97/12/13	M-C. Chen, C-H. Pan*, C-J. Chen*, S-J. Chang*
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Note:\*IOSH Research Staff

### 5. Presentation of theses-Foreign academic conferences(Table 7)

Topic	Conference	Site	Date	Presenters
Survey on Status of Occupational Health in Health Care Workers	3rd International Scientific Conference of IOHA	Sweden	97/9/13-18	C-W. Chang*, Y-H. Huang, T-H. Hsieh, L-H. Hung, Y-K. Wu, M-H. Lin*, W-Y. Yeh*
Determination of Total Chromium and Hexavalent Chromium Contents in Taiwan Cements	Occupational Hygiene 97'	United Kingdom	97/4/15-18	C-H. Pan*, C-M. Hsieh*, T-S. Shih*, C-J. Chen*
The Role of Ergonomics in the Rehabilitation Program for Injured Workers	IEA 97'	Finland	97/6/29-7/4	K-C. Yeh*, H-L. Lai*

A Study of Work Postures for Hair Dressers	IEA 97'	Finland	97/6/29-7/4	K-C. Yeh*, H-L. Lai*
Physical Conditioning, Work Demand, and Implications for Aging Workers	IEA 97'	Finland	97/6/27-7/8	H-L. Lai*, C-C. Chen, M-W. Tsai, H-C. Lee
Increased Morbidity Odds Ratio of Primary Liver Cancer and Cirrhosis of Liver among Vinyl Chloride Workers in Taiwan	ISEOH 97'	South Africa	97/9/17-19	C-L. Du*, J-D. Wang
Reconstruction of Job Exposure Matrix among VCM Exposed Workers in Taiwan	ISEE 97'	South Africa	97/8/18-20	C-L. Du*, C-C. Chan, J-D. Wang
Immunoblot Analysis of Components of Barley Recognized by IgE Antibodies in Sera from Pig Farm Workers	'97 International Council of Electrophoresis	United States	97/3/23-27	Y-M. Chiung*, J-W. Huang*

Evaluation of Sensitization by Biological Allergens for Respiratory Disorders in Swine Farm Workers	9 <sup>th</sup> International Conference on Occupational Respiratory Disease	Japan	97/10/13-16	Y-M. Chiung*, J-W. Huang*, C-L. Du*, C-W. Chang*
Assessment of Nutritional and Physiological Status of the Day, Evening and Night Shift Workers	16 <sup>th</sup> International Congress of Nutrition	Canada	97/7/28-8/1	J-W. Huang*, T-L. Hsu, H-F. Liu, H-P. Hu

Note:\*IOSH Research Staff

## 6. Awards(Table 8)

Award	Recipient	Reason for the Award	Date
Executive Yuan Outstanding Research Award-Class B	S-H. Wu, C-C. Tsao	Analysis of Safety Problems Related to Falls in Construction Projects	97/3/5
Executive Yuan Outstanding Research Award-Honorable Mention	S-H. Wu, M-K. Chang, C-C. Lin	Safety Problems Related to Excavations in Pebbly Areas	97/3/5

Executive Yuan Outstanding Research Award-Class A	T-S. Shih	Survey of Occupational Manganese Exposure in Taiwan	97/3/5
National Science Council Outstanding Research Award-Class A	Y-K. Chen	Handbook for Using Respiratory Protectors	97/5

### 7. Academic seminars(Table 9)

Topic	Speaker	Position/ Affiliation	Date
Research in Occupational Cancers	Otto Wang	Chief Epidemiologist, Applied Health Sciences Inc., San Mateo, CA, USA	97/8/9
Present and Future of Pesticides in Taiwan	K-C. Lee	Director, Institute for Testing of Agricultural Chemicals and Toxicants, Taiwan Provincial Government	97/9/22
Processes and Safety and Health Concerns in Semiconductor Industry(I)	C-Y. Chang	Professor, Department of Electronic Engineering, Feng-Chia University	97/10/16
Processes and Safety and Health Concerns in Semiconductor Industry(II)	C-Y. Chang	Professor, Department of Electronic Engineering, Feng-Chia University	97/11/6

