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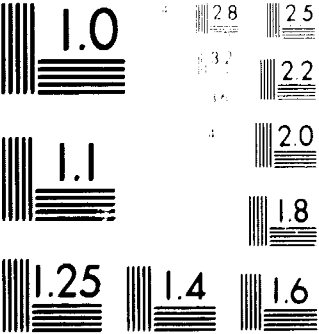

MICROCOPY RESOLUTION TEST CHART

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DP/ID/SER.B/330
16 April 1981
English

Philippines. ASSISTANCE TO THE METALS INDUSTRY
RESEARCH AND DEVELOPMENT CENTER.
(MIRDC), PHASE II
DP/PHI/74/004
THE PHILIPPINES

Terminal report

Prepared for the Government of the Philippines
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Paavo Asanti, metallurgical
research and development engineer

United Nations Industrial Development Organization
Vienna

V.81-24279

Explanatory notes

References to dollars ($) are to United States dollars, unless otherwise stated.

The monetary unit in the Republic of the Philippines is the peso. At the end of 1975, the value of the peso in relation to the United States dollar was $1 = 7.5 pesos.

A full stop (.) is used to indicate decimals.

A comma (,) is used to distinguish thousands and millions.

Besides the common abbreviations, symbols and terms, the following have been used in this report:

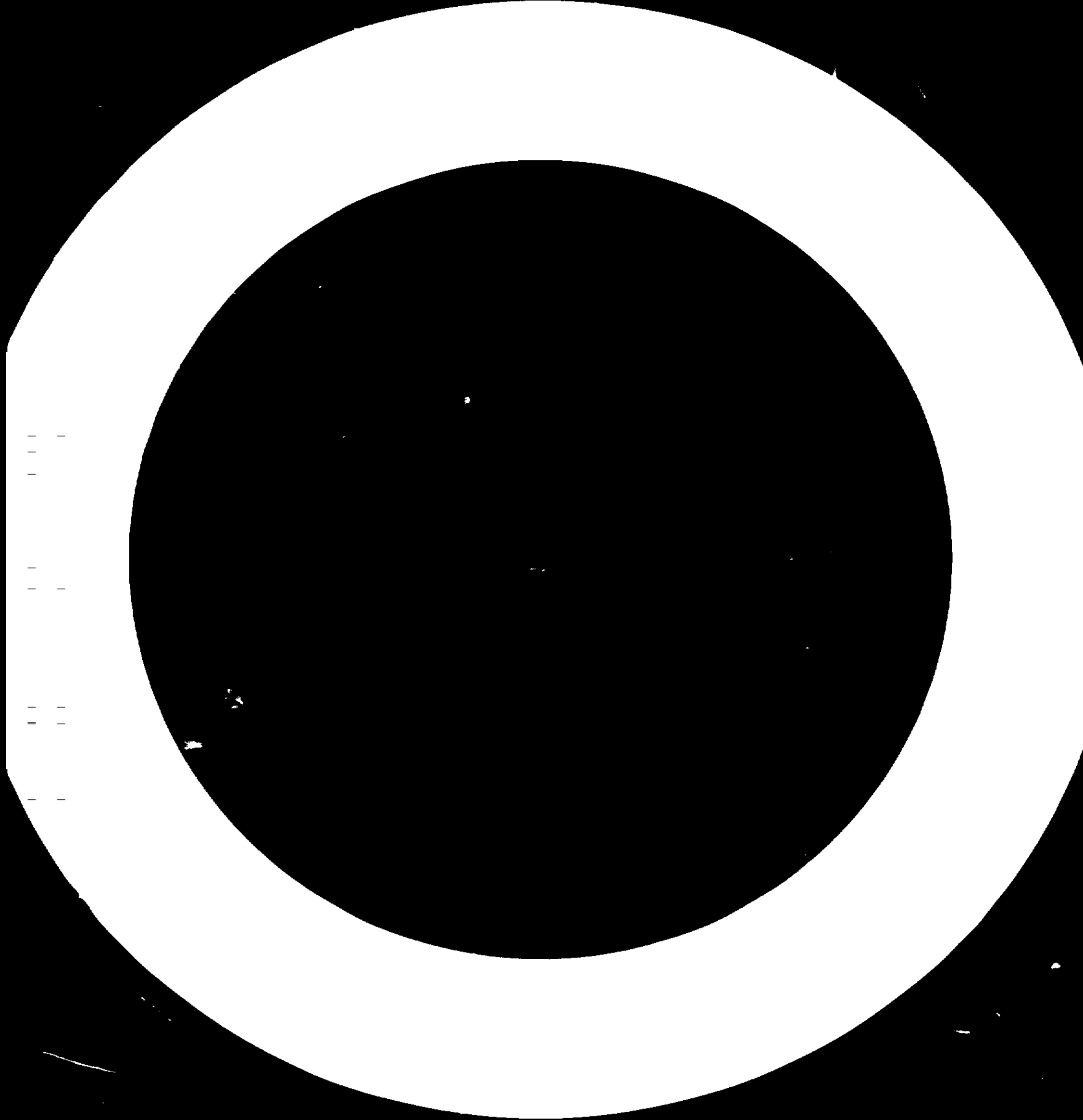
ABM	Advisory Board for the Metal Industries
AIME	American Institute of Mining and Metallurgical Engineering
ASTM	American Society for Testing and Materials
CHEMABS	Chemical Abstracts
COMPENDEX	Engineering Index
CRDC	Ceramics Research Development Centre
EDAX	Energy Dispersive Analyzer
BMGS	Bureau of Mines and Geological Sciences
MIRDC	Metals Industry Research and Development Center
MTRD	Materials Technology Research Department
NF	non-ferrous
NTIS	National Technical Information Service (USA)
SEM	Scanning Electron Microscope
UP	University of the Philippines
VES	vacuum emission spectrometer
WELDSEARCH	Welding Institute Data Base
XRF	X-ray fluorescence analyser

ABSTRACT

The project "Assistance to the Metals Industry Research and Development Center, phase II" (DP/PHI/74/004) began in January 1975 and was completed in December 1980, with the United Nations Industrial Development Organization (UNIDO) acting as executing agency on behalf of the United Nations Development Programme (UNDP) and the Metals Industry Research and Development Center (MIRDC) acting as counterpart agency on behalf of the Government of the Philippines.

The major goal was to assist the Government in establishing a centre which would offer training and technical assistance to the rapidly growing metals and mining industries, especially in relation to technical extension services, applied research and up-to-date technologies. The emphasis of phase II was on the establishment of spectrochemical and electron microscopy laboratories for testing and research purposes. Three major analytical instruments were purchased, fellowship training programmes in their operation were carried out, and maintenance and a review of research and development needs in the metals and related industries were undertaken.

There is an urgent need for training of additional personnel for the laboratories, for additional analytical equipment and for improvements in communication, transportation and marketing services to customers. A proposal is made for the establishment of a metals research and development advisory board. It is recommended that the project be extended through 1981, with some additional funding.



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INTRODUCTION

The project "Assistance to the Metals Industry Research and Development Center, phase II" (DP/PHI/74/004) began in January 1975, with the United Nations Industrial Development Organization (UNIDO) acting as executing agency on behalf of the United Nations Development Programme (UNDP) and the Metals Industry Research and Development Center (MIRDC) acting as counterpart agency on behalf of the Government of the Philippines.

The first phase of the project (DP/PHI/69/530) had commenced in June 1969 and was completed in December 1974. However, in light of the rapid expansion of the metal and mining industries in the Philippines, and the corresponding increased need for training and technical assistance, UNDP approved the project continuation. Phase II was originally scheduled to end in 1977, but was extended for three years, to December 1980.

A. Long range objectives

The major long range objective of the project was to assist the Government in establishing a metals industry research and development centre which would play a leading role in the accelerated growth of the industrial sector, promoting the upgrading of performance and efficiency in existing industries and planning and servicing those to be established. A particular goal of MIRDC was the promotion of quality consciousness, so that products would achieve a uniformly high standard.

The centre, through its various departments, was to serve the varied and expanding needs of the Philippine metal industries, especially in relation to technical extension services, applied research and the introduction of up-to-date technologies in all of the important engineering and allied disciplines. These included tool and die design, tool making and proper application, heat treatment, metalcasting and formability, instrumentation and its technology, mechanical maintenance and repair, including machine rebuilding, metrology, quality control and inspection and machine and product design.

In both of the project's phases, assistance was intended to ensure the orderly and rapid development of MIRDC as a means of providing training and technical assistance to industry and as a medium for the promotion and transfer of technology to industry. The purpose of phase II was to continue support of MIRDC efforts to strengthen its capabilities to be more responsive to the demands of the metals industries, the twin goals being those of enhancing industrial performance and raising product quality.

B. Immediate objectives

In its first phase, the project had started activities relating to technical extension services, tool making, heat treatment, metrology, quality control and inspection and instrumentation. Among the immediate objectives of phase II, therefore, were those of sustaining the progress already made and further expanding activities in these areas. In addition, the project was to assist the center in planning, developing and implementing programmes relating to tool design, metalcasting and metal-forming, machine rebuilding, product and machine design, production engineering and applied research.

A vital field that was considered in need of improvement was that of testing activity, including quality control of domestic raw materials and products. The joint UNDP/UNIDO review report of 1978 concluded that the major emphasis of phase II should be on assistance to the analytical services department of MIRDC and on the establishment of spectrochemical and electron microscopy laboratories, which would enable MIRDC to offer fast and accurate services in materials characterization and failure and defect analysis. In this regard, it was also considered necessary to review the research and development demands and needs of the metals and related industries, particularly to improve MIRDC capability to assist small- and medium-scale industries.

C. Project activities

The main activities of phase II were concentrated on the development of analysing facilities, on consultant services to the analytical services department, on metallurgical research and development, on training fellowships for spectrochemical analysis, electron microscopy and the maintenance of analytical equipment and on the marketing of analytical services. Assistance to other departments of MIRDC consisted primarily of the continuation of expert/consultant services and the fielding of several fellowships.

Experts in different fields had been engaged for phase I and some of their consulting, training and skill-upgrading services were also considered necessary for the centre's continued development during phase II. Expert services and duration during phase II were as follows (see annex I for assignment details):

	Job title	Duration (months)
(a)	Chief project adviser	6
(b)	Patternmaking	8
(c)	Maintenance and repair	6
(d)	Tool and die making	8
(e)	Instrumentation	12
(f)	Tool and die design	12
(g)	Quality control, inspection and metrology	3
(h)	Foundry engineering	12
(i)	Design of dies and moulds for plastic and rubber	8
(j)	Metallurgical research and development	19
(k)	Calibration and application of VES/SEM	2

Fellowship training during phase II totalled 96.2 man-months and was divided as follows (see annex II for details):

	Field of training	Duration (months)
(a)	Industrial instrumentation technology	6
(b)	Modern metallographic methods of examination	6
(c)	Operation and maintenance of equipment in mobile testing unit	4.2
(d)	Materials testing and third party inspection	6
(e)	Metrology and quality control	6
(f)	Copy milling and model making, spark erosion machining	9
(g)	Machine tool designing	9
(h)	Molding technology	5
(i)	Die casting and plastic mould making	6
(j)	Mechanical maintenance for engineers	9
(k)	Scanning electron microscopy	6
(l)	Spectrochemical analysis	12
(m)	Repair and maintenance of analytical instruments	12

Although the major equipment purchases during phase II were related to the work of the analytical services department (for details, see chapter I, section B), equipment was also acquired for other MIRDC departments. Total equipment purchased during phase II was as follows:

(a) Equipment for industrial instrumentation
(b) Sequential X-ray spectrometer
(c) Scanning electron microscope
(d) Numerically controlled jig borer
(e) Vacuum emission spectrometer complete with accessories
(f) Vehicles
(g) Training aids
(h) Laboratory grinding mill
(i) Hydraulic press
(j) Cut-off machine
(k) Lathe1/
(l) Circular sander1/

A year-by-year comparison of expenditures in time and money is given in tables 1 and 2. It should be noted that, with the extension of the project in 1977, the project document was revised and this revision put into effect in January 1978.

Table 1. Actual expenditures for phase II, January 1974 to December 1977

Budget category	1974 m/m	1974 $	1975 m/m	1975 $	1976 m/m	1976 $	1977 m/m	1977 $	Total m/m	Total $
Experts	0.1	616	53.7	193 713	29.2	129 600	8	31 962	91	355 891
Training		-		-		20 725		4 289		25 013
Equipment		-		26 673		313 368		28 489		368 530
Miscellaneous		50		4 370		6 319		383		11 122
Total		666		224 756		470 012		65 123		760 556

1/ Not yet delivered as of 5 March 1981.

Table 2. Actual expenditures after phase II project document revision, January 1978 to December 1980

Budget category	1978		1979		1980		Total	
	m/m	$	m/m	$	m/m	$	m/m	$
Experts	20	88 000	23	110 400	12	62 400	55	260 800
Training (Fellowships)	83	107 900	8	11 200	2	3 000	93	122 100
Equipment		370 000 a/		200 000 b/				470 000
Vehicles		12 000 a/		6 000 b/		—		18 000
Total		577 900		327 600		65 400		870 900

a/ Recommended for purchase in 1978:

1 X-ray fluorescence analyser with spare parts and accessories ($200,000)

1 direct reading vacuum optical emission spectrometer, with spare parts, supplies and accessories ($170,000)

2 vehicles ($12,000)

b/ Recommended for purchase in 1979:

1 electron scanning microscope, with spare parts, supplies and accessories ($200,000)

1 vehicle ($6,000)

A comparison between the project documents and actual use of project resources can be seen in annex III.

D. Project achievements and evaluation

The purpose of phase II assistance, to further strengthen the centre's capabilities to serve the metal industries, especially in relation to technical extension services, applied research and application of up-to-date technologies, has been adequately achieved.

The centre's departments have responded to the needs of industries in terms of manufacturing, fabrication, training, manpower development and consultant services. Particularly to be mentioned in this regard are the tool and die shops, the foundry and the departments dealing with metrology and quality control and materials technology and research.

A major goal of phase II, the delivery, installation and calibration of the three pieces of analytical equipment has been achieved. The centre presently has limited experience in the operation of this equipment and in stabilizing its operations. There remains the need to determine performance of the equipment over a period of continuous operation. Additional parts and accessories are still required. More trained technical staff is necessary for operation, maintenance and repair purposes.

Looking at the use of project inputs by individual departments within MIRDC, the following results can be seen:

Tool and die workshop

This division enjoyed substantial UNDP/UNIDO assistance in terms of equipment, expertise and fellowships. To date, the tool making capability of MIRDC has been fully developed in the manufacture of stamping tools, including the use of multi-stage press equipment provided by the project assistance. This has been supplemented by a substantial amount of equipment provided by the Government. All equipment is in use and needed for both training and manufacturing purposes.

