No. 1

JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF HIGHER EDUCATION
THE REPUBLIC OF ZIMBABWE

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR DEVELOPMENT OF CHEMICAL SCIENCE AT THE UNIVERSITY OF ZIMBABWE IN THE REPUBLIC OF ZIMBABWE

NOVEMBER 1993

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CHEMICALS INSPECTION & TESTING INSTITUTE, JAPAN

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PREFACE

In response to a request from the Government of the Republic of Zimbabwe, the Government of Japan decided to conduct a basic design study on the Project for the Univeristy of Zimbabwe and entrusted the study to the Japan International Cooperation Agency (JICA).

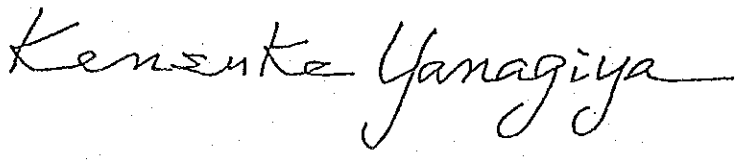
JICA sent to Zimbabwe a study team headed by Dr. Takumi Hikida, Professor of the Department of Chemistry of Faculty of Science of Tokyo Institute of Technology, and constituted by the members of the Chemicals Inspection and Testing Institute, Japan from August 14 to September 7, 1993.

The team held discussions with the officials concerned of the Government of Zimbabwe and the staff of the University of Zimbabwe and conducted a field survey at the study area in the University of Zimbabwe. After the team returned to Japan, further studies were made, and as a result the present report was finalized.

I hope that this report will contribute to the promotion of the Project and to the enhancement of friendly relations between two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Zimbabwe for their close cooperation extended to the teams.

November, 1993



Kensuke Yanagiya
President
Japan International Cooperation Agency

November 1993

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

We are pleased to submit you the basic design study report on the Project for the University of Zimbabwe in the Republic of Zimbabwe.

This study was conducted by the Chemicals Inspection and Testing Institute, Japan under a contract to JICA, during the period from August 9, 1993 to November 15, 1993 based on the field survey. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of the University of Zimbabwe concerning equipment type, quantity and layout, and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs and the Ministry of Education. We would also like to express our gratitude to the officials concerned of the Ministry of Higher Education, Department of Technology of the Office of the President and Cabinet, the Ministry of Finance, and the Embassy of Japan in Zimbabwe for their cooperation and assistance throughout our field survey.

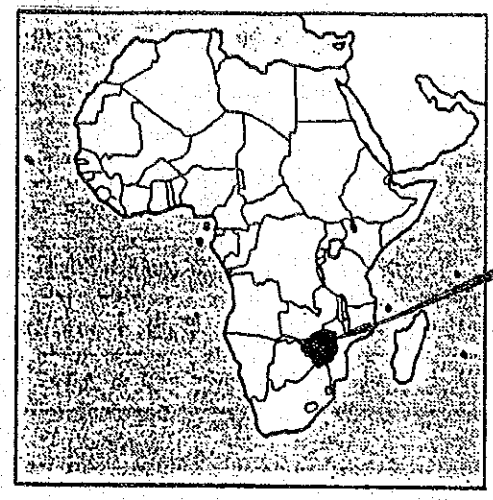
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