Processes and Safety and Health Concerns in Semiconductor Industry(III)	C-Y. Chang	Professor, Department of Electronic Engineering, Feng-Chia University	97/11/13
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## II. Publications

Primary publications of the Institute include research reports, *Journal of Occupational Safety and Health*, *IOSH Newsletter*, *annual Report*, and technical books (see Table 10). Depending on the nature of the organization, appropriate publications are sent to enterprises, government agencies, research agencies and associations, in order to disseminate research results and information on occupational safety and health. For 1997, a total of 88 new publications were published, with 42,160 copies printed.

**Table 10 Publications in 1997.**

Title	Type	Issues	Copies	Note
1996 annual Report	yearly	72	180	--
Journal of Occupational Safety and Health	quarterly	4	1000	Vol. 5, no. 1 - 4
IOSH Newsletter	bimonthly	6	4000	no. 21 - 26
Technical Books	irregular	6	~200	titles per Appendix I

### III. Information Services

In conjunction with the development of National Information Infrastructure, the Institute continues to expand its library collection and to upgrade the quality of its software and hardware, in order to support safety and health research.

#### 1. Library

The Library now has a collection of some 3100 books and 99 periodicals (see Table 11), including also research reports, bulletins, conference proceedings, reports of fact-finding missions and studies. It is open to the public, providing up-to-date safety and health information services to enterprises.

**Table 11 1997 Collection in IOSH Library.**

Type	1996	Addition/Subtraction in 1997	Total in 1997
Books	3070	+90	3160

Subscribed Periodicals	111		-12	99
Chinese	37		0	37
English	61		-14	47
Japanese	13		+2	15
Audio-Visual Materials	47		+210	257
Videotapes	43		0	43
Cassettes	4		+210	214

## 2. Computer information system

The main purpose of the computer information system is to support safety and health research. The long-term goal is to establish a national safety and health information center. In 1997, functions of the Internet network system were expanded, with the addition of databases in occupational medicine and occupational safety and health statistics. In conjunction with administrative reform and office automation, 10 computers and 3 laser printers were purchased. Office network was established in step with the current trend in information technology.

#### **IV. Technology Dissemination and Consulting Services**

In 1997, the Institute sponsored 2 exhibitions (see Table 12), assisted in 15 investigations into suspected cases of occupational diseases (see Table 13), and offered inspection apparatus calibration services 4 times (see Table 14).

In terms of disseminating research results, patents for highly mobile ergonomic chair and safety helmet for construction sites have been obtained and are in the process of technology transfer. 8 patent applications under review (see Table 15).

In addition to sponsoring "Exhibition of Safety and Health Equipment, Personal Protective Equipment, and Research Results of the Institute of Occupational Safety and Health" in the 1997 National Safety and Health Conference (Figure 13), the Institute held "Special Exhibition on People, Work, Safety and Health" in the Third Special Exhibition Room of the National Natural Science Museum, from December 27, 1996 to May 31, 1997, after a year of planning and preparation in cooperation with the professional staff in the Museum, so that concepts of labor protection were presented in a lively way. The content of the Exhibition included:

##### **1. A case resulting in occupational injuries**

Remains and 360 degree panoramic photograph of fire and explosion occurred in Yung Hsing Resin Coating Company located in Lu-chu Village, Taoyuan County, in October 1996, were shown (Figure 14).

##### **2. Problems of labor protection**

Visitors would understand the most serious occupational safety and health problems in Taiwan, including suffocations, fires, falls, flying objects, collapses, mechanical injuries, electrocution, and noise, their effects on workers, and ways to address them, from exhibits using virtual reality technology, imaging technology, optic principles and reconstructions of actual scenes.

### **3.New developments and threats**

The exhibits would guide visitors into experiencing a humane work environment with applications of ergonomic principles.