Foundry

The UNDP/UNIDO inputs to the foundry were expertise in foundry engineering and pattern-making as well as providing of the equipment. The foundry is now engaged in extensive services to the metal casting industry, with full use of the equipment and an increase in skills of its personnel.

Design

MIRDC is presently strengthening and developing its design capabilities. It undertakes design work, not only as a support service to its own tool and die shop, but also for outside customers.

Instrumentation

The activities of the section are centered around building up the capabilities of flow and process control. The instrumentation section is now actively servicing industries in calibration, repair and maintenance of analytical instruments and equipment.

Heat treatment

General technical skills relating to the various heat treatment methods and techniques have been developed. The section is now servicing the private sector in the different treatment processes.

Metrology, dimensional inspection and quality control

This section undertakes the dimensional inspection of precision products (tools) and the calibration of dimensional measuring equipment and gauges, not only for the MIRDC workshops but also for the private industries.

Analytical services department

With the installation of the three pieces of analytical equipment, MIRDC has been provided with an analytical and research and development capability unequalled in the Philippines. After proper calibration and operational training, the new facilities will offer industry substantial savings in time and energy and will also contribute to the improvement of quality in the foundry, metals and mining industries.

Since the focus of phase II has been on the development of analytical services and on improved research and development activities, these are dealt with in detail in chapters I and II of the body of this report.

RECOMMENDATIONS

1. The project should be extended to the end of 1981, using unexpended funds for miscellaneous expenses, including the purchase of the most vital spare parts and accessories for the analytical equipment. The savings of six man-months for experts or consultants should be applied to the priority needs of the centre.

2. The project should be extended with an additional funding of $190,000, to be applied to training fellowships, continuation of consultant services and the purchase of additional spare parts and accessories for the analytical equipment.

3. Additional technical personnel (operators, chemists, metallurgists, technicians) should be trained in the operation, maintenance and repair of the three new analytical instruments.

4. Consultants are needed for different aspects of metallurgy, specifically in the following areas of applied research and development:

   Application of the new laboratory facilities
   Training of MIRDC staff
   Consulting services to industries
   Marketing and seminars
   Selection, planning and training of staff for research and development projects

5. The capabilities of the new laboratories, particularly the XRF and the SEM/EDAX, should be strengthened in the areas of improved instrumentation, spare parts and accessories acquisition and the use of reference standards.

6. Analytical services should be broadened by the addition of an Energy Dispersive Analyser for quantitative analysis and the addition of an x-y recorder or photographic device.

7. Additional sample preparation equipment should be acquired.

8. A mobile analyser for field services should be established.

9. MIRDC literature services at Bicutan should be reorganized and intensified.

10. Telephone and mail communication and transportation to and from MIRDC laboratories should be improved.

11. The marketing of analytical services to industries should be promoted, with an emphasis on using personal contacts and visits to customers.

12. Fast and efficient reporting of results to customers should be developed.

13. There should be a readily available supply of cash for the use of the analytical laboratories.

14. Research, development and testing policies should be organized.

15. A metals research and development advisory board should be established.

16. A trained group of researchers should be developed.

17. Close co-operation should be established with other research institutes.

18. Co-operation w. h foreign backstopping institutes and corresponding experts should be established; foreign experts should be invited to join short- and long-term projects for advice and assistance.

19. Experienced engineers from abroad and the Philippines should be attracted to work in research and development and to make use of the new facilities.

I. THE ANALYTICAL SERVICES DEPARTMENT

The primary objective of phase II of the project was the strengthening of MIRDC capability to provide testing services to industries in the fields of material characterization and failure analysis. For this purpose, spectrochemical and electron microscopy laboratories were established, training fellowships were introduced in the operation and maintenance of the analytical equipment and efforts were undertaken in the marketing of analytical services to metals and related industries in the Philippines.

A. Previous equipment and use

No equipment for analytical work had been provided by UNIDO until 1979. The existing analytical facilities had been well used, with the department consistently serving the industries in the fields of chemical analysis, metallographic evaluation, instrumentation and control, surface treatment and corrosion, mechanical and non-destructive testing and sand and binder control. The previously existing facilities at MIRDC used for analytical services are the following:

(a) For wet chemical analysis, a small laboratory including an absorption instrument (Varian);

(b) For quality control of cast iron and steel in the foundry, a rapid analyser for carbon and sulphur (Leco);

(c) For metallographic analysis and examination, a small conventional equipped metallography laboratory (Reichert microscope etc.);

It is considered that all the existing analytical facilities, particularly the atomic absorption apparatus and carbon-sulphur analyser, continue to be well-used. These facilities will also be needed for future service work, mainly in the control and development of standard samples for the spectrometers, and in the event of breakdown of the new equipment.

B. New equipment and use

On the basis of recommendations made in the 1978 review report and the analytical programme prepared by MIRDC, three major analysing instruments were proposed. Evaluation and selection of the sophisticated and costly equipment were made by the assigned expert, a metallurgical research and development engineer. The instruments were subsequently purchased by UNIDO and put into operation. They are:

(a) A direct reading vacuum emission spectrometer (VES), installed February 1981;

(b) A direct reading X-ray fluorescence spectrometer (XRF), installed June 1980;

(c) A scanning electron microscope (SEM) with energy dispersive analyser (EDAX), installed July 1980.

Following are descriptions of the functions of each of the instruments as well as their applications for internal (MIRDC) and external (industry) use:

Direct reading vacuum emission spectrometer (VES)
Jarrel Ash, Atomcomp 750

The importance of this equipment lies in the fact that it has the capability of analysing, among other elements, carbon, boron, beryllium and sulfur in the materials, particularly concentrations in cast irons and various steels. The analyser works fast, simultaneously analysing up to 33 elements. It is computer-controlled, and gives a direct percentage concentration. Metal sample types which can be analysed using the VES are the following (an analytical programme for the VES is given in annex IV):

Aluminum-based alloys
Low-alloy steels
Zinc-based alloys (pure alloy)
Cast irons
Lead-based alloys
Stainless steel alloys
Copper-based alloys (brasses and bronzes)

External service: the market for analytical service for the VES lies in the area of steel plants and ferrous and non-ferrous foundries. In addition, there are melting and rolling shops and extrusion plants which potentially can fully utilize the capabilities of the equipment. Copper wire and cable manufacturers and many hundreds of fabrication shops could reasonably be expected to benefit, particularly in the area of quality control. From a review of a substantial proportion of sources, it was concluded that approximately 1,500 samples per month for analysis could be generated by MIRDC as an independent testing facility. It is confidently expected that the equipment would be working to its full capacity on a single shift basis even if less than this quantity of samples was forthcoming.

Following discussion with MIRDC personnel and visits to steel plants, foundries and fabrication shops, the expert considers that this estimate may be justified. It was especially anticipated by companies in which equipment of a similar type had already been installed or is intended for installation, that the MIRDC equipment would be used on a routine check basis and/or to augment their own analytical capability.

Internal service: it is estimated by MIRDC that approximately two to three melts per day in the iron and steel foundry and two melts per day in the non-ferrous metals foundry will occur when both foundries are in full production. This would mean some 250 samples per month for melt control processes. In addition, analysis would be required on incoming raw materials, including scrap materials for the metal working shop, tool and die shop and foundry.

As metallurgical research, development and testing work increases, it is expected that an additional 250 samples per month will be forthcoming. It is therefore estimated by MIRDC that the equipment will be used for internal service applications to the extent of approximately 20 to 30 per cent of total VES use, again on a single shift basis.

Direct reading sequential X-ray flourescence spectrometer (XRF), Philips PW 1400

Together with the VES, this equipment will provide an effective response to the analytical requirements of the metal and allied industries, such as mining, cement, glass and ceramics, particularly in the areas of material characterization through elemental analysis and quality control. Metal sample types which can be analysed using the XRF are the following:

Low alloy steels
Stainless steels
Copper-based alloys
Plain carbon steels

External service: the importance of this equipment lies in the fact that it has a capability of analyzing both metallic and non-metallic materials. Mining is one of the most important aspects of the industrial economy of the country, producing such materials as copper, nickel, chromium, coal and gold, and it is considered that analytical loading, particularly by those companies undertaking exploration, research and development, will lead to the generation of large numbers of samples for which MIRDC would be ideally equipped to provide rapid chemical analysis. It is estimated that approximately 1,500 samples per month will arise from these sources. In addition to mining undertakings, cement factories, refractory and ceramic plants, glass companies and several mineral processing plants could be expected to generate an additional 400 samples per month.

In the metals sector, the steel smelting and foundry industries could reasonably be expected to require samples to be tested at the rate of 350 per month, giving a total load of 2,000 samples per month for analysis on an independent or third party inspection basis. This requirement is expected to consume approximately 75 per cent of the total equipment capacity. The expert reviewed these estimates and, following discussions with MIRDC, companies and industry associations, is satisfied that a sufficient demand potentially exists, despite the fact that some larger companies, particularly those engaged in exports, have equivalent or similar equipment available. These companies are, however, concerned that an independent authority should exist. They further estimate that they will use the MIRDC facility on a regular basis for routine checking, quality control applications and for checking their own instrument performance.

Internal service: MIRDC foundries expect to be melting ferrous and non-ferrous alloys for the control of which 200 to 300 analysed samples per month will be required. Materials purchases would also be checked in both the metallic and non-metallic sector.

As MIRDC develops its materials-testing capacity for refractories, moulding materials, bentonites, binders, slags and fuels, further needs for analyses will arise. It is estimated that internal service applications will represent some 25 per cent of total capacity use.

It is important to indicate the difference in application between VES and XRF equipment. The application of the Vacuum Emission Spectrometer is in the analysis of metallic materials, such as commercial metals and alloys, usually with low to moderate concentrations of alloying elements or small concentrations of impurities. This instrument produces rapid analysis, which is essential for the quality control of molten metal in the foundry.

The application of the sequential X-ray fluorescence spectrometer is in the analysis of non-metallic materials and also of ferro-alloys or alloys, where concentration of additional elements is greater than in alloys applicable to the VES, although the instrument is not a particularly rapid analyser in comparison with VES. In addition to the testing work, further applications of the XRF include analysis in research and development in the fields of metallurgy, mineral processing and geosciences, thus permitting the conventional slow wet-chemical methods at MIRDC to be replaced by physical methods. The two analytical instruments are therefore complementary, and form the basis of a comprehensive analytical system.

Scanning electron microscope, Philips SEM 501 B with EDAX energy dispersive analyser (SEM, EDAX)

This equipment is a powerful research and analytical tool for metal failure analysis and total materials characterization.

The SEM/EDAX provides a capability not only to inspect the surface topography of metals and non-metals at relatively high magnifications and resolutions (fractures, microstructures etc.) but also to carry out the analysis of small particles, details and defects which may occur in the surfaces being examined. The semi-quantitative analysis determines the composition of the solid surface, which remains undestructed.

External service: with the development of a relatively large number of engineering and related industries in the Philippines, covering a wide spectrum of components and materials, there is expected to be an increasing demand for the services of equipment of this nature. It is expected, therefore, that the use of this equipment for simple failure analysis and quality control purposes will amount to 300 to 500 samples per month.

During its operation period since September 1980, a total of 140 samples was studied and analysed by the SEM/EDAX instrument. The major part of these analyses concerned failure and defect cases for external customers.

Internal service: expected sample quantities in this area amount to approximately 200 per month.

In addition to the routine examination of various metals and non-metals, SEM has valuable application to research and development in the fields of production of castings, metallurgy, minerology, corrosion protection and mining, materials science, semiconductors, plastics, medical sciences, geosciences and commercial minerals. Very small quantities of various inclusion components can be analyzed and identified. It is said that a major part of successful metal ore prospecting is dependent on modern instruments, such as SEM. The SEM instrument is not only complementary to the existing metallographic facilities at MIRDC, but also, because of EDAX to the new XRF and VES equipment.

C. Samples for analysis

Recommended workload

For external and internal service applications on the XRF and VES, an estimated 4,000 samples per month would be a maximum total number, according to the evaluation report of 1978. The one-shift daily maximal work load for 1981 (noting that the instruments are still in the training and calibrating phase) could be estimated at 48 samples on the VES and 16 samples on the XRF, or an approximate total of 1,280 samples per month. Theoretically, the estimated total number of samples could be analysed by using three shifts and thus, utilization of the instruments capacities would be optimal. Samples for the SEM/EDAX usually require more careful examination and individual preparation. Thus the total number of samples to be examined and studied on this instrument could be estimated at 10 to 20 per day, on a one-shift basis, or 200 to 400 per month. If the total number of samples for external and internal services increases as expected to about 600 per month (1978 estimate), the workload will require a three-shift use of the instrument. However, before reaching this target, numerous problems remain to be solved in marketing, communication and personnel training.

Use of reference samples

For training purposes and for calibration of the spectrometers, a number of reference samples are needed. The total number presently required is 347. The number of samples provided by UNIDO totalled 114 and the reference samples received as a donation from Finland was 182. The demand for additional reference samples can be estimated only after several months of analyzer operation.

D. Laboratory space and equipment

All instruments with sophisticated optics, electronics, and computer systems have to solve severe problems connected with environmental conditions in the Philippines. In installing the new analytical equipment, it was therefore necessary to incorporate measures to avoid mechanical vibration, high relative humidity, fluctuations in working temperature and electric power interruptions.