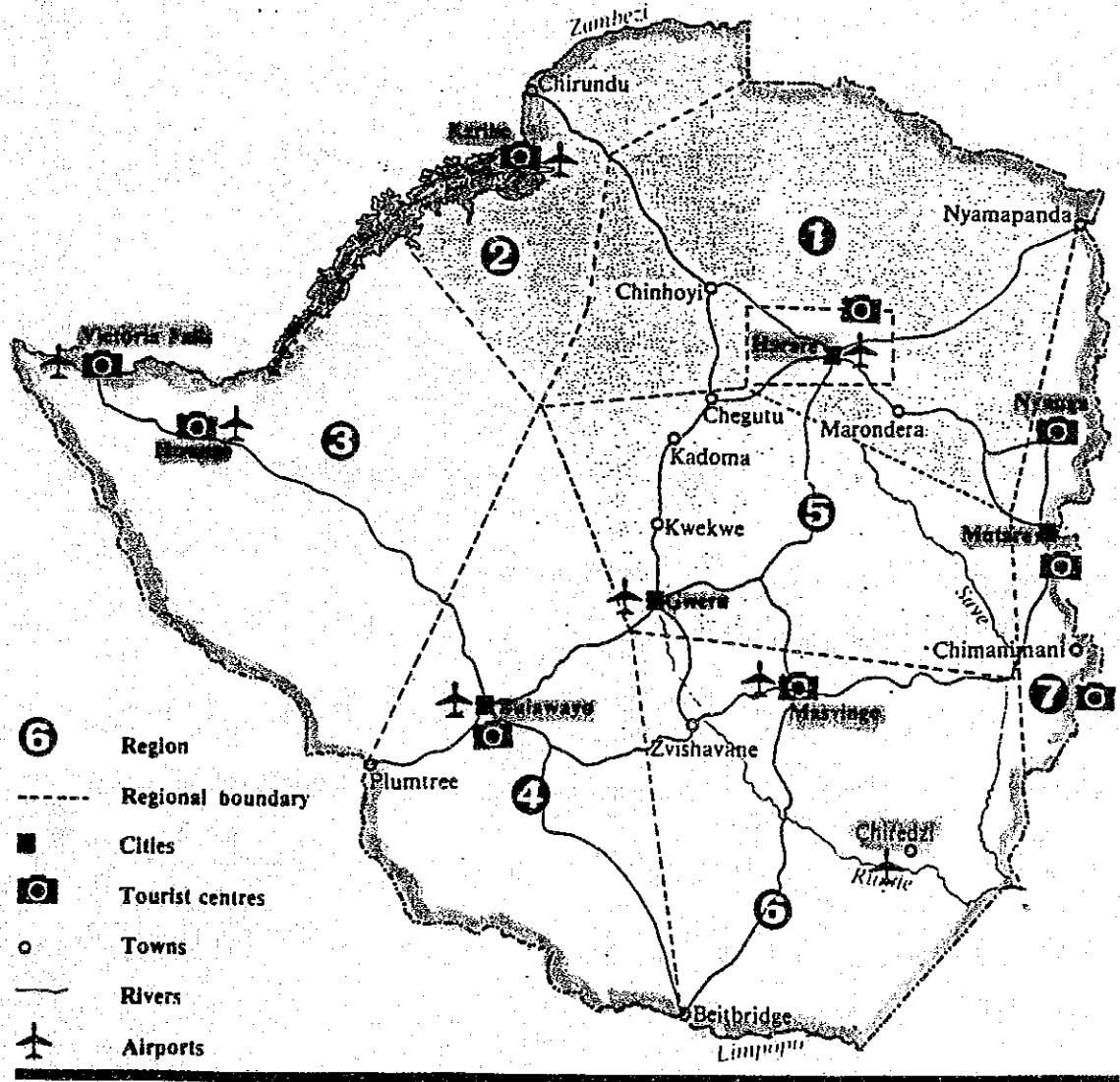
C, Kurihara

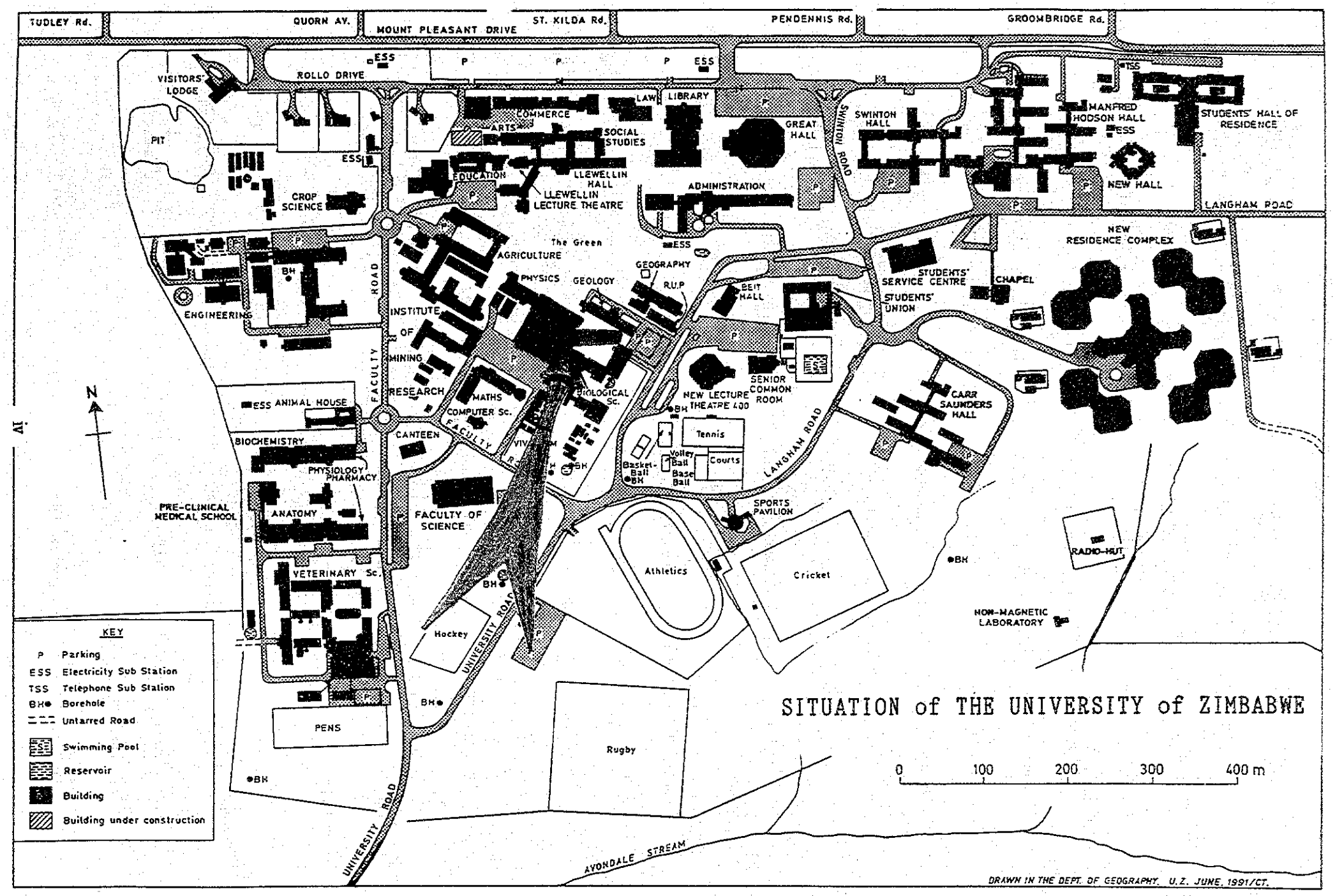
Chikara Kurihara
Project Manager
Basic design study team on the
Project for the Department of Chemistry of
The University of Zimbabwe
Chemicals Inspection and Testing
Institute, Japan

MAP of THE REPUBLIC of ZIMBABWE



Zimbabwe





SITUATION of THE UNIVERSITY of ZIMBABWE

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PANORAMA of THE UNIVERSITY of ZIMBABWE

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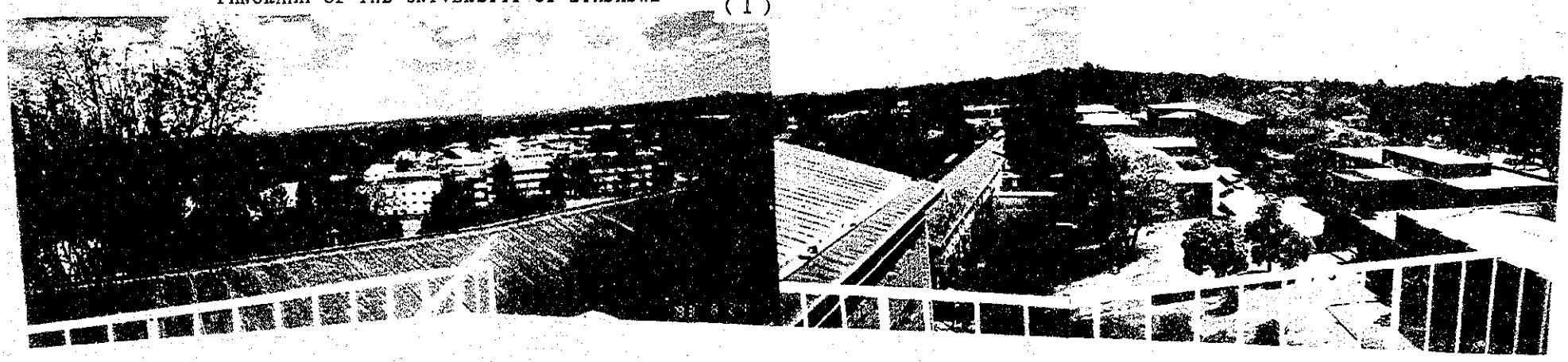

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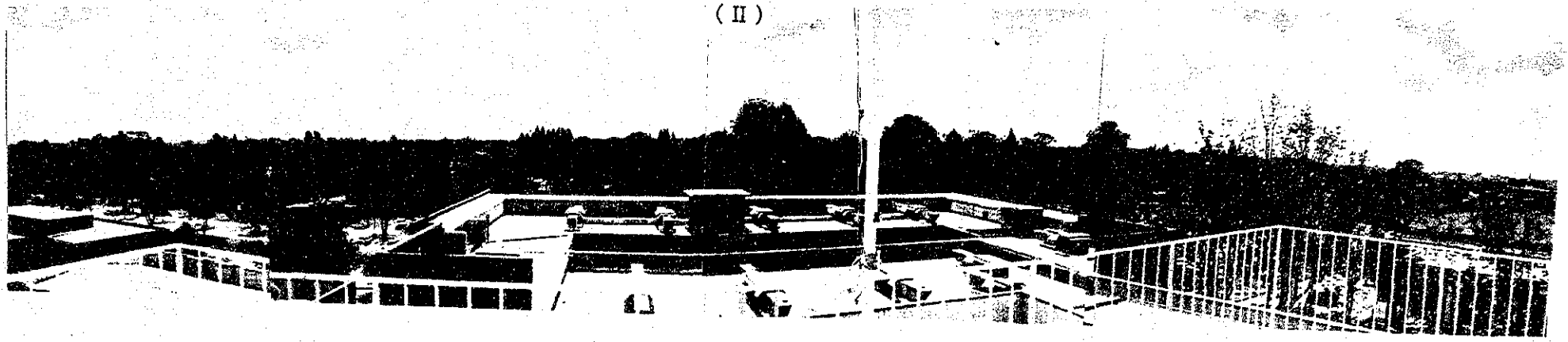

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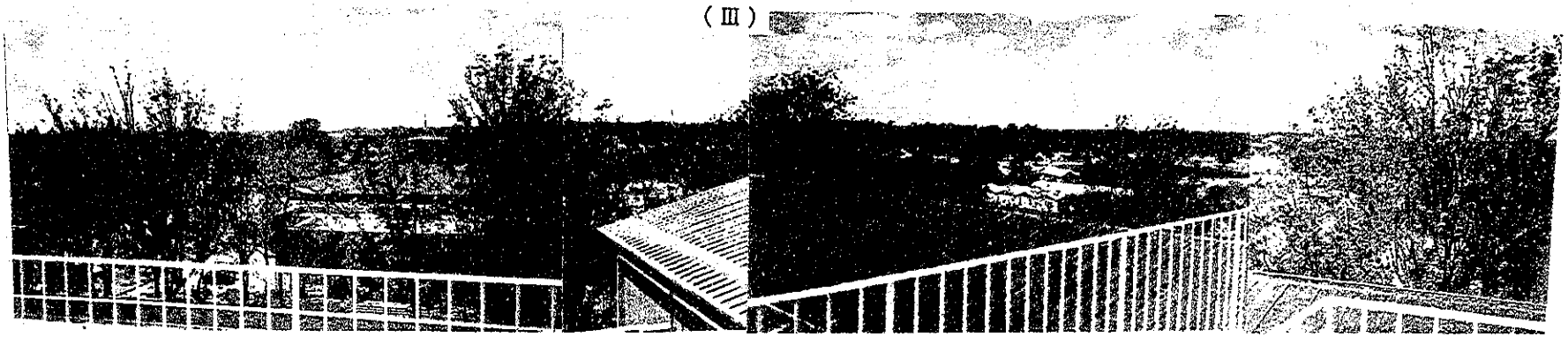
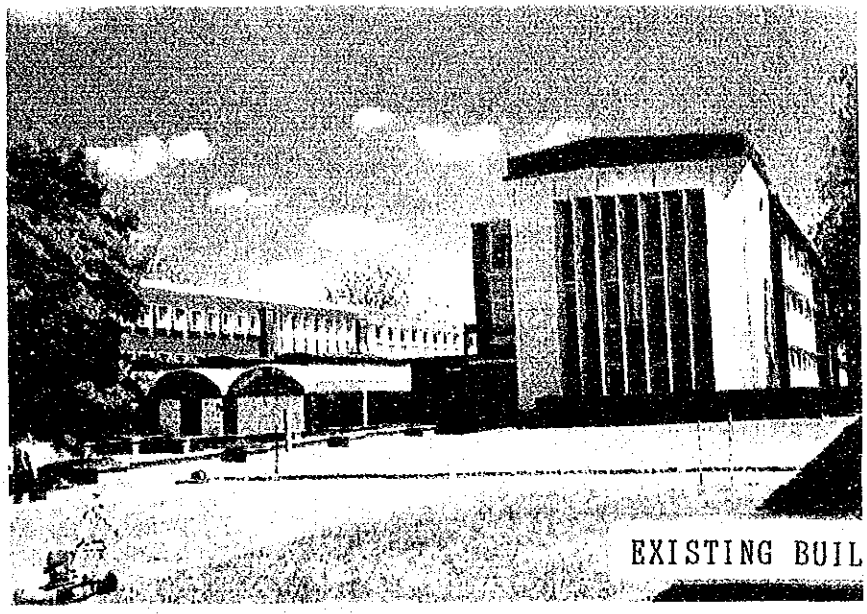
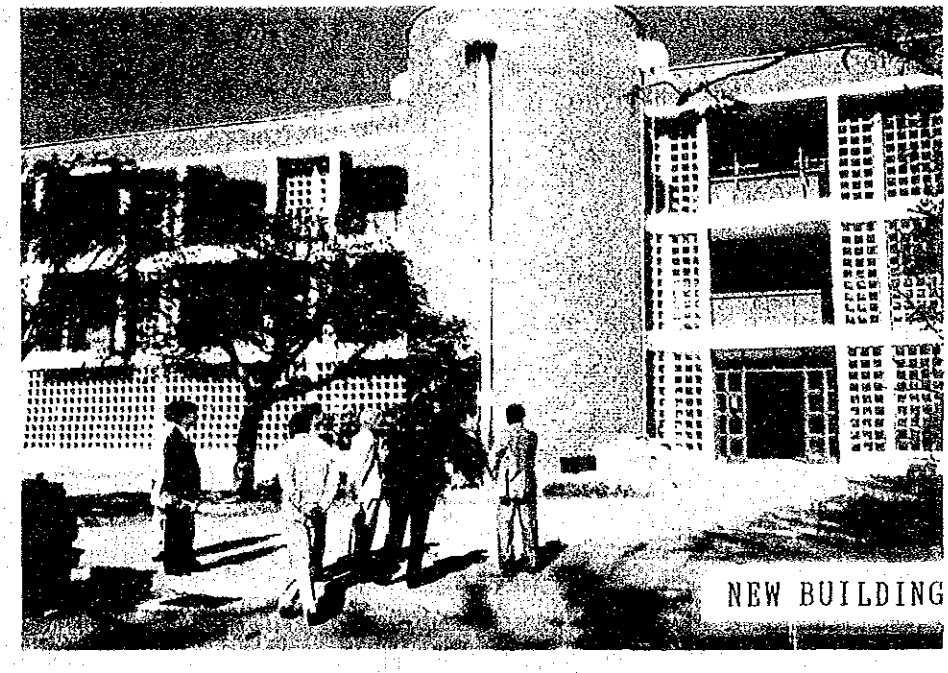