Figure 13 Exhibition of Safty and Health Equipment, Personal Protective Equipment, and Research Results of the Institute of Occupational Safty and Health.



Figure 14 Remains and 360 degree panoramic photograph of fire and explosion occurred in Yung Hsing Resin Coating Company located in Lu-chu Village, Taoyuan County, in October 1996, were shown in "Special Exhibition on People, Work, Safty and Health" in the National Natural Science Museum.

**Table 12 Exhibitions.**

Theme	Summary of Activities	Location	Date

Special Exhibition on People, Work, Safety and Health	Held in cooperation with National Natural Science Museum. Attended by about 100,000 workers, students and members of the public.	Third Special Exhibition Room of the National Natural Science Museum in Taichung	96/12/27 - 97/5/31
Exhibition of Safety and Health Equipment, Personal Protective Equipment, and Research Results of the Institute of Occupational Safety and Health	In cooperation with the 1997 National Safety and Health Conference. 16 research results shown. Attended by 500 people.	Fifth Floor, Taipei Main Station	97/11/3-4

**Table 13 Investigations into Suspected Cases of Occupational Diseases.**

<b>Name of the Organization</b>	<b>Items Investigated</b>	<b>Date</b>
a lead stearate factory	Exposure to lead dust, recommendations for improving the work environment	97/1-97/3
a systems manufacturing center	Hearing loss	97/3/20
a fire brick corporation	Silicosis	97/3/21
an industrial corporation	Allergic asthma due to TDI/MDI	97/5/6

a sand spraying corporation	Silicosis	97/6/26
a sofa chair manufacturing corporation	Ergonomic hazards	97/7/11
a textile corporation	Hearing loss	97/9/10
a textile corporation	Hearing loss	97/9/25
Ping-tung area	Cornea infection among onion farm workers	97/9/28
a porcelain factory	Occupational skin disease	97/9/30
a porcelain factory	Occupational asthma	97/10/15
an electronics corporation	Intoxication due to mixed gases used in semiconductor manufacturing	97/11/3
a plastics manufacturing corporation	Physical hazards	97/11/25
a chemical fibers corporation	Carpel tunnel syndrome	97/12/24
a velcro manufacturing corporation	Occupational asthma	97/12/24

**Table 14 Inspection Apparatus Calibration Services Provided to Inspectorates.**

<b>Name of the Agency</b>	<b>Services</b>	<b>Date</b>
Various Inspection Organizations	75 photometers	97/2-97/4

Various Inspection Organizations	106 noise measurement apparatus	97/2-97/5
Various Inspection Organizations	24 anemometers	97/2-97/5
Various Inspection Organizations	16 combustible gas detectors, 42 industrial safety inspection apparatus	97/3-97/5

**Table 15 Patents.**

<b>Patent Number</b>	<b>Invention</b>	<b>Inventors</b>
Open for Public Comments	Safety Helmet for Construction Sites	S-H. Wu*, C-Y. Gau*, Y-L. Hsu, H-T. Tsai
Under Review	Overwinding Warning Device for Mobile Cranes	S-H. Wu*, C-Y. Gau*, C-H. Yang
Under Review	Overturning Warning Device for Fork-lift Trucks	S-H. Wu*, C-Y. Gau*, C-C. Chiu
Under Review	Wireless Warning Device for Mobile Cranes to Prevent Acidental Contact with Overhaed Power Lines	C-F. Tai*, W-Y. Su*, C-F. Yang, C-R. Wu, S-H. Yen
1996/11 US patent no. 575534	Highly Mobile Ergonomic Chair	C-Y. Yu, C-L. Lee*