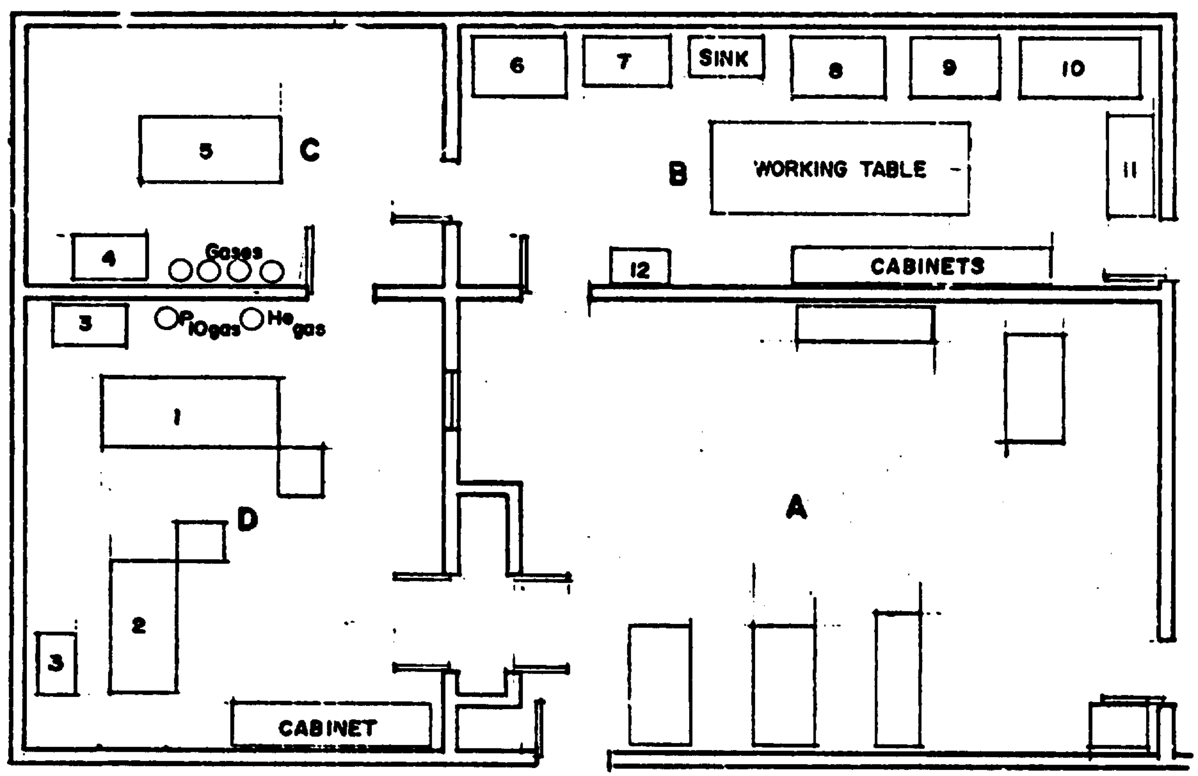
A thorough inspection of the available space and existing equipment at MIRDC Laboratories was carried out by the expert. For all of the three analysing instruments and for sample preparation, proper laboratory rooms were furnished. Major purchases and installation work were required in the form of air conditioning, power supply, furniture and secondary apparatus such as benches, taps and sinks. All of these were provided by the government.

The new laboratory rooms were finished by January 1980, and the technical specifications for operational conditions in spectrochemical laboratories were met. The layout of the XRF/VES spectrochemical laboratory is shown in figure I. The total floor area is 180 m^2. The air conditioned VES and XRF room has a constant temperature of 22°C and relative humidity of 50%.

The layout of the electron microscopy laboratory is shown in figure II. The total floor area is 80 m^2. Provision is made for future expansion (e.g. transmission electron microscope). The SEM room has a constant temperature and relative humidity equal to those of the VES and XRF room, 22°C and 50%.

The three major instruments are ground separately. All are supplied by separate voltage regulators to maintain the proper elctric power supply. A 116 kVA stand-by generator with automatic on/off switch will supply the electric power during brown outs. The generating unit is powered by a diesel motor. In case of brown outs the lapse of time until the equipment is back in operation will be about five seconds. This arrangement will permit the smooth operation of all three major analysing instruments and the optimal use of machine time, in view of the frequency of brown outs at the MIRDC laboratories, estimated by experience to be around 150 annually. The analytical performance of all instruments is expected to be more stable due to the controlled environmental conditions.

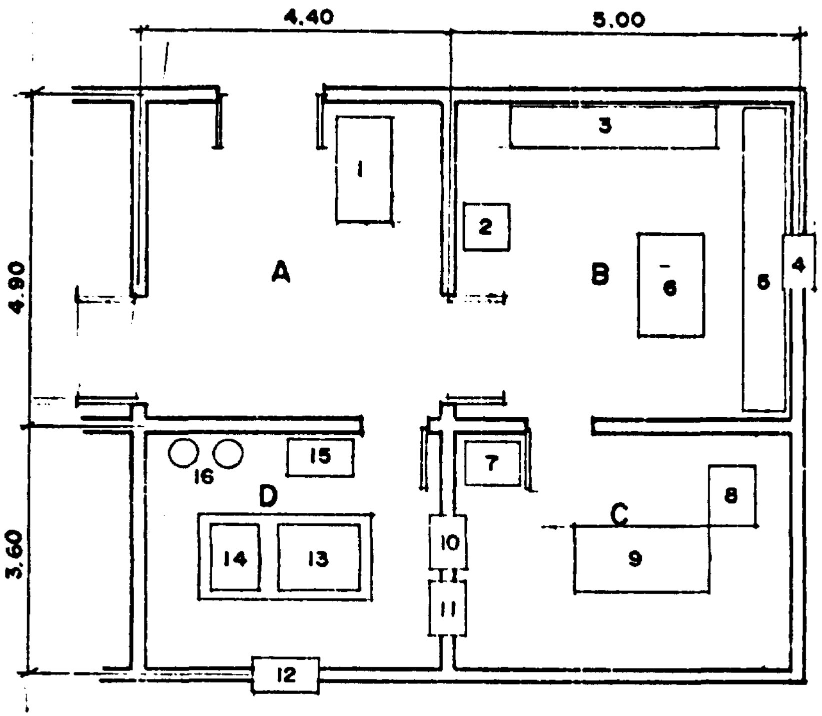
Figure I. XRF/VES Spectrochemical laboratory



<u>Key</u>:

1	XRF with typewriter	7	Belt and circular sander	A.	Office room
2	VES with typewriter	8	Grinding mill	B.	Sample preparation room
3	Voltage regulator	9	Hydraulic press	C.	Air-conditioning room
4	Argon purifier	10	Dust hood	D.	VES and XRF room
5	XRF cooling water unit	11	Balance table		
6	Cut-off machine	12	Lathe		

Figure II. Electron microscopy laboratory



Key:

1	Table	7	Filing cabinet	13	SEM cooling system	A.	Office and reception room
2	Refrigerator	8	EDAX 9100 display and computer	14	Air compressor	B.	Proposed transmission electron micrscope room
3	Bookshelf	9	Scanning electron microscope	15	Voltage regulator	C.	SEM room
4	Air-conditioning	10	Air-conditioning	16	Voltage regulator	D.	Utility room
5	Work table	11	Air-conditioning				
6	Table	12	Air-conditioning				

E. Personnel and training

In order to ensure the proper use of the new analytical facilities, an important component of phase II assistance was the training of MIRDC staff in the operation, methodology and maintenance of the three instruments.

Fellowship training

Two fellows in spectrochemical analysis, one in scanning electron microscopy and two in the mechanical maintenance of analytical equipment, were trained in Europe and the United States. This took place from June 1979 to March 1980. The training programme was developed by the project's metallurgical research and development consultant.

The two fellows in spectrochemical analysis, Ms. Panlilio and Ms. Villanueva, are now in charge of the spectrochemical equipment. They have calibrated and operated the two instruments. They will also be training operators and technicians in the principles, methods of operation and evaluation of the results of spectrochemical analysis.

The fellow in scanning electron microscopy, Mr. Balangue, has been effectively operating the scanning electron microscope and has analysed various kinds of samples from the industries. This analysis is coupled with the evaluation and analysis of metal failure and materials characterization. A need to train more personnel in electron microscopy is evident. Only one research engineer is presently undergoing training in the operation of the equipment. For undisrupted operation, several additional engineers are needed.

The maintenance and repair fellows have performed well in the installation, repair and maintenance of all three analysing instruments.

Personnel requirements

To ensure uninterrupted operation, of the equipment, additional personnel must be trained in operation, evaluation, repair and maintenance. The number should range from 10 to 15 trained staff members, distributed as follows:

VES	3
XRF	3
SEM	3
Sample preparation	3
Supervisors	3

Additional training

With the anticipated growth in demand for analytical services, it will be essential for MIRDC to have sufficient operators, supervisors, engineers and other personnel for the operation of the instruments and for the development of analytical methods. In order to build up a core of trained personnel, the three fellows in spectrochemical analysis and scanning electron microscopy should be able to train chemists, metallurgists and technicians to operate the equipment. To develop expertise in the application of the equipment over as wide a range of industries as possible and to acquire the interpretive skills necessary to use the instruments with maximum effectiveness, the metallurgists and chemists should be exposed to a variety of different samples from industry. A programme for the training of operators for the XRF, VES and SEM is presently being applied to the existing staff of the physico-chemical and physical metallurgy laboratory.

The training of personnel for sampling and sample preparation is also of primary significance. Proper and fast operations on the analyser, as well as reliability of the results are much dependent on the quality of the samples.

For optimal, and smooth operation of the instruments, a good maintenance and repair staff is needed, and thus the present number of staff in this area should be increased and improved. Maintenance and repair should be handled efficiently by the centre's own staff with training from the fellows who studied the construction and maintenance of the components and complete unit. A training programme to offer this expertise is presently underway.

It should be emphasized that continued training of MIRDC staff in the Philippines and abroad will be of vital importance to the analytical services department in the years ahead.

F. Expert/consultant services

In order to provide adequate expert guidance during the training of staff, installation and subsequent commission programmes for all three items of equipment and accessories, the UNDP/UNIDO Evaluation Mission of February 1978 was of the view that one expert should be appointed for a term of two and one half years, and that he should have the responsibility for co-ordinating development of the analytical laboratories as a whole, assisting especially in the building up of the unit as a service to industry.

The expert, Dr. Paavo Asanti, was appointed to the post of Metallurgical Research and Development Engineer in April 1979 and fielded at MIRDC in August 1981. His stay of duty in the Philippines expired March 1981. Before fielding, and while at UNIDO headquarters in Vienna, he prepared the final selection of the instruments and completed development of the detailed fellowship training programme.

During his stay of duty, Dr. Asanti accomplished the fielding of the five fellows in the application of the XRF, VES and SEM/EDAX and maintenance/service of the analysing instruments. He was instrumental in the planning and setting up of the laboratory rooms, the ordering and subsequent delivery, calibration and operation of the three instruments, along with the sample preparation equipment.

It is proposed that the UNIDO expert assistance originally planned for 30 man-months, should be continued and one expert should be appointed for an additional term of six months. He should have the responsibility for co-ordinating development of the capability as a whole, assisting especially in the improvement of sample preparation, and in the application of the analysing instruments to industries and in the training of MIRDC staff. He should also assist in consultancy services to industries, particularly to the small-scale and medium-sized metals industry and in the planning and evaluation of metallurgical research and development projects at MIRDC.

Short-term consultants

In the course of the project, two short-term consultants were engaged to offer training in their particular areas of expertise.

Mr. Tomas Tornkvist joined the project for two months, 15 October to 15 December 1980. During his stay, the personnel, particularly Ms. Panlilio and Ms. Villanueva, were instructed in the training of new personnel as operators. The XRF was calibrated for copper base alloys with an accuracy in accordance with American Society for Testing and Materials (ASTM) standards. The personnel was also instructed in conducting and completing calibration for additional materials. Practical analyses were performed on internal samples from the MIRDC foundry and selected samples of various grades of steels from the industrial sectors.

Professor Gareth Thomas joined the project for ten days in January 1980. He presented lectures on engineering alloys and on special applications of the SEM.

Seminars and demonstrations

A series of seminars on spectrochemical methods of analysis, principles of operation, application and evaluation of results was conducted in 1980. These lectures also dealt with scanning electron microscopy, its operations and applications. Subjects discussed included energy savings in the foundry, corrosion control and foundry processes.

Demonstrations of the equipment were provided to give the participants the opportunity of witnessing sample preparation techniques, calibration procedures and the operation of the instruments.

Future consultant needs

Consultants/experts are needed for different aspects of metallurgy, specifically in the following areas of applied research and development:

(a) Application of the new laboratory facilities;

(b) Training of MIRDC staff;

(c) Consultancy services to the industries;

(d) Marketing and seminars;

(e) Selection, planning and training of staff for research and development projects.

The present staff is already skilled in further calibration of the instruments and is capable of training internal personnel. There is no need for a consultant in calibration and repair.

G. Relationship to industries, research institutes and universities

During visits to mining and metals industries, the expert found that a significant need exists for development and research work in which the input of the three analysing instruments, particularly the SEM, will play an essential role. By March 1981, the laboratories will start to accept orders for metals analysis on the XRF and VES. This will continue step by step during the training period, until sufficient experience is gained and a trained staff made available. The use of SEM/EDAX for the analysing of defects, failures, compositions etc., on various solid materials is ongoing. The optimal use of this instrument will also be largely depending on the development of an experienced staff.

Marketing

A major element in the increased industrial use of the analytical laboratories will be MIRDC efforts to disseminate information about its new facilities.

For marketing and information purposes, several brochures have been prepared, describing the facilities and services available (see annex V). However, the expert considers frequent personal visits to industrial firms to be the most effective means of reaching and informing potential customers.

Co-operation with industries: mining and metal casting

The direct result of plant visits and surveys conducted by the UNIDO/UNDP project adviser was the establishment of close co-operation with several mining and metal casting industries. These industries submitted to MIRDC several samples for analysis and evaluation, co-ordinated research work on the recovery of important elements in their scrap and used the services of the consultant/ expert in the evaluation of their operation and the use of the SEM/EDAX, VES and XRF. These industries subsequently involved the expert in the discussion of their operations and sought advice on new technology.

This kind of mutual co-operation will be a continuous process for MIRDC and the different industries.

Additional services

In addition to the testing and analysing of materials, the consultancy services of MIRDC to individual industries is of importance and should be improved. Here, personal visits to industrial firms can be of particular advantage.

It is also envisaged that the existence of the laboratories will provide the opportunity to offer supervised training programmes for the analytical staffs of companies. The five seminars on the application of XRF, VES and

SEM, carried out in 1980 showed that there exists a keen interest among the industries and research and development institutes. It is anticipated that further industries will become involved in due time. In this regard, it will be necessary to continue to develop an adequate information system for marketing the new analysis services.

It is also anticipated that the new facilities will enable the promotion of closer links between MIRDC and universities, a factor considered important in the context of generally rising academic standards and the input of high technological capability to the solution of industrial problems.

At present, the MIRDC analyzing facilities offer high-level services to the industries and research institutes. The SEM/EDAX combination today exists as a one-of-its-kind facility in the Philippines, opening the way for research and development work not before possible.

Future needs

In order to create optimum conditions for use of the analytical facilities and services by industry, the following recommendations are made:

(a) The marketing of testing services should be improved, emphasizing personal contacts through visits to customers;

(b) Communication to and from the customers (i.e. telephone and mailing services) should be improved;

(c) A fast system should be set up for customers to send samples and receive results of analyses;

(d) The laboratory staff should be improved, expanded and trained for new duties, including the production of certificates of analyses;

(e) MIRDC literature services in the shops and laboratories in Bicutan should be reorganized and intensified (see chapter II, section E).

The urgent target at present is the organization of telecommunication and mailing services. The project vehicles should be used entirely for assisting the external services (i.e. for the marketing of analytical services).

H. Maintenance of analysers

As the UNIDO project at MIRDC comes to an end, the matter of maintenance must be resolved. For fast repair services and urgent needs for spare parts, a system, including manufacturers annual service contract, should be developed. It is essential that funds be made available for the operation, maintenance and repair of the analysers. Following are the main points for review:

1. The manufacturers, Philips (XRF, SEM/EDAX) and Jarrel Ash (VES), could undertake the entire maintenance work. However, in view of the existence at MIRDC of two well-trained engineers whose extensive training was paid for by UNIDO, there is no point in assigning this responsibility to the manufacturer. MIRDC engineers have proved themselves capable of handling all faults to date.