NEW and EXISTING BUILDING
of THE CHEMISTRY DEPARTMENT of FACULTY
of THE UNIVERSITY of ZIMBABWE



EXISTING BUILDING



NEW BUILDING

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SUMMARY

SUMMARY

The Republic of Zimbabwe is an inland country located in the center of the Southern Africa which became independent from England on April 18, 1980. Main feature of the country is an economic structure which is composed of balanced and diversified sectors of industry, agriculture and mining industry developed on the industrial basis and infrastructure which have been improved since the independence. The total population is approximately 10.4 million as of 1992, about 95 percent of which is blacks.

The population of cities including Harare which has the largest population of 1.02 million comprises nealy 20 percent.

The country has a republican form of government with a two-chamber system based on moderate socialism, but recently the nation introduced a free market economy to promote improvement in national fiance and economy because the past political system had led the country to a deadlock. Since her independence, the Tentative National Development Plan (1982-85) in 1982 and the First Five-Year National Development Plan (1986-1990) in 1986 have been formulated, and currently the Second Five-Year National Development Plan (1991-1995) has been implemented since 1990 in order to improve social economy.

The economy aims at achieving 4.4 percent of average growth rate of GNP for the ten years from 1980 to 1990, but the actual growth rate did not exceed 3.0 percent. The average growth rate of output in agriculture, mineral and manufacturing industries was 3.1 percent, and especially for these five years it was as low as 1.7 percent. Currently under severe circumstance, it is extremely difficult to achieve the goal because of piled-up problems such as stagnation of investment and production due to shortage of foreign currency, aggravation of inflation and increase in unemployment rate.

The nation adopts an English mode of educational system in which compulsory education is provided at elementary schools which is followed by five-year secondary education and higher education. In the educational environment elementary and secondary education is provided at public and private school all over the country. The nation has provided free elementary education to emphasize basic education, but they are forced to require minimum payment due to shortage of national funds.

Higher education system varies with each department in the university, but normally students graduate in three or four years. The University of Zimbabwe is the only university in the country. There are National College of Science and Technology and private Africa College in Burawayo, but it is not long since they were established and no students have graduated yet.

As the graduates of the University of Zimbabwe are supporting social and economic sectors in the country on leadership positions, it is considered that enhancement of the educational level of the university and upgrading their facilities will directly lead to improvement of the total educational sector in the nation and contribute directly as well as indirectly to the development of the country. The division of chemistry of the university which is to be covered by the Project has made a contribution to the development of industry sectors in correlation with other divisions of science department and engineering and medical departments because chemistry is a foundation of all the sectors including major national industries of chemical, medical, food and mining industries and agriculture.

However, in the University of Zimbabwe which is the only university in the country, some departments do not offer master's degrees and doctorates, and doctorates are not offered by the Chemistry Department of the Faculty of Science covered by the Project. It seems that it will be possible to offer doctorates in the near future by upgrading educational facilities and equipment in the Chemistry Department through the implementation of the Project.

The faculty system in the Chemistry Department which is sufficiently developed, and experiment equipment for students and storage of chemicals which are maintained in good condition shows the high level of operation and maintenance in the university. All the faculty staff who obtained doctorates in overseas colleges are engaged in a fairly high level of education and research activities. However, due to deterioaration and shortage of facilities and equipment they face considerable difficulties in more advanced higher education and reseaches in compliance with updated technologies in each sector. Therefore, it is urgently required to upgrade educational facilities and equipment to meet the advanced level of technologies in industry sectors.

Under these circumstances, the government of Zimbabwe requested a grant aid from the government of Japan for the Project for the upgrading of the educational and research equipment of the Chemistry Department of the University of Zimbabwe. The contents of the request include educational and research equipment focusing on analytical equipment in four fields in

analytical, organic, inorganic, physical chemistry in the Department.

In response to the request from the government of the Zimbabwe, the government of Japan decided to conduct a basic design study on the Project, and entrusted the study to the Japan International Cooperation Agency (JICA) to send a study team from August 14, 1993 to September 7, 1993. The team held discussion on the request contents with the officials concerned of the Manpower planning and Development of the Ministry of Higher Education which is responsible for the Project, conducted a study on the current conditions of the facilities and equipment in the University of Zimbabwe and levels of industry sectors and research organizations in the country. Further studies were made regarding the significance of implementation and appropriateness of the Project. Based on the results, the basic design study of the Project was conducted.

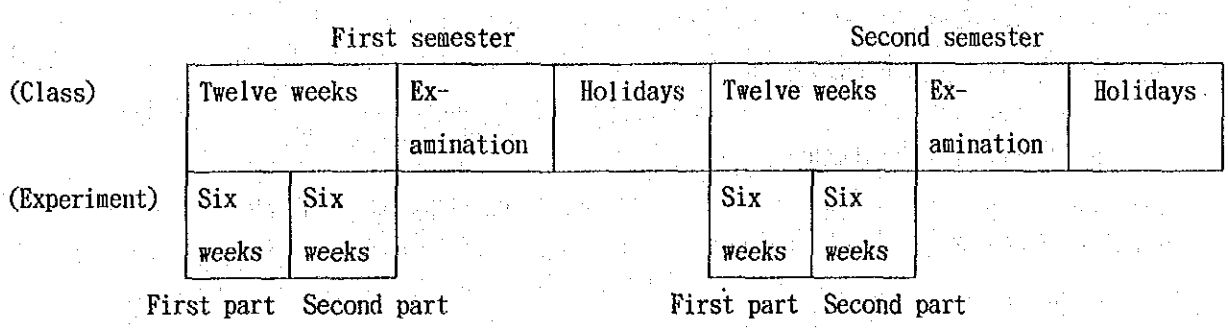
The Chemistry Department of the University has been executing partial renovation of the existing school buildings and construction of new buildings to comply with the implementation of the Project. The work is scheduled to be completed by the end of 1993, and the total cost of the Project was estimated to be Z$12.369 million including construction cost of adjacent school building of the Physics Department.