Under Review	Highly Mobile Ergonomic Chair	C-Y. Yu, C-L. Lee*
Under Review	Knife for Meat Processing	M-C. Wang, C-L. Lee*
Under Review	File with Bent Handle	S-H. Hsu, Y-H. Chen, C-L. Lee*
US patent no. 08/733,081	Method and Device for Size-Selective Sampling for Airborne Particulates	T-S. Shih*, W-Y. Yeh*, C-C. Chen, C-Y. Lai
Under Review by the European Union (no.96116678.2)	Method and Device for Size-Selective Sampling for Airborne Particulates	T-S. Shih*, W-Y. Yeh*, C-C. Chen, C-Y. Lai
Under Review by R.O.C. (no.85112506)	Method and Device for Size-Selective Sampling for Airborne Particulates	T-S. Shih*, W-Y. Yeh*, C-C. Chen, C-Y. Lai

Note:\*IOSH Research Staff

## V. International Exchange and Cooperation

In 1997, the Institute invited 6 scholars from USA, Japan, France and Germany to lecture on special topics and to discuss with the Institute's staff. The Institute also sent 7 of its staff abroad for fact-finding missions and studies, with topics and countries visited shown in Table 16. Currently, the Institute maintains regular information exchange channels with more than 50 academic research institutions in 20 some countries.

**Table 16 Fact-Finding Missions and Studies.**

<b>Purpose</b>	<b>Country</b>	<b>Topic</b>	<b>Name</b>	<b>Date</b>
Study	Japan	Safety and Health Inspection in Construction Projects	J-C. Lin	97/2/16-3/8
Study	Japan	Safety Protection for Industrial Robots	C-Y. Gau	97/3/2-22
Fact-Finding Mission	France	Occupational Medicine in France	C-H. Pan	97/4/7-21
Fact-Finding Mission	Germany, Belgium	Certification and Performance Evaluation System for Respiratory Protectors	Y-K. Chen	97/11/1-15
Fact-Finding Mission	Japan	Occupational Health Examination and Occupational Health Management	C-J. Chen	97/11/9-20
Study	Japan	Safety Inspection for Cranes	S-J. Wang	97/11/16-12/13
Fact-Finding Mission	United Kingdom	Occupational Health Protection	S-J. Chang	97/12/2-13

## **APPENDICES**

### **I. Technical Book Collections**

No.	Title	Date
IOSH86-S-601	Dictionary of Terms Used in the Safety Profession	97/1
IOSH86-T-020	Guidelines for Occupational Hearing Protection Plan	97/6
IOSH86-S-205	Technical Information from Construction Safety Research	97/8
IOSH86-S-301	Technical Information from Mechanical and Electrical Safety Research	97/8
IOSH86-T-021	Technical Information from Occupational Hygiene Research	97/11
IOSH86-T-022	Handbook on Computerized Local Exhaust System Design	97/12

## II. Index of Accompanying Figures

Figure 1 Organizational Structure.

Figure 2 Analysis of Level of Education of Current Research Personnel.

Figure 3 Budget for Fiscal Years 1993~1998.

Figure 4 Virtual Reality Simulation.

Figure 5 Safety Protection for Robots: Classification and Parameters

Figure 6 Dimensions of Newly Designed Separator

Figure 7 Experimental System for Aerosol Size Selective Sampler

Figure 8 Channel Connection System for Automated Biological Monitoring Method for the Determination of Lead in Blood Samples

Figure 9 Study of Occupational Hygiene Conditions in Medical Facilities

Figure 10 Respirator Fit Test with Human Subject

Figure 11 Fires often occur from the main motor in the center of the fishing boat because of carelessness during maintenance or mechanical failure.

Figure 12 Even if isocyanate is used in an enclosed system, respiratory protection is still necessary.

Figure 13 Exhibition of Safety and Health Equipment, Personal Protective Equipment, and Research Results of the Institute of Occupational Safety and Health

Figure 14 Remains and 360 degree panoramic photograph of fire and explosion occurred in Yung Hsing Resin Coating Company

located in Lu-chu Village, Taoyuan County, in October 1996, were shown in "Special Exhibition on People, Work, Safety and Health" in the National Natural Science Museum.

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Table 12 Exhibitions

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Table 16 Fact-Finding Missions and Studies

1998.6.100 Vols