2. The major problem is spare parts availability and payment. Some spare boards were purchased with the original equipment and, in addition, the manufacturers have submitted a number of quotations to MIRDC for spare boards and components. If purchased, these should cover 90% of all requirements, provided the parts are replaced by new purchases as they are used. If additional parts are required, there are two alternatives: (a) import by MIRDC (this would require them to open a letter of credit) and (b) maintain a small credit balance abroad with the manufacturers bank or UNIDO, out of which small, urgently-required spares could be purchased. This amount could be around $3,000.

In either case, the systems will be rather slow due to the necessity of processing paperwork through the Government's budget system.

3. For major problems which cannot be solved by MIRDC engineers, assistance can be provided by Philips and Jarrel Ash (represented by Elasco) locally. It is believed that problems which will need to be handled by the manufacturer will be few if any. However, if such assistance is required after the expiration the guarantee period, service requests will need to be accompanied by an [illegible] order from MIRDC.

. Consideration should be given to an annual overhaul of the equipment by factory engineers. This would take three to four days per machine and cost approximately $6,000 per machine. The first overhaul could be in 1982.

A decision on these matters should be reached by MIRDC, to avoid surprises for manufacturers and delays in solving any servicing problems.

I. Additional equipment and accessories for the improvement of analysing facilities

To complete and finalize the new spectrometry analysing facilities, some additional equipment is recommended. A complete list of accessories, however, can be prepared only when sufficient experience of routine operation on the equipment is available e.g., after several months of operation on the instruments.

Sample preparation of minerals and ores, and powders for accurate analysis on the XRF, require, in addition to the new existing equipment, some melting facilities, including crucibles for beads.

For the emission spectrometer, VES, insufficient experience is available since its final installation in February 1981.

On the other hand, several months of successful operation on the scanning electron microscope have shown that for fast and accurate analysis on EDAX, the instrument should be completed by a device for quantitative analysis. This would permit analysis of samples which cannot be analysed on the XRF or VES because of size, shape, composition etc.

For recording and documentation of results, an x-y recorder or photographic device is recommended as an addition to EDAX.

For advanced field services in the multi-element analyses of materials, a lightweight portable X-ray analyser is recommended. The concentration of the elements is measured using energy dispersive analysis of the fluorescent X-rays from the sample. The direct reading analyser could successfully complete the capability of the MIRDC mobile testing unit to analyse metals, alloys, rocks and ores.

An analyser of magnetic materials is recommended for analysis of magnetite in iron ores, concentrates and tailings, control of copper and nickel in smelting slags, determination of martensite or ferrite in austenitic steels, and the control of roasting of ores, iron ore pellets, and sintering. This instrument would enable MIRDC to improve the analysing services it offers to mining industries, steel mills, foundries and metal shops.

J. MIRDC proposals

MIRDC has submitted proposals for the use of the unexpended project fund balance and for the extension of phase II to the end of 1981 (for details see annex VI). It is proposed that the unexpended funds be used for miscellaneous expenses, including purchase of the most vital spare parts and accessories for the three analytical instruments. The six man-months savings for the expert or consultant will be applied to the priority needs of the centre.

It is further proposed that the project be extended with an additional funding of $190,000. Since the readjusted budget had originally approved 139 man-months of fellowship, the difference between it and the actual input is 23.4 man-months. Thus, additional fellowships may still be fielded to approach what was originally allocated.

Candidates for fellowships shall be selected from the MIRDC staff. These candidates have already received training in the use of the present analytical facilities. Applicants from universities, institutes and industries may also be evaluated for such training.

In order to compensate for the difference in cost of the equipment due to price fluctuation over a period of six years, the centre is requesting additional funds to finance the purchase of additional spare parts and accessories for the VES, XRF, and SEM, for training of additional operators for the analytical equipment, and to allow continuation of expert/consultant services.

As a general consideration, it should be noted that the new MIRDC laboratories already offer a perfect forum for further training. The facilities may be used for laboratory work and for training or study visits by other industries and institutes. Training may be conducted by an experienced UNIDO expert, through UNDP assistance. The proposed fields of training are sample preparation, and the application of the XRF, VES and SEM/EDAX for the metals, cement, mining, metal shops and foundry industries.

II. RESEARCH AND DEVELOPMENT

A. Survey of metallurgical research and development activities

The assignment of the UNIDO expert in metallurgical research and development brought into focus the urgent need for research and development in the different industries. As a key part of his activities, various government research institutes and private companies were surveyed to determine the type and scope of metallurgical research and development already existing in the country. Based on this survey, the training of a technical staff and the offering of consultative services were subsequently developed at MIRDC to complement present metallurgical research and development work. The various research and development activities being undertaken by existing industries are discussed below (for a list of companies included in the survey, see annex VII).

Metalworking industry

Research and development activities are minimal in many metalworking establishments, especially those doing job-shop maintenance work and those manufacturing relatively simple products.

A sample of 120 representative firms in the industry showed that only about 21 firms, or 18 per cent, have R and D facilities. Four of these firms, or 19 per cent, are machine shops and the rest have their own production lines. Only a few of the firms undertaking research activities have included in their budgets expenditures for research and development.

The following table shows the distribution of firms that have R and D facilities:

Table 3. Distribution of firms with research and development in the metalworking industry

Size of firm	Total number of firms	Firms with R and D	
		Number	% of total
Small (less than 50 employees)	70	6	9
Medium (50-99)	22	1	4
Large (100 or more)	28	14	50

As shown in table 3, it is the firms employing more than 100 workers that undertake research and development activities.

The product's basic design comes from a number of sources: trade journals, a foreign company as a licensed producer or the company's staff. Design staff is composed mostly of engineers and factory foremen who, after careful scrutiny of an imported model or after an observation tour, undertake continued experimentation and development of prototypes until they are able to perfect a design. Foreign consultants and suppliers of foreign equipment are also tapped as possible sources of product design.

Changes in product design are carried out in order to make the product better suited to local conditions or to the company's production capabilities, to replace expensive or unavailable materials or components or to improve its performance.

Products are developed and redesigned on the recommendations of ultimate users and through evaluation of the engineering staff. Research is based on product demand and on the adaptability of existing production lines.

Foundry industry

Very few foundries, apart from the larger firms, employ technologists in the management of the company. Some of these firms have purchased know-how from abroad and have usually made arrangements for continuing technological support. Small jobbing metal casters, however, often continue to retain "craft image" and have a built-in resistance to change. Those who have been successful have bridged the gap between craftsmanship and the application of modern technology.

Research being done in some plants is on production methods which are adopted to improve casting quality and reduce casting cost. Other firms probe continuously into new product lines. These are developed and re-designed on the recommendations of ultimate users and through the evaluation of their staffs.

Larger foundry corporations have also established in-plant training programs intended to adequately educate new employees and upgrade experienced personnel to meet production needs. In addition, about 12 government-owned trade schools offering courses in foundry technology are increasing the skills and the qualified manpower in the country's metal casting field. These schools are strategically located throughout the Philippines.

Non-ferrous metals industry

Many enterprises, because of resource limitations, have no technologists in their employ. Others are not able to even minimally appreciate the advantages of industrial research, or of allied technical services. Not realizing the importance of modern technological assistance, they continue to adopt age-old techniques. This is not to suggest that all such companies are at a stage at which they require new products or processes. In most cases, however, they are in need of standardization of raw materials and of guidelines relating to processes and products.

Those firms that do undertake research activities gear their efforts toward expansion, quality improvement of products, cost reduction and, sometimes, the development of local substitutes for expensive imported supplies.

Metal finishing

As far as process technology is concerned, there are slight differences in methods among individual shops. Marked differences lie only in the equipment being used by the large and small shops. From the point of view of product technology, there is also not much difference in methods from shop to shop. Although techniques are claimed to be acapted to the manufacture of quality products, there has been no great demand for such products up to the present. A great number of consumers consider price as one of the decisive factors in purchasing, and they pay little attention to the quality of surface finish.

Even under such conditions, research and development is still undertaken by some metal-finishing plants, though generally at a low level. Of the total number of shops covered by the industry, about twenty firms are engaged in R and D, and of these, only four are classified as jobbing firms. A few of these firms have fully established research and development sections with permanent staffs.

Research being done by some plating shops includes experiments in the use of various electrolytes, other than those being presently used. This has resulted in an improvement of quality of the finished product and an accompanying reduction in costs. Hard chrome plating is now being perfected on industrial rolls and molds. One firm has sent a trainee to Japan to study plating processes, among other subjects.

In the field of enameling, different colours for gas-range panels are being developed, and processes are being adapted to suit local conditions.

One large firm engaged in anodizing gears its research and development activities to the latest aluminum application trends and, guided by market preferences, probes continuously into other applications. Product research takes into consideration adaptability and other requirements as well as existing production lines.

B. The need for applied research and development work

The almost explosive expansion of the mining and metals industries in the Philippines has created and intensified the need for applied research and development, including testing. During visits made by the metallurgical expert to the mining industries in the Baguio area in Luzon and to the Cebu and Surigao area in Mindanao, information was collected about applied R and D. Numerous visits to foundries and other metal firms particularly at Metro Manila and Cebu, Iloilo and Davao, revealed an urgent demand for R and D (see annex VII).

As previously mentioned, the larger companies have their own research and development organizations. Development work usually is carried out abroad or by foreign consultants and experts. Small- and medium-scale metal industries, particularly foundry shops, are without technical development facilities, experienced staff and laboratories. The laboratories in some medium-scale foundry shops deal primarily with routine product quality controls and trouble shooting.

There exists an urgent need to extensively review the demands and needs in research and development among the metals and mining industries in the Philippines. Basic raw materials in casting production, e.g. foundry moulding sand and metallurgical coke, are often of extremely low quality. This leads to many problems in production. Lack of accepted specifications and insufficient information about domestic and imported raw materials and products contribute to unsuccessful performance and poor results.

It is widely known that an independent testing laboratory can assist in the preparation of specifications and standards for testing materials (see annex VIII for a list of companies and organizations with testing facilities). However, at the same time, domestic raw materials and products must be developed and improved to meet such specifications. In such fields as metallurgical ore processing, alloy design, smelting and melting, casting production, forging, welding and corrosion and surface protection, tremendous work has to be done to bring average technology to an acceptable and competitive international level. The only correct way to achieve this is to strengthen metallurgical research and development activities within the industries and institutes involved.

According to observations made by the expert and additional information received through the counterparts, applied research work within the metals and related industries, as well as the mining industry, is concentrated largely on improvement and trouble shooting in materials, methods, machines and manpower. Beyond research done with foreign expertise, in very few cases do companies conduct their own development work.

C. New and proposed research and development activities

The initial survey of industries, metallurgical institutes, metal melting, forming and fabrication shops in the country was undertaken to ascertain existing process and quality control measures as well as testing in operation, applied research, investigation and/or development in the metals and engineering industries. As a result of the survey, several R and D projects were started with the supervision of the UNIDO expert. These projects were aimed at the use of indigenous raw materials to produce and develop finished products and the introduction or adaptation of new or up-to-date techniques and processes directly applicable to local conditions. The projects undertaken were in the following areas:

(a) Moulding materials in the foundry

(b) Wear-resistant materials

(c) Glass moulds

(d) Domestic charcoal utilization in iron and steel metallurgy

For detailed descriptions of currently ongoing research and development projects, see annex IX.

Numerous additional project ideas were suggested by the UNIDO Adviser to be carried out by the research group of MIRDC. These ideas are summarized in annex X. For implementation of these projects, trained personnel are needed from the core MIRDC technical group. Several engineers should be recruited to supply the exposure and technical training demanded by the research projects.

D. Outline for an advisory board for the metals industries

It is proposed that a board (the ABM) be established at MIRDC to advise the Philippine metals industries and assist the Government in formulating national metals and materials policies.

Membership

Initially, the board will not exceed seven members, and will include two foreign advisors.

Scope

Initially, the board will be concerned with the following:

(a) Metal alloys, in particular steels, cast-irons, copper alloys, aluminum alloys and other NF alloys;

(b) Mining and metallurgy materials: metallurgy processing and characterising of ores and minerals; foundry materials, including sands, binders, metal scrap, coke, charcoal; refractory materials and ceramics;

(c) Corrosion and surface protection materials and methods;

(d) Research and development and testing facilities: planning, equipment, training, materials and methods.

Functions

The board's primary functions will be:

(a) To advise MIRDC and the metals industries in the formulation of policies, priorities, development programmes and applied research, especially the co-ordination of existing facilities, with a major emphasis on materials selection and development using domestic materials and resources, including fuel and manpower;

(b) To advise on the setting up of the new research and development laboratory and facilities in order to best organize new R and D and testing activities and to select and transfer the R and D technology to the industries, e.g. to the mines, melting shops, foundries, metal fabrication and machine shops.

Policies

Policies to be considered should deal with the following:

(a) Short and long term R and D programmes, policies, priorities;

(b) Financial problems in implementing selected R and D projects, nation-wide and sectoral;

(c) Sectoral co-operation: MIRDC, universities, institutes and industries;

(d) Organization of sub-committees, technical project groups etc., e.g. for materials problems in mining and foundry industries, energy problems in melting of iron and steel, metallurgical upgrading of metals in ores and minerals, commercial use of poor minerals deposits, use of metallurgical ore tailings and slags, non-destructive testing, corrosion and testing on nuclear power plant and hydropower plant materials and equipment, identification and characterization of corrosion problems.

(e) R and D management, as a whole and on sectoral levels: Can the board assist in planning a training and study programme for experienced engineers to go abroad for one to three years? Such a training programme, in some cases leading to a doctorate, should be established immediately.

A faster way to solve some of management problems is to attract experienced Filipino metallurgical engineers abroad to join selected development projects and work in the Philippines.

(f) Promotion of assistance to MIRDC by foreign experts in R and D for met

Co-operative funding by government-supported agencies, private industries, foundations etc. of new posts at high R and D levels;

(h) Encouragement of co-operation among industry, universities and MIRDC to establish long-range R and D programmes and make best use of laboratory facilities, equipment, experienced scientists and industrial practice;

(i) Establishment of closer ties with backstopping metallurgy institutes abroad;

(j) Close co-operation and ties with industrial associations, technical societies (such as the Philippine Foundry Society, mining groups, the National Corrosion Association) and with the industries in order to develop programmes for materials specifications in various industrial sectors;

(k) Advise on priorities in selecting R and D study projects. (For a more detailed list of suggested project ideas, see annex X):

(i) Metallic raw materials in iron and steel foundry production, specifications and recommendations on cast iron scrap, steel scrap, metallurgical coke and charcoal, sponge iron, iron ore;

(ii) Moulding materials such as silica sand and chromite sand, specifications and recommendations for bentonite suppliers and users, requirements for export;

(iii) Energy saving in casting production (see annex XI), new ideas and hints on energy conservation for metalcasting. (Note: these topics were presented and discussed during a four-day seminar conducted by the expert, as described in annex XII);

(l) Advise on policy and means of attracting private industry to materials testing and R and D work;

(m) Advise on setting up nationwide industrial R and D centres and laboratories, particularly in the government industrial sector.