A new three-story steel reinforced building with the area of approximately 2,150 ㎡ will be constructed in connection with the existing buildings. Office of teachers and staff will be located in one side of the corridor on each floor which connects the existing buildings, and workshop, seminar rooms, library and computer rooms will be located on the first floor of the main building. It is planned that laboratory and storage of analytical and inorganic chemistry will move from the existing building to the second floor, and laboratory and storage of physical chemistry, to the third floor. A part of the first floor of the existing building will be renovated into a storage exclusively used for Fourier transform nuclear magnetic resonance apparatus, gas chromatography mass spectrometer, Fourier transform infrared spectrophotometer, etc. After the new building is completed, the existing buildings will be used as common facilities for administration department and general lecture room as well as laboratories for organic chemistry, graduate and general researches.

Curriculum is provided for three grades under a semester system, and classes and experiments are given according to curriculum and time table of each grade. One year is divided into two semesters which contain twelve weeks respectively. Each semester is further divided into the first and second

parts to conduct experiments in all the four fields in each grade.
Examinations are given at the end of each semester.

Figure - 1 Curriculum Schedule of the Chemistry Department



The Project includes the above-mentioned existing four sectors but excludes new planned sectors. As the focus of equipment covered by the Project was put on educational equipment, the necessity and required quantity in each sector was studied according to use purpose and method. Then, layout plan was made based on the existing and new laboratories with the minimum duplication of the existing equipment. The minimum quantity was planned to be installed in laboratories and storage in each sector in consideration of convenience of education and research.

Major equipment provided under the Project is as follows.

Table - 1 Major Project Equipment

Name of major equipment	Quantity	Use
Fourier transform nuclear magnetic resonance spectrometer	1	Aalysis of stereo structure of natural substance.
Gas chromatograph mass spectrometer	1	Analysis of separation and structure of substance.
Fourier transform infrared spectrophotometer	1	Analysis of bonding condition and structure of substance.
Ultraviolet/visible spectrophotometer	1	Qualitative & quantitative analysis of substance.
Gas chromatograph	2	Separation & analysis of gas and liquid.
High-performance liquid chromatograph	1	Analysis of composition of liquid.
Atomic absorption spectrophotometer	2	Qualitative & quantitative analysis of metals.
Thermal analyzer	1	Analysis of composition of substance.
Liquid nitrogen plant	1	Generating liquid nitrogen for pretreatment and analysis apparatus.
Ion chromatograph	1	Qualitative & quantitative analysis of anion in liquid.
Stopped-flow spectrophotometer	1	Quantitative analysis of inorganic substance in liquid.
Circular dichroism/optical rotatory dispersion meter	1	Identification and qualitative & quantitative analysis of optical active substance.

Equipment maintenance section of the Chemistry Department will be responsible for the operation and maintenance of the equipment. Equipment supervisor is placed under a dean and a total number of eighteen engineers are engaged in inspection and repair as well as operation and maintenance supervisor has a large power to control equipment, and all the staff and students must get his approval to use equipment.

Costs for annual operation and maintenance are estimated to be approximately Z$500,000 (about ¥8.11 million). The University of Zimbabwe has taken a budgetary measure to meet the costs of activities planned in each Department, and Z$770,000 was appropriated in 1993-94. When the Project is implemented, overseas travel expenses for the staff of the Chemistry Department which was approximately Z$500,000 in 1993 will be practically unnecessary, and they will be appropriated for the operation and maintenance expenses. The Ministry of Higher Education in Zimbabwe promised to take necessary budgetary measures with the top priority on the Project.

The work schedule is expected to be about 3.0 months for detailed design and about 9.5 months for procurement, transportation and delivery of equipment. The organization in the field responsible for the Project is the Manpower Planning and Development of the Ministry of Higher Education, and the executing agency is the Chemistry Department of the Faculty of Science of the University of Zimbabwe.

At present, competent educational and research staff and engineers are in shortage in the university and other educational institutions and industry sectors, forming a big block to the self-reliant development of the nation. The implementation of the Project will provide necessary educational and research equipment to enhance the efficiency of classes and experiments and subsequently raise the quality of educational activities. As a result, upgraded education will be provided not only for undergraduates but also for graduates. Improvement in the Chemistry Department will produce higher level of engineers and researchers to meet the requirements in each sector in the country. Therefore, it will bring forth social and economical growth and stability and contribute to the welfare of the nation.

CHAPTER 1

INTRODUCTION

Chapter 1 Introduction

Currently, formation of chemical industry sector is considered to be one of the important pillars to support the economy of the Republic of Zimbabwe (hereafter called as Zimbabwe) among the economic structure development plans promoted by the government of Zimbabwe. The Chemistry Department of the University of Zimbabwe is the only institution that can support the chemistry sector in respect of formation of human resources, research and development. Therefore, the government of Zimbabwe decided to strengthen human resources education in the Chemistry Department of the University of Zimbabwe, and constructed a new building for the division in the site of the University.

However, it is necessary to raise the educational level and quality of research and development in order to conduct research and development which can produce required human resources to lead and support the industry sector. At present, the facilities and equipment in the Chemistry Department of the University of Zimbabwe are deteriorated and in shortage. As the government of Zimbabwe are running short of foreign currency which will be required in a large amount to procure appropriate educational and research equipment, it is impossible for them to do so under the current domestic conditions.

Under such circumstances, the government of Zimbabwe requested a grant aid from the government of Japan. The request contents include facilities and equipment for analysis for education and research/developmentin the fields of analytical, organic, inorganic and physical chemistry in the Chemistry Department.

In response to this request, the government of Japan decided to conduct a basic design study, and entrusted the study to the Japan International Cooperation Agency (JICA) who sent a study team to study the appropriateness of the aid and optimal scale and content of the project. The basic design study team headed by Prof. Takumi Hikida, Professor of the Science Department of Tokyo Institute of Technology conducted a field survey at the University of Zimbabwe for twenty-five days from August 14 (Saturday) to September 7 (Tuesday), 1993. The team held discussions regarding request contents with the officials concerned of the Manpower planning and Development of the Ministry of Higher Education who are responsible for the Project, studied the conditions of the existing facilities and equipment in the project area, formulated equipment layout, and collected related materials.

After the team returned to Japan, the survey materials were examined and analyzed, and further studies were made regarding the content of the request equipment, implementation of the Project, estimation of the costs, and appropriateness of operation and maintenance. Based on the results, this basic design study report was drafted.

Members of the study team, itineraries, list of the pertinent officials in Zimbabwe, and minutes of the discussions are included in the attached Appendix. (Appendix-1, 2, 3, 4)

CHAPTER 2

BACKGROUND OF THE PROJECT

Chapter 2 Background of the Project

2.1 General Description of the Republic of Zimbabwe

Zimbabwe is a landlocked country with a total area of approximately 390,000 km^2 (approx. 1.03 times as large as Japan) situated in the central part of southern African Continent between 15.5 degrees and 22.5 degrees South and 22.5 degrees and 33 degrees East. Approximately 65 percent of the territory is highlands which are 1,000 to 1,800 meters or more above the sea, and its western and southern borders are lowlands which are less than 900 meters.

The climate of Zimbabwe belongs to the subtropical zone with the average annual temperature of (excluding the western and southern lowlands) approximately below 22 degrees and low humidity. The country is blessed with mild climate in general. A year has two seasons; namely, the rainy season from November to March and the dry season from April to October. The annual precipitations in the eastern and southern districts are 1,400 mm and 400 mm respectively and the average precipitation of the entire country is approx. 700 mm.

Although nealy 70 percent of the land constitutes an area of psammitic soil of granitic rock which lacks fertility, traditional agriculture is practiced mainly in this area. The relatively fertile area accounting for only 7 percent of the entire land is used for plantation agriculture of a large scale.

Zimbabwe which became independent of England on April 18, 1980 is a republic based on Socialism with the president as its head, and the parliament has adopted the bicameral system of the U.K. The government consists of twenty ministries, and moderate policies are taken to maintain harmony between two large tribes and whites of a minority (approx. 90 percent of the population). Therefore, the political power has been stabilized so far. Recently, due to a dead lock of its past policies of socialism, the country has been trying to improve its national finance and economy by shifting its economic base to free market economy.

The total population of Zimbabwe is approximately 10.4 million (as of 1992), and the average annual rate of population increase covering the decade from 1982 to 1992 is 3.1 percent. The Negro population of the country consists of two large tribes namely Shona Tribe distributed in

northern/eastern districts centering around Harare, the capital, and Ndebwere Tribe distributed in southern/western districts. The populations of Shona Tribe and Ndebwere Tribe account for approximately 75 percent and 25 percent respectively to the entire Negro population, which accounts for 95 percent to the total population of the country. The populations of Harare and Bulawayo cities are approximately 1,020,000 and approximately 610,000 respectively. The urban population including other middle to small-scale cities accounts for approx. 20 percent of the total population.