E. Technical and scientific literature

More than two million scientific and technical articles are written and published annually in 30,000 periodicals and magazines. It is anticipated that the number of published articles will double every 10 years. In this regard it shou d be noted that almost 90 per cent of the world's scientists are living in our time.

Technical and scientific societies and organizations usually provide their members with the necessary information by following, collecting and abstracting the literature. The use of published registers contributes to easy searching for particular information.

Data bank

Data bank facilities offer worldwide information services. These include access, retrieval and processing of local and foreign data. One can easily formulate the searchwords for questions in a way that the answer from the data bank presents only articles relevant to the query. Thus, the system is highly effective.

There are today numerous data bases, such as CHEMABS (Chemical Abstracts), COMPENDEX (Engineering Index), WELDSEARCH (Welding Institute) and NTIS (National Technical Information Services, USA). Data bases are co-ordinated with certain data bank systems. Those situated in Frascati (Italy) and Palo Alto (California, USA) are the most advanced.

In the Philippines, Technobank of the Technology Resource Center (TRC Bldg., Buendia Avenue Extension, Makati, Metro Manila) is a computerized data banking facility. Its Technoresearch service enables the user easy and convenient access to foreign data bases containing worldwide literature and reference data.

Handbooks

Almost all scientists in research and development work at the MIRDS/MTRD laboratories (for example, in fields such as physical metallurgy) are dependent daily on reference books and various textbooks dealing with subjects such as materials properties, testing methods and failures and defects of materials and products. The information needed should therefore be promptly available. Although this kind of literature is available at the MIRDC library, it is often missing at the laboratories at Bicutan as well as at staff members' office desks or shelves.

Today, there are many modern handbooks available. Those which could be best recommended for testing are the complete selection of ASTM handbooks. The Metals Handbook deals with almost all activities conducted by MIRDC/MTRD. In the materials field, important information sources are Metallurgical Transactions and Acta Metallurgical. For special fields such as welding, corrosion, casting and metallography, additional handbooks in English can be found in the literature lists of English and United States publishers. For the organization of research and development project work and feasibility studies, one can refer to several publications.

To follow up the latest developments in a particular technical field, current literature, periodicals and technical magazines should be made available at the laboratories. Selected periodicals should circulate among the laboratory staff. The top priorities for literature services should be given to the laboratory staff. An effective system would attract scientists and contribute to improved research, development and testing work at the MIRDC laboratories at Bicutan. The reorganization and improvement of internal literature services at the MIRDC Bicutan laboratories should therefore merit proper concern and attention. In comparison to experimental work, information collected from literature offers a necessary, and inexpensive method of study.

For further reference, the following list of selected United Nations publications can be consulted:

Engineering industry.
Sales No.: 69.II.B.39, vol. 4.

Guidelines for contracting for industrial projects in developing countries.
Sales No.: 75.II.B.3.

Guidelines for establishing a demonstration foundry in a developing country.
Sales No.: 76.II.B.5.

Guidelines for evaluation of transfer of technology agreements. (ID/233)

Guidelines for project evaluation.
Sales No.: 72.II.B.5.

Guide to practical project appraisal. Social benefit-cost analysis in developing countries.
Sales No.: 78.II.B.3.

Industrial Research Institutes.
Sales No.: 75.II.B.9.

Iron and steel industry.
Sales No.: 69.II.B.39, vol. 5.

Manual for the preparation of industrial feasibility studies.
Sales No.: 78.II.B.5.

Manual on the use of consultants in developing countries.
Sales No.: 72.II.B.10.

Non-ferrous metals (A survey of their production and potential in the developing countries).
Sales No.: 72.II.B.18.

Non-ferrous metals industry.
Sales No.: 69.II.B.39, Vol. 1.

Technical services for small-scale industries.
Sales No.: 70.II.B.19.

Utilization of non-ferrous scrap metal. Report of the Expert Group Meeting on Non-ferrous Scrap Metal, Vienna, 25-28 November 1969.
Sales No.: 70.II.B.31.

Annex I

EXPERT SERVICES

Budget line	Name and field of expertise	Remarks
11-01	P. Mallik, Chief project adviser	The services of this expert were a continuation of the project Phase I, until 30 June 1975 only.
11-02	R.G. Tibbets, Foundry engineering	The expert was fielded with some delay. His mission extended from October 1975 to October 1976.
11-03/ 11-11	S.B. Snitt, Pattern making	The expert was fielded in June 1974, and was extended several times until his contract terminated in June 1976. The arrival time of the expert was approximately half a year too early and during this time, in the absence of pattern-making equipment, his services could not be fully utilized.
11-04	G. Van Zantvliet, Repair and maintenance	The services of this expert were a continuation of the project Phase I. The expert remained in this project phase for 6 months only.
11-05	M. Garrolini, Tool and die making	The services of this expert were a continuation of the project Phase I. His contract terminated in June 1976. The expert was in a position to build up basic tool making capabilities and enabled MIRDC personnel to manufacture press and stamping dies, including multistage tools.
11-07	R. Fardin, Instrumentation	During the project Phase I the expert determined the requirements in his field in the course of a 6-month assignment. He returned in October 1975 for a second 6-month UNIDO assignment after arrival of the equipment, in order to supervise its installation, and train the local staff in its use. After completion of his second UNIDO assignment in 1976, the expert was requested to return to the project under a French bilateral agreement in 1977 and in 1978, each time for a period of 6 months.

Budget line	Name and field of expertise	Remarks
11-08	W. Sienkievics, Tool design	The services of this expert were a continuation of the project Phase I. The expert is basically a machine tool designer with experience in cutting, stamping and press tool design. The expertise put MIRDC staff in a position to cover the above tool design aspects without outside assistance.
11-09	R. Winter, Metrology, quality control and inspection	This department had substantial UNDP/UNIDO inputs in Phase I. The expertise was required to consolidate the required knowledge and skill. The expert arrived in May 1975, but unfortunately died in August 1975.
11-12	D.A. Williams, Design of dies and moulds for plastic and rubber	For a great number of reasons, the fielding of this expert was delayed. He was fielded in May 1977 for a one year assignment. For unknown reasons his services were abruptly terminated by MIRDC as of 30 January 1978.

Annex II

FELLOWSHIPS

	Fellow	Country	Duration	Departure
1.	Alfredo Pineda	United States	6 months	2 Jan. 1976
2.	Tacita Daoa	United States	6 months	18 May 1976
3.	Alberto Palmon	United Kingdom	2.1 months	12 Sep. 1976
4.	Fidelino Adriano	United Kingdom	2.1 months	12 Sep. 1976
5.	Tagumpay Cruz	United States	6 months	27 Feb. 1978
6.	Benedicto Contreras	Switzerland, United Kingdom	6 months	7 Sep. 1978
7.	Nilo Fontanos	United States	9 months	30 Sep. 1978
8.	Mario Patricio	United States	9 months	30 Sep. 1978
9.	Eleno Dotig	United Kingdom	5 months	7 Jan. 1979
10.	Isagani Blasco	United Kingdom	6 months	3 Mar. 1979
11.	Edgardo Lopez, Jr.	United States	9 months	26 Mar. 1979
12.	Rene Balangue	Finland, Federal Republic of Germany, Netherlands, United States	6 months	1 Jun. 1979

Return	Field of training
9 Aug. 1976	Industry instrumentation technology
29 Jan. 1977	Modern metallographic methods of examination
22 Nov. 1976	Operation and maintenance of equipment in mobile testing unit
22 Nov. 1976	Operation and maintenance of equipment in mobile testing unit
30 Aug. 1978	Material testing and third party inspection
8 Mar. 1979	Metrology and quality control
12 July 1979	Copy milling and model making, spark erosion machining
12 July 1979	Machine tool designing
24 May 1979	Molding technology
29 Sep. 1979	Die casting and plastic mould making
15 Dec. 1979	Mechanical maintenance for engineers
18 Dec. 1979	Scanning electron microscopy

	Fellow	Country	Duration	Departure
13.	Mercedes Panlilio	Finland	6 months	1 June 1979
14.	Thelma Villanueva	Finland	6 months	1 June 1979
15.	Emmanuel Dayo	Netherlands, United States	6 months	19 Sep. 1979
16.	Felicisimo Jamolin	Netherlands, United States	6 months	19 Sep. 1979
		Total	96.2	

Return	Field of training
31 Dec. 1979	Spectrochemical analysis
15 Dec. 1979	Spectrochemical analysis
1 Mar. 1980	Repair and maintenance of analytical instruments
1 Mar. 1980	Repair and maintenance of analytical instruments

Annex III

PHASE II BUDGET MATERIALS

A. Comparison of actual expenditures vs. budget

Budget category	A. As per project document[a]		B. Readjusted budget (10 December 1980)[b]		C. Actual deliveries to the project by 31 March 1981		D. Difference (D = B - C)	
	m/m	$	m/m	$	m/m	$	m/m	$
Project Personnel								
a. Expert	269	672,500	128.5	525,959	122.5	491,159	6.0	34,800
b. Other cost		42,000		69,656		69,656		-
Sub-total		714,500		595,615		560,815		34,800
Training								
a. Fellowship	169	145,020	139	168,228	96.2	168,228	23.4	-
b. Other cost		-		7,470		7,470		-
Sub-total		145,020		175,698		175,698		-
Equipment		902,430		1,021,665		1,021,665		-
Miscellaneous		15,500		15,730		15,730		
Total		1,777,450		1,808,708		1,773,908		34,800

a/ 1975-1977

b/ 1975-1981

B. Yearly UNDP contributions

	1974		1975		1976		1977		1978		1979		1980[a]		1981[b]		TOTAL	
	m/m	$	m/m	$	m/m	$	m/m	$	m/m	$	m/m	$	m/m	$	m/m	$	m/m	$
1. Project personnel																		
a. Experts	0.1	250	53.7	183,200	29.2	115,710	8.0	29,813	4.5	18,248	3.9	44,958	15	81,000	9.1	52,780	128.5	525,959
b. Support personnel				10,513		13,793		1,576										25,882
c. Official travel						97						1,110		4,800				6,007
d. Other cost		366								28,296		(895)		10,000				37,767
Sub-total		616		193,713		129,600		31,389		46,544		45,173		95,800		52,780		505,615
2. Training																		
a. Fellowships (16 fellows)					16,7	17,600		(57)		56,304	59,7	83,381	4	11,000	42,8	-	139	168,228
b. Study tours UNDP group training/ Meetings						3,125		4,345										7,470
Sub-total						20,725		4,288		56,304		83,381		11,000				175,698
3. Equipment				26,673		313,368		28,489		381,988		80,936		190,211				1,021,665
4. Miscellaneous		50		4,370		6,319		396		1,115		1,943		1,537				15,730
UNDP total contribution		666		224,756		470,012		64,562		485,951		211,433		298,548		52,780		1,808,708

a/ Estimated UNDP contribution for 1980 (done 10 December 1980).

b/ Balance.

Annex IV

ANALYTICAL PROGRAMME FOR VES

	Element and wavelength	Cast iron and steels	Al	Cu	Zn	Sn	Pb	Channels
1.	Fe 2599 2714	 Int. Std.	.001-4%	.01-5%	.001-.01%	.005-0.10%	.005-0.2%	2
2.	C 1930	.007-4.5%	*Requires an as white cast structure for high C.					1
3.	P 1782	.003-.6%		.002-0.25%				1
4.	S 1807 (2nd order)	.006-.22%		.002-0.40%				1
5.	Mn 2933 3482	.006-16%	.001-2%	.01-3.0%	.001-0.5%			2
6.	Si 2516 2414	.05-4%	.001-20%	.01-5%				2
7.	Ni 2316 2437	.005-35%	.001-4%	.01-35%	.001-0.50	.002-0.2%	.005-0.10%	2
8.	Cr 2677 2989	.005-30%	.001-3%					2
9.	Mo 2816	.005-8%						1
10.	V 3102	.01-3%	.001-.05%					1
11.	Ti 3504	.01-3%	.005-2%					1

Element and wavelength	Cast iron and steels	Al	Cu	Zn	Sn	Pb	Channels
12. Nb 3194	.005-4%						1
13. Cu 3274 (.001-.5) 2218 (.1-12) 4530 (I.S.) 2212.04	.005-8.5%	.001-12%	Int. Std.	.01-5%	.005-10%	.01-0.8%	4
14. Al 3961 2567	.001-2%	Int. Std.	.01-12%	.005-6.0%	.001-0.20%		2
15. W 2204	.02-25%						1
16. B 1825	.005-0.4%	.0005-0.4%					1
17. As 1937 (2)	.001-0.5%				.001-0.2	.005-1.5%	1
18. Sn 1899 3175	.001-1%	.001-7%	.01-20%	.002-0.20%	Int. Std.	.01-50%	2
19. Mg 2795 3832	.001-10%	.001-12%		.002-0.2%			2
20. Ce 4186	.001-1.0%						1
21. Pb 4057 2476	.001-.20%	.002-0.7%	.01-20%	.002-0.20%	.01-50%	Int. Std.	2
22. Zn 2138 4810	.001-1%	.001-12%	.01-40%	Int. Std.	.001-0.20%		2

Element and wavelength	Cast iron and steels	Al	Cu	Zn	Sn	Pb	Channels
23. Ca 4226		.001-.05%				.01-0.5%	1
24. Co 2286	.01-9%				.002-0.10%		1
25. Na 5890 outrigger		.0002-.10%					1
26. Be 3130		.0001-0.5%	.005-0.2%				1
27. Ba 4934		.001-1%					1
28. Cd 2288		.001-0.5%		.001-0.20%	.005-.05%	.005.0.2%	1
29. Bi 3067		.001-0.5%			.001-0.20%	.002-0.5%	1
30. Sb 2068 (2) 3232					.005-20%	.01-20%	2
31. Ag 3383		.001-5%			.001-0.1%	.001-1.5%	1
32. Se 1960 (2)	.005-1%						1
33. Zr 3438	.005-1%	.001-1%					1
						Total channels	47

Notes: 1. Ferrous samples require an "as white" structure for spectrometer analysis.

2. Standards may not be available for certain of the above specifications.

Annex V

MIRDC ANALYTICAL LABORATORY BROCHURES

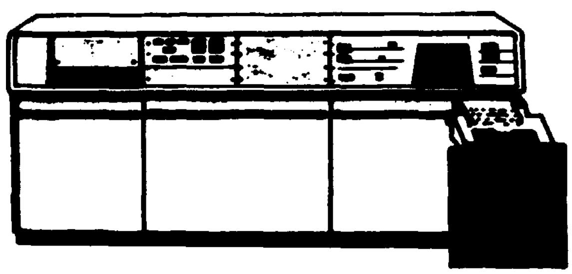
Our service capability is firmly based on advanced equipment and highly competent personnel.