Zimbabwe has a diversified economic structure supported by its industrial base and infrastructure which had been prepared before the independence of the country. Thanks to the cooperation between the developed division of manufacturing industry with the agricultural and mining divisions, all the divisions of the country have been well balanced in their development.
However, since this landlocked country has no seaport of its own, it is forced to suffer from high transportation cost for exports and imports. This, together with the stagnation of investment, caused shortage of raw materials, machinery and equipment as well as the rise in prices, resulting in the chronic insufficiency of foreign currency. Consequently, the recent economy of Zimbabwe tends to be stagnant. The gross domestic product (GDP) for 1992 (based on 100, the standard price for 1980) decreased by 7.7 percent compared with the record of the year before. The GDP for 1993 indicated a further stagnation compared with that of the previous year. The average annual consumer price based on 100 for 1990 increased to 175 and 213 in 1992 and 1993 respectively, indicating an increasing tendency to the progress of inflation.
Changes in GDP covering the period from 1970 to 1992 are indicated in the following table:

Table - 2 Transitions in Gross Domestic Product

Unit: Z$1,000,000 (Based on 1980 Prices)

Year	1970	1980	1984	1985	1986	1987	1988	1989	1990	1991	1992
GDP	3,134	3,224	3,540	3,803	3,881	3,861	4,143	4,332	4,426	4,641	4,284
Compared with Previous Year				1.085	1.021	0.995	1.073	1.046	1.022	1.049	0.923

GDP: Gross Domestic Product

Source: Quarterly Digest of Statistics, March 1993
General Statistical Office

With regard to the education to be provided in the country, Zimbabwe has employed a system of the U.K. After receiving compulsory education for seven years (From six to thirteen years old), and middle school education for five years, the students are to receive higher education. The educational environment of the country is well prepared with both public and private schools located in various districts of the country.

Regarding the basic education as important, the government of Zimbabwe initially promoted the gratuitous primary school education. However, owing to the current poor financial condition of the nation, the government has been recently forced to impose minimum expenses on parents. The present situation in 1993 of the education practiced in both public and private primary and middle schools is indicated in the table below. Compared with the future prospect made as of 1990, the number of primary school students represents an in crease of approximately 7.6 percent, while that of secondary school represents a decrease of approximately 8 percent.

Table - 3 Number of Stucents/Teachers in Primary and Secondary Schools

Unit: Person

District	Primary School			Secondary School		
	No. of Schools	No. of Students	No. of Teachers	No. of Schools	No. of Students	No. of Teachers
Harare	224	228,595	5,785	74	88,761	3,613
Manicaland	769	387,289	9,884	250	100,004	3,767
Mashonaland Central	382	184,275	4,637	107	35,270	1,243
Mashonaland East	550	271,909	5,785	235	79,680	2,494
Mashonaland West	429	231,670	5,953	152	58,700	2,074
Masvingo	666	350,326	8,867	231	88,330	3,245
Matabeleand North	556	266,741	6,926	130	67,641	2,679
Matabeland South	432	154,099	3,847	115	34,860	1,603
Midlands	624	325,109	8,194	224	85,415	3,340
Total	4,632	2,400,013	59,878	1,518	638,661	24,058

Source: Primary and secondary schools: enrolments and staffing statistics
First term 1993
Policy Planning Section, Ministry of Education and Culture

It takes three to four years for the students to graduate from university/college depending on the departments they belong to. Currently, the only university in the country is the University of Zimbabwe, where some departments are still without master/doctor courses established for graduates to continue their study. The Chemistry Department of Faculty of Science is one of those to which no doctor courses are provided. The establishment of the doctor course to the Chemistry Department is desired since the department deals with studies in basic fields of various industries. It is expected that strengthening the foundation of the Chemistry Department by supplying equipment will enable to provide the doctor's course in the near future.

In addition to the University of Zimbabwe, there are National University of Science & Technology in Bulawayo city and Africa University, a private institution. Since both of them were founded only recently, no students have yet graduated from them.

2.2 Outline of Related Projects

2.2.1 Five-Year National Development Plan

After its independence in 1980 Zimbabwe has formulated a series of five-year national development plans. Subsequent to Transitional National Development Plan for 1982-1985 which was formulated in 1982, the nation formulated the First Five-Year National Development Plan for 1986-1990 in 1986. The current development plan of Zimbabwe is the Second Five-Year National Development Plan for 1991-1995 which was formulated in May, 1990.

However, on account of needs for preparation of its social infrastructure and the increased expenditure caused by its defense budget as a countermeasure against the Republic of South Africa, the nation was unable to obtain sufficient results as had been expected in its original plans.

For instance, since the average growth of its GDP covering the decade of 1980 to 1990 was no more than 3.0 percent, the planned growth rate of 4.3 percent was not attained. Moreover, the average growth of outputs for agricultural, mining and manufacturing fields turned out 3.1 percent; in particular, the average annual growth for the recent five years turned out only 1.7 percent.

As a means to break through these circumstances, in 1988 the Government of Zimbabwe established National Plan Bureau under the Ministry of Finance. The bureau formulated "Investment Promotion Policy and Regulations" in the same year. In 1991 the government reviewed the actual state of investment, employment and exports on basis of its Economic Policy Improvement Plan which was established for their promotion.

On the other hand, the government commenced an adult education campaign in order to decrease the number of the uneducated persons which amounts to approximately 2.5 million as of 1985. The education plan constitutes Fundamental Education Course for Adults which is similar to the primary school education provided in the country.

With regard to the university education, the University of Zimbabwe established new departments in order to upbring technical experts of advanced levels. This measure was also taken so as to meet the requirement that experts of a higher level should be raised for various fields. As a result, the framework of subjects required for graduation was widened.

Quota of the students per faculty in the University of Zimbabwe in shown below.

Table - 4 Quota of Students per Faculty in the University of Zimbabwe

Unit: Person

Faculty	1991	1992	1993	1994	1995
Agriculture	380	405	465	505	510
Arts	1,670	1,720	1,720	1,720	1,720
Education	1,400	1,450	1,460	1,500	1,550
Commerce	1,280	1,230	1,170	1,130	1,080
Engineering	691	722	789	856	930
Law	375	382	389	397	405
Medicine	1,243	1,296	1,342	1,370	1,394
Science	1,430	1,660	1,660	1,660	1,660
Social Studies	1,660	1,620	1,650	1,650	1,650
Veterinary Studies	176	181	186	191	196
Master Course of Technology	915	610	305	-	-
Total	11,220	11,276	11,136	10,979	11,095

Source: Second Five-Year National Development Plan

In addition to this fiscal plan, the University conducted cultivation of experiment engineers. The number of the graduates including experiment engineers is shown below.

Table - 5 Number of Graduates Including Experiment Engineers (1980-1989)

Unit: Person

Faculty	1980	1983	1984	1985	1986	1987	1988	1989
Agriculture	12	31	36	41	64	62	97	101
Engineering	18	9	29	42	53	73	82	92
Medicine	56	62	15	62	77	69	84	86
Science	35	42	68	58	80	87	122	200
Veterinary Studies	0	0	0	0	11	9	18	13
Total	121	144	148	203	285	300	403	492

Source: Second Five-Year National Development Plan

Both the University of Zimbabwe and other technical colleges have faced the problems of shortage of instructors before the plan to improve the quality of teachers was formulated. The fact is that the graduates of Faculty of Science of the University of Zimbabwe have had more opportunities to work in the field of education than the graduates of other faculties.

Measures to promote the cultivation of human resource are as follows:

① To raise skilled technical experts to comply with requirements of the entire economic world.

② To provide high quality education and training.

③ To provide subsidies to the people from the economically unprivileged level of society.

④ To promote the educational system to correspond with local conditions.

⑤ To eliminate the financial loss of the central government.

With regard to the primary/secondary school education, it is planned to increase the number of students to 3,100,000 by 1995. According to the plan, the total numbers of primary and secondary school students will be 1.08 times and 1.09 times as large as current numbers respectively.

Table - 6 Quota of Students of Primary and Secondary Schools

Unit: Person

School	1991	1992	1993	1994	1995
Primary School	2,145,107	2,180,495	2,229,933	2,274,750	2,317,156
Secondary School	678,763	680,116	693,827	719,226	742,231
Total	2,823,870	2,860,611	2,923,760	2,993,976	3,059,387

Source: Second Five-Year National Development Plan

Owing to the shortage of its financial revenue, the Government of Zimbabwe has decided to collect tuition fees from parents by changing the initial system of gratuitous education. As a compensation, the government is to establish science laboratories and technical workshops aiming at an effective promotion of scientific education so that technological development may be achieved.

As a means to reeducate teachers, special training is to be provided concerning scientific technologies. The attempt is to promote the improvement of the quality of scientific education for secondary school students. Scientific education is expected to be improved by using basic educational materials stored in local schools. In order to maintain the economic growth and development of Zimbabwe, it is essential for training of teachers to immediately strengthen scientific technologies as a measure to cope with the demand of technological progress. The quota of primary and secondary school teachers to be trained in Training College for the period from 1991 to 1995 are indicated in the table below. In spite of the decrease in the number of primary school teachers who enter Training College, the quota for the secondary school teachers majoring in the fields other than technology and those majoring in the technological field represent remarkable growth of 1.09 and 1.6 times respectively.

Table - 7 Quota of Teachers of Primary and Secondary Schools in Training College (1991-1995)

Unit: Person

School	1991	1992	1993	1994	1995
Primary School	9,118	8,657	7,877	7,365	7,617
Secondary/ Technical School	2,003	2,469	2,939	3,133	3,233
Secondary School /Others	3,341	3,254	3,254	3,507	3,636
Total	14,462	14,380	14,070	14,005	14,486

Source: Second Five-Year National Development Plan

From the above viewpoint, in order to give training to all the teachers, the curriculum of colleges should always be reviewed by looking at both the present and future conditions of the nation.

As a major issue in education and training offered by universities/colleges is to raise human resource with a higher level of technical ability. For this purpose, the scientists and technical experts having acquired considerable knowledge in scientific technology should be offered the opportunities of reeducation. As a specific plan to achieve the above goal, the University of Zimbabwe must be improved, which requires at least 25 million Zimbabwe Dollars (hereinafter referred to as "Z$") or ¥405,000,000.

The Second Five-Year National Development Plan has been formulated based on the above concept reflecting the severe economical condition of Zimbabwe. As mentioned above, however, the stagnation of both investment and production caused by the shortage of foreign currency, the progress of inflation as well as raising unemployment rate are hindering the achievement of the initial goal.

2.3 General Description of the University of Zimbabwe

2.3.1 University of Zimbabwe

(1) Position of the University of Zimbabwe

The University of Zimbabwe was founded in 1955 as an affiliated school to London University. As an only university in the country, the university has contributed to cultivation of human resouce. Although many students went abroad to study subjects or take courses which were not prepared in the university, the university has gradually improved its faculties and departments in response to the needs of manpower in various fields of the society.

The graduates of the University of Zimbabwe are playing leading roles in each field to support the society and economy of the country. Consequently, to raise the level of the education and upgrade facilities of the university is considered to raise the level of other educational institutions in Zimbabwe and to contribute to the development of the country.

(2) Current Situation in the University of Zimbabwe

The total number of students which reached its peak in 1989 has been on the decrease. This may be attributed to the decrease in number of the students majoring in literature courses in Faculties of Education, Commerce and Sociology.

On the other hand, the numbers of students majoring in scientific courses in Faculties of Engineering, Science and Medicine for 1993 tend to increase by approximately 13 to 30 percent compared with the records of 1989. This may have been caused by a general tendency of the students to choose their courses based on current needs in society and economy.

The total number of the students in the University of Zimbabwe in 1994 is 7,276, out of which the number of students in master courses is 1,187. 414 students majoring in master courses are full-time students, while 773 are part-time research students who work for companies. 433 students belong to four-year bachelor course. Transitions in numbers of students in the University of Zimbabwe are indicated as follows:

Table - 8 Number of Students per Faculty in the University of Zimbabwe

Unit: Person

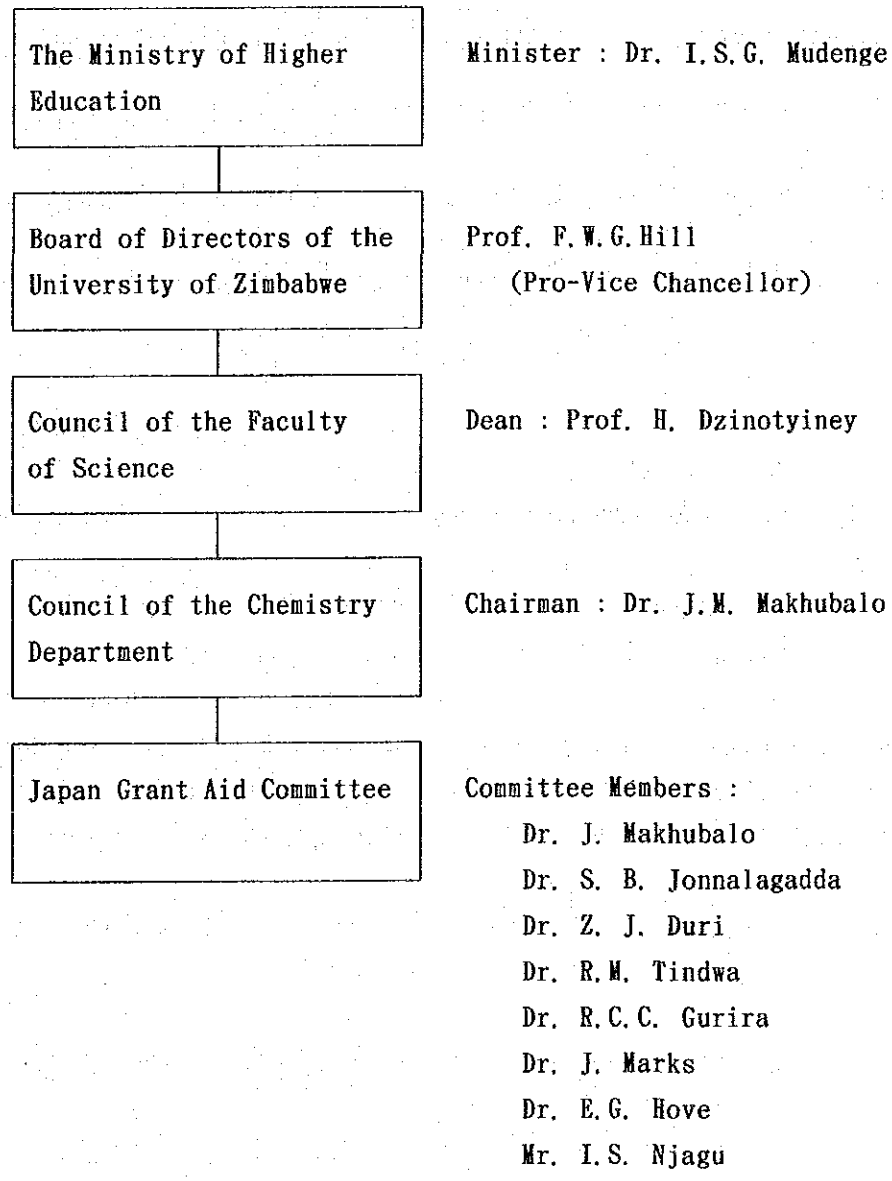
Faculty	Year										
	1980	1983	1985	1956	1987	1988	1989	1990	1991	1992	1993
Agriculture	102	151	255	290	297	340	361	352	339	388	302
Arts	307	478	898	1,016	1,096	1,190	1,234	1,305	1,380	1,331	1,181
Education	316	566	705	672	926	835	1,006	714	688	783	680
Commerce	512	871	1,136	1,348	1,120	1,187	1,027	831	762	676	774
Engineering	126	232	335	392	483	578	635	677	674	656	837
Law	-	-	-	-	290	329	330	339	357	316	275
Medicine	300	419	569	557	606	618	641	719	752	842	832
Science	205	250	392	471	595	709	723	748	723	757	821
Social Studies	372	627	807	1,008	1,207	1,479	1,792	1,844	1,772	1,714	1,436
Veterinary Studies	-	26	65	89	102	120	123	135	144	138	129
Total	2,240	3,620	5,162	5,843	6,722	7,385	7,872	7,664	7,591	7,601	7,276