Recent additions to the Center's PHYSICO-CHEMICAL LABORATORY are two of the most advanced instruments for fast and accurate chemical analysis:

1. Philips PW 1400 X-ray Fluorescence Spectrometer
2. Jarrell-Ash 750V AtomComp Emission Spectrometer

These equipment will provide the best answers to the analytical requirements of the metals and allied industries such as mining, cement, glass and ceramics, particularly in areas of material characterization through elemental analysis and quality control work. The following technical notes will explain what we mean....

1. X-RAY FLUORESCENCE SPECTROMETER: (XRFS)



PHILIPS PW 1400 X-RAY FLUORESCENCE SPECTROMETER

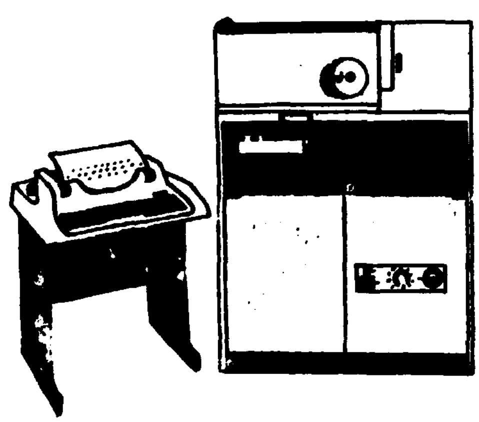
Applications:

- non-destructive determination of elements from fluorine to uranium.
- detection of element concentrations of 100% down to less than a part per million
- analysis of conducting and non-conducting samples (metallics and non-metallics) in a variety of sample forms (solids, powders, liquids)

Features:

- sequential, allowing flexibility to cope with routine and non-routine applications
- computer-controlled, giving direct % concentrations via a teletypewriter
- linked to a chart recorder which provides element identification through a spectrogram
- typical analysis time: 15 min for metals and 30 min for powders.

2. OPTICAL EMISSION SPECTROMETER: (OES)



JARRELL-ASH 750V ATOMCOMP VACUUM OPTICAL EMISSION SPECTROMETER

Applications:

- determination of elements including carbon, boron and beryllium
- detection of high and low concentrations
- analysis of solid ferrous and non-ferrous metals

Features:

simultaneously analyzes up to 33 elements
computer-controlled, giving direct % concentrations via a teletypewriter
typical analysis time: 1 min for metals

ELEMENTS PROGRAMMED IN THE OES

Iron	Chromium	Tungsten	Zinc	Bismuth
Carbon	Molybdenum	Boron	Calcium	Antimony
Phosphorous	Vanadium	Arsenic	Cobalt	Silver
Sulfur	Niobium	Tin	Sodium	Selenium
Manganese	Titanium	Magnesium	Beryllium	Zirconium
Silicon	Copper	Calcium	Barium	
Nickel	Aluminum	Lead	Cadmium	

PRESENT CAPABILITIES OF OES AND XRF

A. METALS

Steels (low alloy; Plain carbon, Mild, Austenitic stainless, Ferritic stainless, Low tungsten, High speed, High manganese, Cast)

Cast Irons (Ductile, Blast furnace, White cast)

Aluminum Base (Aluminum-Silicon alloys, Free machining aluminum, Aluminum casting alloys)

Copper Base (Brasses-cartridge, free cutting, naval, red, aluminum; Bronzes-commercial, phosphor, gilding metal, Beryllium copper)

Zinc base (Zinc, Zinc alloy)

Lead Base

Tin Base

B. POWDERS (slags, ores, cement, clay, bentonite, limestone, etc.)

For further information, see or call:

Materials Technology and Research Department

c/o Marcelo B. Villanueva
Manager, MTRD
MIRDC Laboratories Bldg.
Bicutan, Taguig Metro Manila

or

Priscilla A. Mantaring
Physico-Chemical Laboratory
Tel. nos: 78-86-62; 78-73-70
78-23-93; 78-27-22
Loc. 270 or 267

Seminar Coordination Section
Information Division
5th Floor, Ortigas Building
Ortigas Ave., Pasig Metro Manila
Tel nos: 693-36-64 to 66

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MIRDC PHYSICAL METALLURGY LABORATORY
THE MICROSTPUCTURAL ANALYSIS LABORATORY

A few words about the Physical Metallurgy Laboratory

The Physical Metallurgy Laboratory is a section of the MIRDC, a non-profit technological service organization which provides assistance to the government as well as private metals and allied industries.

The Physical Metallurgy Laboratory has a sample preparation room, several light microscopes, a scanning electron microscope, an energy dispersive spectrometer and a pool of highly trained engineers and technicians.

Our instrumental capabilities could help you zero-in on problems involved in the fields of mineralogy, chemistry, ceramics, electronics, metallurgy etc.

Guide to our services

Microscopy/Microanalysis

- Scanning Electron Microscopy
- Energy Dispersive Spectroscopy
- Metallography/Light Microscopy

Surface Analysis

- Scanning Electron Microscopy/Energy Dispersive Spectroscopy (SEM/EDS)

Special and Other Services

- Metallurgical Failure Analysis
- Energy Dispersive Electron Probe Microanalysis
- SEM Pictures
- Training
- Analytical and Consultancy Services

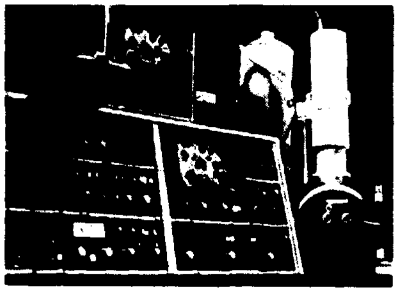
MICROSCOPY/MICROANALYSIS:

Scanning Electron Microscopy (SEM)

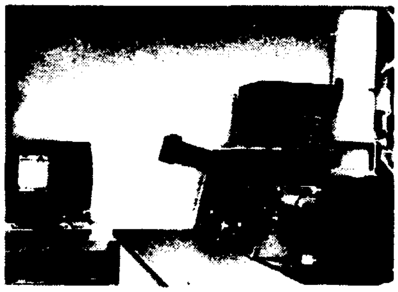
High resolution Philips Scanning Electron Microscope PSEM 501B with maximum magnification of 150,000x. Micrographs provided at several magnifications. Results described in brief report.

Energy Dispersive Spectroscopy (EDS)

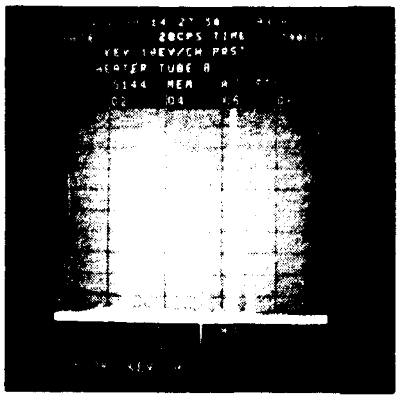
EDAX 9100 is an advanced computer-supervised elemental analysis system including peak identification background subtraction, peak stripping, multiple data display, smoothing, x-ray mapping and auto calibration.



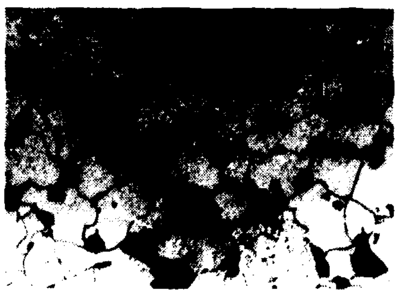
Scanning electron microscope



Scanning electron microscope with EDAX analyzer



EDAX analyzer display



Microstructure of mild steel (100x)

Metallography

Including all mounting, grinding, polishing, and micrography over a range of magnifications. Identification and interpretation of metallurgical structures, e.g. metallic phases, grain size, inclusions etc.

SURFACE ANALYSIS:

Our surface analysis research services can help you solve problems like the following:

Measure - The thickness and/or composition of a layer/coating or thin film (less than 1.0 micrometer)

Analyse - A layer on the surface by EDS

Uncover - An area or a corrosion product

SPECIAL AND OTHER SERVICES:

Metallurgical Failure Analysis

Includes all required fractographic inspection (SEM micrograph if required), microprobe analysis using EDS if required, analysis of surface scale if appropriate, optical metallography and complete report with recommendations.

SEM Pictures

High resolution micrographs of any specimen surface. Micrograph provided at magnifications as high as 150,000x with sharp crisp images. Results provided in brief report.

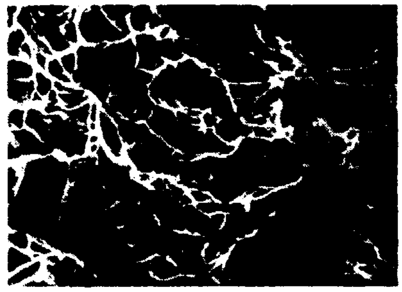
Energy Dispersive Electron Probe Microanalysis

Do you want to identify particles? Microstructural chemistry? Or examine alloy composition or corrosion products? Our SEM is attached with Energy Dispersive Spectrometer (EDS) to provide a logical extension in your search for answers.

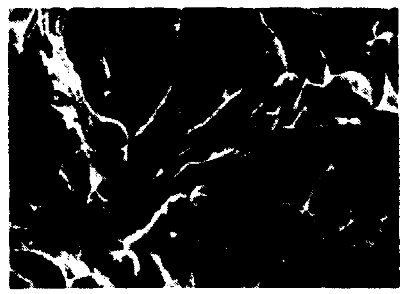
It offers the ability to combine specimen images with elemental analysis of selected features and the distribution of selected elements. The system provides optimum detection for point analysis, elemental mapping and elemental line scans.

Information is computer-corrected to give semi-quantitative and quantitative results. Qualitative analyses are carried out in seconds. Quantitative analysis may require minutes.

Microstructure of hardened steel (500x)



Dimple structure in steel SEMicrograph (1250x)



Clearage fracture in steel (2500x)

SEMicrograph of an ant head (80x)

Training

The training course includes theoretical lectures and practical jobs which will be held in our laboratories.

Consultancy Services

Call upon our engineers for advice from microstructural analysis for solving industrial problems to presenting a seminar in electron microscopy application.

Problems requiring more intensive study may be also accepted by our staff.

SEMicrograph of sponge (160x)

For any inquiry - write or call:

MATERIALS TECHNOLOGY AND RESEARCH DEPARTMENT
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Microanalyst

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5th Floor, Oritgas Building
Ortigas Avenue, Pasig, Metro Manila
Tel. Nos. 693-36-64 to 66

Annex VI

PROPOSAL FOR THE DISPOSAL OF UNEXPENDED PROJECT FUND BALANCE AND FOR THE EXTENSION OF PHASE II

By the termination of the project, in March 1981, the project had an unexpended balance of $34,800. This amount represents the budget for six man/months of consultants.

The important parts of the project were accomplished, i.e., the delivery, installation and calibration of the three analytical instruments. Only the delivery of two vital pieces of sample preparation equipment was delayed. These were expected to be installed and operational during the second quarter of 1981. Since the project was to be terminated by March 1981, the centre had barely enough time to gain experience and to stabilize operations of the analysing instruments and sample preparation equipment. Determining the performance of the equipment over continuous operation will require still more time. Requirements for spare parts and accessories will have to be evaluated.

In consideration of the above needs, the centre proposes the following:

A. Project extension

The project shall be extended to the end of 1981. This shall utilize the savings for miscellaneous expenses, including the purchase of the most vital spares and accessories for the three equipment. The six man-months savings for the expert or consultant may be applied during the extension.

B. Additional funding

The project shall be extended with an additional funding of $190,000.

Since the readjusted budget had originally approved 139 man/months of fellowships, the difference between it and the actual input is still 23.4 man/months. Thus, to approach what was originally allocated, additional fellowships may still be fielded.

In order to compensate for the difference in costs of the equipment due to price fluctuations over a period of six years, the center is requesting additional funds to finance the purchase of additional spare parts and accessories for the VES, XRF, and SEM, for training of additional operators for the analytical equipment and to allow continuation of expert/consultant services.

The requested additional funding of $190,000 is broken down as follows:

Item	m/m	$
Project experts/consultants	12	80,000
Training fellowships	36	60,000
Spare parts and accessories	-	50,000
	Total	190,000

Training of technical personnel in operation and maintenance services for the existing equipment is needed. The fields of training are:

(a)	Scanning electron microscopy	6 m/m
(b)	Spectrochemical analysis	6 m/m
(c)	Repair and maintenance of analytical instruments	12 m/m
(d)	Mechanical maintenance services	12 m/m

Consultants or experts will be needed to provide advice on different aspects of metallurgy.

Required spare parts and accessories for the major laboratory equipment is composed of the following:

		Cost estimate
(a)	Spare parts and accessories for the XRF	10,000
(b)	Spare parts and accessories for the SEM	30,000
(c)	Spare parts and accessories for the VES	5,000
(d)	Accessories for sample preparation	5,000
		$50,000

Following are detailed lists of the needed parts, supplies and accessories for each instrument:

XRF spectrometer spare parts and supplies

1	pc	Gearbox 4022 332 1311
1	pc	Gearbox 4023 332 13131
1	pc	Gearbox 4022 332 1312
1	pc	Gearbox 4022 332 1451
1	pc	Photoacintillator 31 3322 214 74023
1	pc	Gasflow detector preamplifier
10	pcs	Neon lamp 4822 134 20128
1	pc	LED display 50827650, 5322 130 34745
1	pc	LED CQY 24A-11, 4822 130 30923
1	pc	LED CQY 90, 5322 130 34634
1	pc	Moving coil meter, 5322 344 64139
1	pc	Rotary switch type 24, 3322 273 44095
1	pc	Rotary switch assy, 5322 273 34112
1	pc	Heat sink compound 5322 390 20019
2	pcs	Belt flat 75293203-8
		10P Printed circuit board 5111-100-06231
1	pc	10T Printed circuit board 5111-100-06241
1	pc	PWR Meatsink 5111-199-78070
1	pc	PWR Harness 5111-199-78060
1	pc	Over voltage printed circuit board 5111-100-05404
1	pc	Sequence card 5111-100-056
1	pc	TBPS Printed circuit board 5111-100-06191
1	pc	CRLPZ Printed circuit board 5111-100-06571
1	pc	RTCZ Printed circuit board 5111-100-06301
1	pc	DCC2 Printed circuit board 511-100-06562
1	pc	SALCUZ Printed circuit board 5111-100-06433
1	unit	Refrigerating compressor MEM 3-3 Type CL122RT-087, 230/208 volts, 60 Hz, 3 ph
1	unit	Water pump, CY028-I spec. with 0.75 HP motor 3 ph, 220 V, 60 Hz

1	unit	Vacuum pump for spectrometer, 5322-360-20033
6	pcs	Mini relay (scitt relais) PTC-A 30813 AC, 220 V
25	bxs	Paper for chart recorder PM 9920/05, 0-100 Lin, 9443 099 20058
8	bxs	Paper for printer PC 1409 2822 100 86611
2	pcs	Shaft seal for geniometer 4022 189 67531
1	pc	Synchronous motor ,904 111327501 18 F 24V, 50 Hz, 250 rpm, 4022 33 70231
2	pcs	Scintillation detector PCB A64
		Imp FDD-std 75890320-7
		PWB Imp FDD E 75890370-2
		PWB Imp FDD-D/9 75890420-5
		PWB Imp FDD-F 75890770-3
		PWB Imp FDD-N 75890570-7
25	kgs	Roeschat-Wacha C
1	pc	Tungsten carbide mill, 100 cc

VES spectrometer spare parts and supplies

4	pcs	Needle pointed thoriated W electrode, 66-888
1	pc	Monitor and function control board 90503G
1	pc	Channel control board 90-503H
1	pc	Slave relay board 90-523N
1	pc	Door switch board 90-523X
1	pc	Power failure and clock board 96-535Y
1	pc	12 V Power supply 11430067
1	pc	High voltage power supply 11430046
1	pc	PM Output integration board, .1 mfd capacitor 9-710B
1	pc	Spare parts kit for ECWS consisting of
		1 ea 90-777A trigger board
		4 ea 11060152 Thyration tube
		1 ea 112 60100 Relay, Arrow Hart
		1 ea 11260116 Relay, thermal delay
		5 ea 11165005 Fuse, little fuse, 2 Amp
1	pc	Spare parts for vacuum pumping system 13020024
1		Bottle (litre) vacuum pump oil, 13030014
10		Teletypewriter copy paper and spare ribbon
1	SS	SS tube for Argon purifying furnace
		Vacuum pump for spectrometer
		Magnesium turnings
		Magnetic tapes and discs
		Heating coils for Argon purifier

SEM/EDAX spares and accessories

System 60 software for EDAX 9100

Spare boards and cards for EDAX:

a. CDU M7270

b. DLV11F M8028

c. KVP11 M8016

d. HIP Board FD0102D

e. ADC Analog 4035 006 01302

f. ADC Digital 4035 006 01401

g. MCA MEM2 4035 006 00303

h. MCA MeM3 4035 006 00202

i. MCA MEM1 4035 006 00403

j. DISP 1 4035 006 00504

k. DISP 2 4035 006 00602

l. DISP 3 4035 006 00703

m. DISP 4 4035 006 00803

n. SCA 4035 006 00903

o. Bus translator 4035 006 00103

p. MEM M8044

X-Y Recorder for EDAX

Wahnelt assembly for SEM

Vacuum pump for SEM Speedivac
Edwards High Vacuum Pump
Model ED100 08481

Spare motor and pump for SEM cooling system.

Annex VII

LIST OF COMPANIES AND INSTITUTES VISITED, 1979-1981

Date	Company name	Location	Activity/ product
	Armco-Marsteel (two visits)	Taguig, Metro Manila	
	University of the Philippines - Engineering Department (two visits)	Diliman, Quezon City	
	Ceramics Research Center (three visits)	Taguig, Metro Manila	Ceramics
	Natural Research Development Center	Taguig, Metro Manila	
	Delta Motors	Parañaque, Metro Manila	Foundry
	Tri-Star	Las Piñas, Metro Manila	Foundry
	Bureau of Mines (two visits)	Quezon City	
	International Rice Research Institute	Los Baños, Laguna	
	San Miguel Creusot-Loire	Cavite	
February 1981	Angat Blast Furnace	Bulacan	Pig iron
14 May 1980	Lepanto Consolidated	Benguet	Copper, gold, silver
16 May 1980	Benguet Consolidated	Benguet	Gold, silver
16 May 1980	Philex Mining	Benguet	

Date	Company name
17 May 1980	Benguet Exploration
	Black Mountain
November 1980	Atlas Consolidated and Mining Development
November 1980	Metaphil Incorporated
November 1980	Nonoc Nickel Project
November 1980	Alinsu Steel Foundry Corporation
November 1980	Strachan and McMurray Ltd.
November 1980	Inducto Cast
November 1980	Philippine International Development Inc.
	Carnation Philippines
	Caltex Philippines
	Firestone

Location	Activity/ Product
Benguet	Zinc, gold, silver, copper
Benguet	Copper, gold, silver
Toledo City	Cu, Au, Ag and foundry
Mandaue City	Foundry
Mandaue City	Nickel
Mandaue City	Foundry
Iloilo City	Foundry
Mandaue City	Foundry
Zamboanga City	Charcoal
Mandaluyong, Metro Manila	Tin cans
Batangas	Oil refinery
Parañaque, Metro Manila	Tires and rubber

Other companies visited

The following additional companies were visited, as part of the survey of research and development activities and needs:

Aircon, Inc.
Allied Industrial Corp.
Arco Metal Products Company, Inc.
Atlas Iron and Steel
Elizalde Security Equipment Mfg. Corp.
Engineering Equipment, Inc.
Marinduque Mining and Industrial Corp.
Permaline, Inc.
Philippine Appliances Corp.
Philparts Manufacturing Co., Inc.

Annex VIII

FIRMS AND INSTITUTES WITH TESTING FACILITIES

Firm or institute

	Melting plants	Products	Field of testing
1.	Allenco Steel Corp. Bo. Pamplona, Las Piñas Metro Manila	Steel ingots, bars wire rods	Chemical analysis
2.	Apollo Steel Mills, Inc. 818 E. Pantaleon St. Mandaluyong, Metro Manila	Steel ingots, bars	Chemical analysis, mechanical testing
3.	Armco-Marsteel Alloy Corp. Napindan Road Taguig, Metro Manila	Steel ingots, alloy steel bars, grinding ball	Chemical analysis, hardness testing
4.	Armstrong Industries, Inc. Arkong Bato, Polo Valenzuela, Metro Manila	Steel ingots, bars	Chemical analysis
5.	Globe Steel Corporation Gujo St., Saint Anthony Subd. Cainta, Metro Manila	Steel ingots, bars	Chemical analysis
6.	Marcelo Steel Corporation Punta, Sta. Ana, Manila	Steel ingots, bars wire rods, nails	Chemical analysis, hardness testing, metallography
7.	Marsteel Corporation 555 Tandan Sora Baesa, Quezon City	Steel ingots, bars castings, machineries	Chemical analysis, sand testing, hard- ness testing, metallographic analysis
8.	Master Steel Products, Inc. 89 Kaingin St. Quezon City	Steel ingots	Chemical analysis
9.	National Steel Corp. Camp Overton Iligan City	Steel sheets, steel ingots, bars, plates	Chemical analysis, hardness testing
10.	Philippine Blooming Mills Co., Inc. Bo. Manggahan, Pasig Metro Manila	Steel ingots, bars wire rods, nails	Chemical analysis

Firm or institute	Products	Field of testing
Melting plants		
11. Union Steel Mfg. Co., Inc. 28 8th St., 9th Ave. Grace Park, Caloocan City	Steel ingots, bars, castings	Chemical analysis, sand testing, hardness testing
Sheet-making plant		
1. Elizalde Steel Consolidated Bo. Kalawaan Sur Pasig, Metro Manila	Tinplates	Chemical analysis, coating thickness tester, hardness tester
Pipes and tube mills		
International Pipe Industries Corporation Ortigas Ave., Bo. Ugong Pasig, Metro Manila	Spiral-welded steel pipes	Radiographic test (X-ray)
Foundries		
1. Alinsu SteelFoundry Corp. Pakna-an, Mandaue City	Steel castings	Chemical analysis, sand testing
2. Arco Metal Products, Inc. New Diversion Road Bo. Santolan, Pasig Metro Manila	Nonferrous castings	Dimensional testing
3. Atlantic Gulf and Pacific Co. of Manila, Inc. Punta, Sta. Ana, Manila	Steel, cast iron and nonferrous castings	Chemical analysis, sand testing, hardness testing, metallographic testing, mechanical testing, non-destructive testing
4. Atlas Consolidated Mining and Development Corp. Toledo City	Cast iron, steel castings, nonferrous castings	Chemical analysis, sand testing, hardness testing, metallographic testing
5. Automatics Center, Inc. 2257 Pasong Tamo Ext. Makati, Metro Manila	Nonferrous castings	Impact testing

Firm or institute

	Foundries	Products	Field of testing
6.	Bataan Shipyard and Eng'g. Co., Inc. Engineer Island Compound Port Area, Manila or BEPZ, Mariveles, Bataan	Steel castings, nonferrous castings	Chemical testing
7.	D.M.G., Inc. 222 E. Rodrigue Sr. Blvd. Quezon City	Cast iron, nonferrous castings	Chemical analysis, sand testing, hardness testing, metallographic testing, mechanical testing
8.	Davao Foundry Corp. Km 18, Tibongco Davao City	Cast iron, nonferrous castings	Chemical analysis, sand testing, hardness testing, metallographic testing, mechanical testing
9.	Delta Motor Corp. Km. 15, South Superhighway Parañaque, Metro Manila	Cast iron	Chemical analysis, sand testing, metallographic testing, hardness testing, mechanical testing
10.	Engineering Equipment, Inc. 991 C. Castañeda St. Mandaluyang, Metro Manila	Steel castings, cast iron, nonferrous castings	Chemical analysis, sand testing, hardness testing, metallographic testing, mechanical testing, non-destructive testing
11.	Filipino Pipe and Foundry Corp. Bol Hulo, Mandaluyong Metro Manila	Cast iron	Chemical analysis, sand testing
12.	High Speed Engineering Works Mandaue City	Cast iron	Chemical analysis, sand testing, hardness testing
13.	Inductocast Philippines, Inc. Tripolo, Mandaue City	Cast iron, steel castings, nonferrous castings	Hardness testing, mechanical testing

Firm or institute

	Foundries	Products	Field of testing
14.	Lepanto Consolidated Mining Co. Lepanto, Mankayan, Benguet	Cast iron, steel castings, nonferrous castings	Chemical analysis, sand testing, hardness testing
15.	Mackay Machinery, Inc. 66 Old Samson Road Balintawak, Quezon City	Cast iron, steel castings	Chemical analysis, sand testing, hardness testing, metallographic testing
16.	Malleable Metal Industries Inc. Km. 19, South Expressway Parañaque, Metro Manila	Cast iron	Chemical analysis, sand testing
17.	Metals Engineering Resources Corp. E. Magalona Sr. St. Mandaluyong, Metro Manila	Cast iron, nonferrous castings	Chemical analysis, sand tasting, hardness testing
18.	Permaline, Inc. 109 C.M. Recto, Bo. Parang Marikina, Metro Manila	Cast iron, nonferrous castings	Sand testing, hardness testing, metallographic testing
19.	Philippine United Foundry and Machinery Corp. 76 Balon-Bato, Balintawak Quezon City	Cast iron, nonferrous castings	Sand testing, hardness testing
20.	Philparts Mfg. Co., Inc. F. Bautista St., Marulas Valenzuela, Metro Manila	Cast iron, nonferrous castings	Chemical analysis, sand testing
21.	Republic Dynamics Corp. Victoneta Park, Malabon	Cast iron, nonferrous castings	Chemical analysis
22.	Singer Industries Phils., Inc. Crtigas Ave. Ext. Taytay, Rizal	Cast iron	Chemical analysis, sand testing, hardness testing
23.	Tri-Star Metal Industries, Inc. CAA Road, Pamplona Las Piñas, Metro Manila	Cast iron, nonferrous castings	Chemical analysis, sand testing
24.	Victorias Milling Co., Inc. Victorias, Negros Occ.	Cast iron, steel castings nonferrous castings	Chemical analysis, sand testing, hardness testing, metallographic testing, mechanical testing

Firm or institute	Field of testing
Additional testing laboratories (for metal products)	
Asiatic Corrosion Control Co., Inc. Tuayan St., Quezon City	Non-destructive testing, corrosion and furnace treatment
Asian Transmission Co. Canlubang, Metro Manila	Metallography, mechanical testing
Bataan Refinery Co. Limay, Bataan	Non-destructive testing
Caltex (Phils.) Inc. Refinery Batangas	Non-destructive testing
Corrosion Engineering Services Baclaran, Parañaque, Metro Manila	Non-destructive testing
Corrosion Technologist Inc. Vito Cruz, Extension, Makati, Metro Manila	Non-destructive testing, corrosion and surface treatment
De La Salle University Taft Avenue, Manila	Mechanical testing
Delta Motors Corp. Parañaque, Metro Manila	Mechanical testing, metallography, chemical analysis
Electroweld Manufacturing Co. Malinta, Valenzuela, Metro Manila	Mechanical testing
Engineering and Construction Corporation of Asia Mandaluyong, Metro Manila	Non-destructive testing, mechanical testing
General Motors Corp. Las Piñas, Metro Manila	Mechanical testing, chemical analysis, metallography, non-destructive testing
Industrial Inspection (Int'l.) Inc. Makati, Metro Manila	Mechanical testing, non-destructive testing (radiography and ultrasonic), corrosion and surface treatment
Mapua Institute of Technology Intramuros, Manila	Mechanical testing, chemical analysis
Marinduque Mining and Industrial Corp. Nonoc Island, Surigao del Norte	Non-destructive testing

Firm or institute	Field of testing
Additional testing laboratories (for metal products)	
Metals Industry Research and Development Center (MIRDC) Bicutan, Taguig, Metro Manila	Chemical analysis, corrosion and surface treatment, instrumentation, metallography, sand analysis, metrology, mechanical testing, non-destructive testing
Mindanao State University Marawi City, Lanao del Sur	Mechanical testing
National Institute of Science and Technology Bicutan, Taguig, Metro Manila	Chemical analysis, instrumentation
Pasig Steel Corporation Pasig, Metro Manila	Mechanical testing, non-destructive testing
Philippine Bureau of Standards Quezon Blvd., Quezon City	Mechanical testing, chemical analysis
Planters Products, Inc. Limay, Bataan	Non-destructive testing
San Miguel Corp. Canlubang, Laguna	Mechanical testing
Shell (Phils.) Inc. Refinery Batangas	Non-destructive testing
University of Sto. Tomas España, Manila	Mechanical testing
University of the Philippines Diliman, Quezon City	Mechanical testing, chemical analysis
Welding Industries of the Phils. Baesa, Quezon City	Chemical analysis, mechanical testing

Firm or institute	Field of testing
Additional testing laboratories (for other products)	
Bureau of Mines Diliman, Quezon City	Ore examination and testing, fine assaying, pilot plant testing, pelletizing, x-ray diffraction, sieve analysis
Ceramics Research and Development Center Bicutan, Taguig, Metro Manila	Chemical analysis, physical testing
Industrial Inspection (Int'l.) Inc. Makati, Metro Manila	Chemical analysis - asphalts, soil drilling
Mapua Institute of Technology Instramuros, Manila	Soil testing
National Institute of Science and Technology Bicutan, Taguig, Metro Manila	Physical tests (textiles, papers), chemical analysis (foods, paints, insecticides, leather and polymer, finished products such as shampoo and soap, water), potability (water)
Ostrea Mineral Laboratories, Inc. Pasong Tamo, Makati	Assaying, patch testing, ore dressing
Phil. Rock Products, Inc. Shaw Blvd., Mandaluyong, Metro Manila	Materials testing for concrete, asphalt, aggregates and soils

Annex IX

ONGOING RESEARCH AND DEVELOPMENT PROJECTS

Project title	Status
1. Development of local materials for investment casting of industrial parts	Extensive literature research on both local and import imported raw materials was undertaken. These include pattern waxes, refractory aggregates, binders and other materials used in the process. Physical and chemical properties of these materials were also listed for further comparison. Steps and procedures of the process to be used were also studied.
2. Fabrication of automatic temperature controller	The fabrication of the prototype is now in progress.
3. Tin and lead recovery from scrap material obtained from semi-conductor plants	Several experiments have already been done to compare and evaluate the solubility of tin and lead from various solvents at variable operating conditions. Experiments have also been undertaken to determine the degree of separation of tin and lead cations and to specify the different process variables for alkali and acid chemical process of detinning.
4. Feasibility study of jewelry making by lost wax process	Only the literature research was done and has been temporarily stopped.
5. Development of hard chrome technology	The literature research was completed and several experiments have been performed, using variable concentrations of plating solutions and operating conditions to optimize conditions involved in the process.
6. Development of gold plating technology for decorative and industrial purposes	Literature research has been conducted. Detailed information regarding the various process sequences and operating conditions involved has been gathered.