Source: Zimbabwe University Report, 1993

(3) Operational Organization

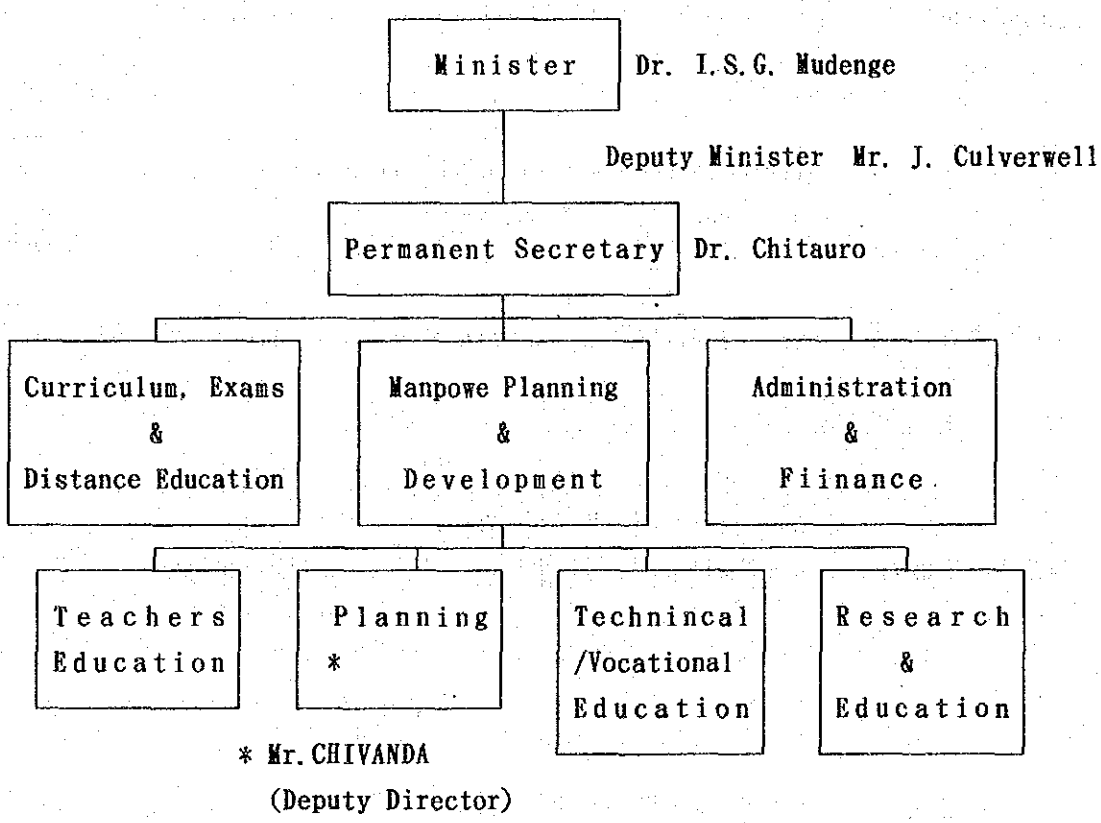
The relationship between the Ministry of Higher Education and the University of Zimbabwe regarding organization and structure of the Project is shown below. The Ministry of Higher Education entrusted the implementation of the Project to the University. Dr. J.M. Makhubalo, Chairman of the Chemistry Department, under the Dean of Science, will be responsible for the promotion of the Project to conduct selection and distribution of equipment.

Figure - 2 Relationship between the Ministry of Higher Education and the University of Zimbabwe



The organizational chart of the Ministry of Higher Education is shown below.

Figure - 3 Organizational Chart of the Ministry of Higher Education



The Ministry of Higher Education is composed of three bureaus of Curriculum Bureau, Manpower Planning and Development Bureau and Finance Bureau. Manpower Planning and Development Bureau is in charge of the Project. Furthermore, the Ministry of Higher Education will be a formal contact with the Government of Japan through the Ministry of Finance in Zimbabwe.

Income and expenditure of the budget for 1991-1992 are shown below.

Table - 9 Income and Expenditure of the University of Zimbabwe
(1991-1992)

Income (Z$)	
Government Subsidy (Personnel Expenses)	76,071,000
Government Subsidy (Materials Expenses)	14,893,000
Consignment Fee	9,505,000
Equipment	5,846,000
Others	3,884,000
	110,199,000

Expenditure (Z$)	
Personnel Expenses	91,582,000
Materials Expenses	9,116,000
Consignment & Supplies Tuition	9,098,000
Equipment	352,000
	110,148,000

Source: Zimbabwe University Report, 1993

(4) Foreign Relations

With regard to foreign relations of the University of Zimbabwe, it is clear that its sister colleges are mainly situated in the U.K. (14 schools) which Zimbabwe used to belong, and North America (6 schools in the U.S.A. and 4 schools in Canada) and Europe (9 schools). Although the University of Zimbabwe has a close connection with major universities in South Africa, it has no relation as a sister college.

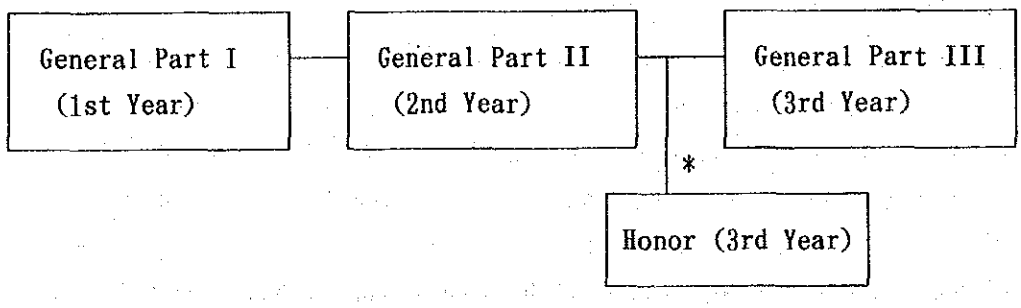
2.3.2 Current Situation of the Chemistry Department in the University of Zimbabwe

(1) Outline of Faculty of Science

Faculty of Science, one of ten faculties in the University of Zimbabwe, consists of eight departments. Other departments include Geology Department, Mathematics Department, Geography Department, Physics Department, Biochemical Department, Biology Department and Computer Department. Each department has an independent campus or an independent section equipped with its own laboratory and classrooms. At present, buildings of Chemistry and Physics Departments under Faculty of Science are now under renovation and construction as a special project for 1992 and 1993.

In principle, three years are required for graduation, each year consisting of two semesters. As described in the following figure, the students are to take general courses and elective Courses.

Figure - 4 Courses in the Chemistry Department



* Students who get more than 60 for average mark of twelve subjects and more than 60 for eight designated subjects can proceed to Honor.

(2) Current Situation of the Chemistry Department

As a fundamental department to provide education in the sectors of chemicals, medicine, food industry, mining industry and agriculture which are basic industries of Zimbabwe, the Chemistry Department has contributed to the development of industrial sectors in cooperation with other departments in the Faculty of Science and Faculties of Engineering and Medicine. Many of the graduates of the Chemistry Department find their jobs

in companies related to the above sectors or research institutes controlled by the government and they often fill leadership posts in such organizations. Major organizations where the graduates in 1990 were employed are indicated in the following table. In addition, details on employment opportunities for graduates are described in the Appendix at the end of this report (See Appendix 5).

Table - 10 Employment Opportunities for Graduates of the Chemistry Department

	Elective Course	General Course
Government Workers besides Teachers	33.3 %	24.1 %
Private Companies	18.2 %	16.7 %
Faculty Staff at the University of Zimbabwe	12.1 %	6.5 %
School Teachers	10.6 %	16.7 %

The Chemistry Department has also contributed to the industrial world of the country through joint research and technical cooperation with private companies in Zimbabwe.

Recently, however, educational facilities and mechanical equipment have become too deteriorated and their quantities have remarkably run short, and it is impossible to cope with increasintg number of students. To provide modernized and advanced education and research, it is required to install new educational and research equipment to comply with the progress of technology in the fields of chemistry and industry.

Most of the students in the Chemistry Department finish their study on completion of their undergraduate course, and few students go on to graduate schools. Therefore, the number of students taking master courses is only around twenty every year. The fact that the doctor course is not established in the graduate school to the Chemistry Department may also account for such small number of students. As exceptional cases, however, a few students who have finished their master course remain studying in the research institutes of the university to become a researcher. In addition, the above situation may also be attributed to the fact that most of

existing facilities and equipment, small in number and too old for use, are designated to be used in classes for undergraduates, and not suitable for the education in graduate schools.

If doctor courses are provided in the presenting graduate school, far-reaching effects may be expected on the chemistry-related education in the colleges and technical schools other than the University of Zimbabwe and supply of technical experts and researchers of a higher level to the industrial world. The following table indicates the transitions in the numbers of students in the Chemistry Department.

Table - 11 Number of Students in the Chemistry Department

Unit: Person

Year	1991	1992	1993
1st Year	120	200	160
2nd Year	66	30	68
3rd Year	52	47	50
Sub-total	238	277	278
Master Course	20	18	22
To tal	258	295	300

Source: Zimbabwe University Report, 1993

(3) Details of Operation

At present, 16 educational staff members (equivalent to professors, assistant professors and lecturers), 6 assistants, 18 technical engineers to control facilities and equipment are working in the Chemistry Department. Since no doctor course is provided, the educational staff consists only of the members who have acquired their degrees abroad. Partly because of a large difference in capacity between educational staff and assistants and partly because of the small number of assistants, the department faces difficulties in conducting the intended education and research as well as in raising qualified successors. Therefore, it is also considered essential, from the viewpoint of raising educational staff members, to establish a system where students can acquire their required degrees within the Chemistry Department of the University of Zimbabwe. For further details, refer to the List of Staff in the Chemistry Department (See Appendix 6) at the end of this report. Normal operation budget of the Chemistry Department for 1991-1994 is shown below.

Table - 12 Normal Operation Budget for the Chemistry Department

Year	Normal Operation Budget(Z$)	Remarks
1991	1,861,370	Actual
1992	2,393,590	Actual
1993	3,309,430	Budget
1994	4,464,520	Budget

Note: Research project approved by the University Research Board is provided besides the above normal budget.

(4) Fields and Details of Education and Research

Lectures and experiments for the Chemistry Department of University of Zimbabwe are provided under a two-semester system. The first semester consisting of twelve weeks covers the period from July to December and the second semester consisting of twelve weeks covers the period from the end of March to July. The students are to take semester examinations for two weeks before the end of each semester. They have short vacations in June and September during the relevant semester and a long vacation from December to March.