Project title

7. Moulding materials for the foundry

8. Wear-resistant material

9. Use of charcoal in cupola

Status

Literature research and plant surveys were conducted. The information gathered was collated and several conclusions presented. The first draft of the project was presented to the UNDP/UNIDO Project Adviser.

Literature research still ongoing.

Research study is still ongoing.

Annex X

SUGGESTED RESEARCH AND DEVELOPMENT PROJECT IDEAS, 1980-1985

1. Develop a list of suggested projects in the fields of foundry metallurgy, mineral processing, machine shop, corrosion prevention, materials and methods.

2. A study of demands and needs for research and development in foundries.

3. Foundry sand binders, guidelines for users:
   (a) The use of organic or inorganic foundry sand binders;
   (b) The demand for binders (note: production and imports totalled between 4000 and 5000 tons per year in 1979); bentonite, sodium silicate, cement, resins (furan, phenolic, others), oils;
   (c) Technical and environmental aspects.

4. Domestic silica sand, review and new developments (note: silica sand is still the most important moulding material used in the Philippines. The use of silica in the country's foundry industries amounted to approximately 100,000 tons in 1979 and is estimated at 200,000 tons for 1980):
   (a) Important properties: purity (quartz content, impurities as secondary materials), limestone content, fineness, grain size and shape, sintering temperature, clay content, moisture;
   (b) Deposits
   (c) Availability, price at foundry;
   (d) Processing for foundry and other purposes, i.e. glass manufacturing, sodium silica, filler material, sand blasting, raw material for ceramics, the production of refractories, bricks;
   (e) Total demand for silica sand for various industrial purposes, estimates from 1979 to 1985.

5. Bentonite as a binder; domestic production needs (note: bentonite is the most important binder for moulding sand):
   (a) Study of the properties of sodium bentonite and calcium bentonite;
   (b) Processing of raw bentonite: mineral composition (silica dust etc.), montmorrilonite, firmness (particle size);
   (c) Deposits in the Philippines, demands of the domestic foundry industry, import and export.

6. Sodium silicate (for CO_2 process) as a molding sand binder.

7. Chromite sand: production, processing, reclaiming and use.

8. Review of mineral deposits as raw material sources for industrial processes, i.e. melting, heat treatment, handling of molten metals, high temperature gasses, in foundry shops, melting shops etc.:
   (a) Review of existing deposits of silica, chromite, Al_2O_3 minerals, magnesite, zircon-silicate, flourspar, other minerals (such as beach sand);
   (b) Demand for industrial minerals as raw material for domestic industry, particularly for refractories (i.e. bricks, masses, fibres).

9. Recovery of iron from nickel ore process tailings (note: tailings from nickel ore processing amounted to 1.5 million tons in 1980 and are expected to reach a total of 30 million tons deposit by 1990.

   Average composition is:

   Fe
   SiO
   CaO
   M_2O_9
   S
   P
   Ni
   Others

   Shape, color, moisture, fines.

10. Foundry and sand casting defects.
11. Quality control in foundry shops.
12. Quality assurance in castings.
13. Ferrous metals casting defects.
14. Non-ferrous metals casting defects, casting defects originating from:
    (a) Charging materials, metallic (returns, scrap) and non-metallic;
    (b) Melting, furnace, fuel (electricity), air, refractories, control (time, temperature), gasses, slag, disoxidation, alloying, insulation, melt processing;
    (c) Tapping, pouring (temperature, time, ladle);
    (d) Moulds and cores, including penetration, burn-on, gasses, cold runs, blows, pin holes, shrinkage cavities, segregation, cracks, surface finish;
    (e) Fettling, cleaning;
    (f) Heat treatment.
15. Prevention of gas porosity in non-ferrous castings.
16. Melting of minerals.
17. Melting furnaces, electric, oil-fired, coke, gas and others:
    (a) Melting of non-ferrous metals in crucible furnaces, induction furnaces, electrical furnaces, oil-fired furnaces;
    (b) Metallurgical comparison of melt yield, gasses, homogeneity, temperature, oxidation;
    (c) Energy consumption comparison;
    (d) Economic comparison.
18. Casting methods processes.
19. Improvement of casting finish.
20. Cleaning of castings: penetration and burn-on. The effect of charging material, steel scrap, phosphorus in cast iron (0.02/0.03% P 0.09/0.12% P). The cost can be reduced by up to 35%.
21. Inoculation of cast iron.
22. Energy preservation.

23. Domestic energy sources for metallurgy, foundry, metals heat treatment.

24. Domestic charcoal for metallurgical purposes:
    (a) Pig iron from the charcoal blast furnace, Angat blast furnace, Bulucan;
    (b) Charcoal in cupola melting;
    (c) Charcoal as carbon addition to cast iron in induction melting furnaces:
    (d) Improvement of charcoal for metallurgical melting purposes;
    (e) Desulphurization of cast iron in cupola melting; replacing of coke by charcoal.

25. Refractories in the metallurgy industry. Demand for domestic production. Consumption.

26. New development of wear-resistant materials in the mining and cement industries. Average production from factories using grinding media, linings, pumps etc.:
    (a) In the mining indus ry;
    (b) In the cement industry.

    (Note: The trend is to use cast materials with high wear-resistance and hardness (60 R_C - 65 R_C). Demand for wear-resistant materials is approximately 1-2 kg/ton in ore processing and 20-50 kg/ton for cement. Wear is dependent on the properties of the ore (hardness) and on the grinding mill (speed, wet or dry grinding).

27. Continuous casting of rods from let batches in the range of 100 to 1000 kg. Horizontal casting system, diameter 15-60 mm. Cast iron. Copper alloys.

28. Continuous casting of rods, tubes, strips and profiles from non-ferrous alloys, using upward casting system (range: 3 mm diameter wire to 20 mm OD tubes), in various shapes and dimensions.

29. Spun casting of cast-iron pipes. Production of 100-120 mm diameter pipes at 10-50 tons per day.

30. Spun cast iron-pipes from motor-car scrap.

31. Nodular cast-iron from cupola. Practical methods for melting and refining of molten cast iron for the production of nodular cast iron.

32. Motor car scrap as metal source in secondary melting (50,000 to 100,000 vehicles per year). Feasibility study of technical and metallurgical aspects (steel cast iron, aluminum alloys, lead, zinc alloys, glass, plastic, tires).
33. Corrosion prevention of motor cars.
    Note: in the Philippines, there are about one million motor cars, trucks, busses, etc., representing an investment cost of approximately P 35 billion. Extension of the life of a motor car by two to four years might be possible through proper corrosion prevention, presenting a considerable capital savings of national magnitude.
34. Analyses of cast metals by the VES and XRF.
35. Application of the SEM in failure analysis of metal products.
36. Non-destructive identification of metals and alloys by spot test.
37. Classification of steel and cast iron scrap.
38. Classification of copper alloy scrap.
39. Classification of aluminium scrap.
40. Blast materials for surface finish of metals, i.e., sand, white cast iron, others:
    (a) Production methods;
    (b) Environmental aspects.

Annex XI

ENERGY SAVING IN CASTING PRODUCTION

Particularly in developing countries, the investigation of domestic resources such as charcoal and moulding materials, could result in energy saving and fewer imports. The replacement of steel castings by alloy and modular cast iron decreases the energy demand remarkably. New casting methods resulting in almost 100 per cent yield and products with excellent properties, allow a tremendous energy saving.

A summary of some of the recommendations for energy saving in the foundry production is given below. Many of these recommendations should be implemented immediately.

Recommendations

1. The reduction of foundry returns has always been important. It is recommended that methods of minimizing them should be re-examined in light of energy saving aspects.
2. Comparison of the total emission levels from cupolas and the different types of melting furnaces is desirable. The melting units should have the same molten metal production rate and tests should include various types of scrap and of scrap cleanliness.
3. The possibility should be explored of developing and marketing a robust after burner that automatically cuts out, once the exhaust gas is burning.
4. It is recommended that chute or feeder charging be considered in preference to central charging. Also, the practice of air dilution of exhaust gas being cleaned by high-efficiency collectors should be discouraged. Either water injection or radiation cooling is an acceptable alternative.
5. The process of conversion of cupolas, both hot and cold-blast, from single row tuyeres to divided-blast should be speeded up and measures should be sought to encourage this.
6. All foundries using long daily melting campaigns should be encouraged to use a recuperative hot-blast cupola, preferably with divided blast.

7. Some form of encouragement for the installation of oxygen injection into the coke bed of continuously tapped cupolas should be considered.

8. Foundries with cold-blast cupolas, which are not operating on long melting campaigns, should be encouraged to use electric duplexing furnaces.

9. A survey of the amount and type of waste heat that foundries can use should be undertaken.

10. A demonstration experiment is required to determine the economics and long-term reliability of a thermal storage system under actual foundry operating conditions.

11. It is recognized that, in any comparison of melting processes, the overall economics will be evaluated so that all resources, not just energy, are properly taken into account. However, it is recommended that the effect of energy demand should be evaluated and considered when making a choice of melting unit.

12. A survey of the use of charcoal pig-iron for the manufacture of high-strength cast irons and nodular cast iron should be undertaken.

13. A study and demonstration experiment of charcoal cupolas is required to determine local economics under actual operating conditions, when melting cast irons with low sulphur content.

14. A comparison of total cost and energy requirements of various moulding materials in foundry production of cast iron and steel castings are desirable factors influencing the casting surface finish and the environmental foundry conditions e.g., dust emissions, should be investigated.

15. A survey should be conducted on wood waste and sawdust used as fuel in melting non-ferrous metals and as a source for gas generation.

Annex XII

SEMINARS

Total energy demand in cast iron production was the primary subject of the seminar on "Energy Saving and Foundry Shop", held 28 April to 2 May 1980 at the MIRDC seminar room in the Ortigas Bldg.

Dr. Paavo Asanti, chief adviser of the MIRDC/UNDP/UNIDO project and resource speaker for this seminar, emphasized the prospects of energy saving through the use of properly designed heat exchangers and the use of wasted heat.

Included in the lectures were: flow of energy in fuels used in a foundry, heat recovery, the pros and cons of an energy saving system, new melting and casting methods in iron casting and non-ferrous foundry production, and indirect energy saving.

A seminar on "X-ray Analysis of Heavy Metals in Mining and Metal Processing" was conducted 30 May 1980 by Philips Industrial Development Inc., in co-operation with the MIRDC seminar coordination section.

Dr. John Kikkert of the X-ray Application Laboratory, N. V. Phillips, Holland, delivered the main lecture. This proved to be of particular value to plant managers and engineers who are using the computerized automatic sequential X-ray fluorescence spectrometer.

Annex XIII

WORK PLAN: JANUARY 1981 TO DECEMBER 1982

1. Calibration and operation of analyzing equipment

		Scheduled completion date
(a)	Calibration of analysers, VES and XRF	March 1981
(b)	Training of operators	April 1981
(c)	Operation of XRF and VES	April 1981
(d)	Training in sampling and sample preparation	April 1981

2. Marketing of MTRD services

		Number of companies to be visited
(a)	Spectrochemical analysis	15
(b)	Scanning electron microscope	12
(c)	Non-destructive testing	25
(d)	Field inspection (third party)	8

3. Consulting services to small and medium scale industries

		Number of companies to be served
(a)	Foundry shops	10
(b)	Mining companies	6
(c)	Fabrication	4
(d)	Tool and die shops	10
(e)	Heat treatment shops	5
(f)	Auxiliary services	10

4. Organization and implementation of research and development projects

		Start date	Completion date
(a)	Moulding materials in foundry	March 1980	June 1981
(b)	Wear-resistent materials	Jan. 1981	Dec. 1982
(c)	Glass moulds	March 1981	March 1982
(d)	Domestic charcoal utilization in iron and steel m tallurgy	Jan. 1981	Dec. 1981

5. Training of research and testing engineers

		Number of trainees
(a)	Operators, technicians and maintenance engineers for XRF, VES, SEM/EDAX	7
(b)	Chemists for XRF, VES	2
(c)	Metallurgists for SEM	2
(d)	Research engineers and technicians	5

6. Organization and participation in technical seminars and workshops

		Number of seminars/yr
(a)	XRF-VES	6
(b)	SEM and failure investigation of metals	2
(c)	Non-destructive testing	2
(d)	Quality control testing and inspection	1
(e)	Foundry quality control	2

7. Assignment of fellowships

		Duration
(a)	Scanning electron microscopy	October 1981-March 1982
(b)	Spectrochemical analysis	October 1981-March 1982
(c)	Repair and maintenance of analytical instruments	October 1981-March 1982
(d)	Mechanical maintenance services	October 1981-March 1982

8. Assignment of short-term experts

	Duration
	October 1981-March 1982

9. Tests and analysis on instruments

	Number of samples
(a) X-ray fluorescence	750
(b) Vacuum emission spectrometry	1000
(c) Scanning electron microscopy	150

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