For acquisition of credits, students attend lectures of physical chemistry, inorganic chemistry, organic chemistry and analytical chemistry for the level set for each grade. Experiments for the above four subjects are to be performed in six hours a week given separately for the first and second parts of each semester. The students in the first and the second years are required to take elective subjects of other departments and faculties. Accordingly, under the system, the subjects provided by the Chemistry Department are taken also by the students in the first and second years of other departments and faculties.

Research activities in the Chemistry Department of the University of Zimbabwe are extremely active, and they have been published in bulletins of societies of chemistry and physics in the U.S. and England, including "Bulletin of Chemical Society of Japan" which is one of the leading bulletins in the academic world of chemistry in Japan. However, due to shortage of major equipment they need to depend upon overseas research facilities, and most of the researches are conducted jointly. These joint researches are effective in maintaining and raising research ability, but

they are not effecive from the standpoint of education and research. The contents of activities and educational curriculum in each sector of the Chemistry Department are attached at the end of this report (See Appendix 7, 8).

2.3.3 Construction Plan of a New Building of the Chemistry Department

New building construction plan of the Chemistry Department was planned under the total budget of Z$12,369,000 (¥207 million) along with the Physics Department building for which construction started at the same time. The work started in 1991 and it is scheduled to be completed in 1993 including interior work. This budget was appropriated and executed as a special project expense. The new building will be constructed in connection with the existing building with an area of about 2,150 ㎡ and three floors.

In one side of the hall on each floor which is connected to the existing building, office of teachers and researchers is located. Computer Room, Library, Seminar Room, Workshop, Glass Tool Storage, Office are located in the first floor. Laboratory of Analytical Chemistry and equipment room are located in the second floor. On the third floor Laboratory of Physical Chemistry and equipment room are located, and some the existing equipment are transferred from the existing building. A part of the first floor of the existing building is being renovated, it is planned to install there Fourier Transform Nuclear Magnetic Resonance Spectrometer (FT-NMR), Gas Chromatograph Mass Spectrometer (GC-MS), Fourier Transform Infrared Spectrophotometer (FTIR), Ultraviolet/Visible Spectrophotometer (UV/VIS) and Gas Chromatograph (GC) to be used as a common equipment room.

After the completion of the new building, the existing buildings will be used as common facilities of administration and general lecture rooms as well as laboratories of organic chemistry and graduate research.

2.4 Background and Content of the Request

2.4.1 Background of the Request

It was determined to implement the Project to improve and upgrade the facilities and equipment for education and experiments in the Chemistry Department, aiming at strengthening cultivation of human resource in the Department and thereby promoting the development of the chemical industries in Zimbabwe based on the Second Five-Year National Development Plan.

2.4.2 Content of the Request

The content of the request included equipment for education, research, experiment and training in eight fields of general chemistry, analytical chemistry, inorganic chemistry, organic chemistry, physical chemistry, chemical processing, textile chemistry, and polymer science. The equipment list contain as many as 481 items, including 320 items in four fields of analytical chemistry, inorganic chemistry, organic chemistry and physical chemistry.

A list of major equipment is shown in the following pages. Use of the major equipment is described at the end of this report (See Appendix 11).

Table - 13 List of Major Equipment in Each Sector of the Chemistry Department

* Analytical Chemistry

Name of Equipment	Quantity	Priority
1. Inductively Coupled Plasma Atomic Emission Spectrometer	1	A
2. Atomic Absorption Spectrophotometer	3	B
3. Automobile	1	B
4. Gas Chromatograph	3	B
5. Gas Chromatograph Mass Spectrometer	1	C
6. High Performance Liquid Chromatograph	3	B
7. Ion Chromatograph	2	A
8. Thermal Analyzer	2	C
9. High Sensitivity Balance	2	A
10. Polarograph	1	C
11. Polarimeter	2	A
12. Coulometer	1	B
13. Densitometer	1	A

Table - 13 List of Major Equipment in Each Sector of the Chemistry Department (Continued)

* Organic Chemistry

	Name of Equipment	Quantity	Priority
1.	Fourier Transform Infrared Spectrophotometer	1	A
2.	Fraction Collector	1	A
3.	Melting Point Apparatus	1	A
4.	Nuclear Magnetic Resonance Spectrometer (200 MHz)	1	A
5.	Gas Chromatograph Mass Spectrophotometer	1	A
6.	Thermal Analyzer	2	A
7.	Elementary Analyzer	1	A
8.	Densitometer (Thin Layer Chromatograph)	1	C
9.	Viscograph	1	C
10.	Polarising Microscope	1	C
11.	Polarimeter	1	A
12.	Table Top Centrifuge	2	A
13.	Liquid Chromatograph	1	B
14.	Table Top Centrifuge	1	A
15.	Chromatograph	2	A
16.	Ultrasonic Washer	1	A
17.	High Performance Liquid Chromatograph	1	A
18.	Gas Chromatograph	1	A
19.	Vacuum Desiccator	4	A
20.	Nuclear Magnetic Resonance Spectrometer (60 MHz)	1	C
21.	Refractometer	2	A
22.	Abbe Refractometer	2	A
23.	Infrared Spectrophotometer	1	C
24.	Ultraviolet/Visible Spectrophotometer	1	B
25.	Water Distilling Apparatus	1	A

Table - 13 List of Major Equipment in Each Sector of the Chemistry Department (Continued)

* Inorganic Chemistry

Name of Equipment	Quantity	Priority
1. Ultraviolet/Visible Spectrophotometer	2	A
2. Infrared Spectrophotometer	1	B
3. Analytical Balance	4	A
4. pH Meter	4	A
5. Vacuum Pump	2	B
6. Melting Point Apparatus	2	A
7. Polarimeter	1	B
8. Table Top Centrifuge	1	A
9. Vacuum Dryer	1	B
10. Rotary Evaporator	2	A
11. Fereezer Refrigerator	2	B
12. Conductivity Meter	1	A
13. X-ray Diffractometer	1	A
14. Fluorophotometric Analyzer	1	A
15. Emission Spectrophotometer	1	C
16. Gas Chromatograph	3	A
17. Fluorescent X-ray Diffractometer	1	C
18. High Performance Liquid Chromatograph	1	C
19. Atomic Absorption Spectrophotometer	1	C
20. Liquied Chromatograph Coloumn	15	A
21. Analytical Balance (Semi-micro)	2	A
22. Kipp's Gas Generator	2	A
23. Muffle Furnace	1	A
24. Ultrasonic Washer	1	A
25. Rotary Evaporator	2	A
26. Gas Chromatograph	10	B
27. Computer	1	B

Table - 13 List of Major Equipment in Each Sector of the Chemistry Department (Continued)

* Physical Chemistry

Name of Equipment	Quantity	Priority
1. Polarograph	1	A
2. Optical Filter	2	B
3. Gas Chromatograph	1	A
4. NOx Analyzer	1	A
5. Ozone Analyzer	1	B
6. Suspended Prticulate Matter Measurement	1	B
7. Hydrocarbon Analyzer	1	C
8. Oxides-of-Sulfur Analyzer	1	C
9. Computer	1	C
10. pH Meter	4	C
11. Ultraviolet/Visible Spectrophotometer	4	A
12. Constant Current Supplier	2	A
13. Pressure Regulator	4	B
14. Flow meter	9	A
15. Calorimeter	1	B
16. Laser	2	B
17. Microscope	2	A
18. Viscometer	1	A
19. Densitometer	2	A
20. Differential Thermal Analyzer	1	C
21. Polarimeter	1	B
22. Abbe Refractometer	2	A
23. Ozonizer	2	A
24. Geiger-Muller Counter	1	B
25. X-ray Diffractometer	1	C

CHAPTER 3

CONTENT OF THE PROJECT

Chapter 3 Content of the Project

Since the University of Zimbabwe is the only university in the country, it gives much influence not only on education and research but also on industrial and technological development of the country. From the viewpoint that the progress of industry and technology of Zimbabwe depends on the level of education and research of the university, the improvement of educational and research facilities of each faculty has been actively promoted as a national policy. Moreover, since many of professors and researchers of the staff have acquired their degrees of masters and doctors abroad, their capacity has been evaluated highly both inside and outside of the country. However, the current educational system is not sufficient to meet various social and economic situations. As a whole, the fact that not many people are engaged in education and research leave issues to be solved in the future.

In order to improve social and economic problems in Zimbabwe from the viewpoints of middle and long term, the highest priority should be put on providing industrial, educational and research fields with as many persons as possible who have acquired higher education of advanced levels. This may be realized by improving the educational system in the fields of chemistry and technology. The Chemistry Department of the University of Zimbabwe provides a basis of major industries in Zimbabwe in the fields of chemistry, medicine, food industry, mining and agriculture. In a close relationship with other departments under the same faculty as well as Faculties of Engineering, Medicine, and Agriculture, the request for equipment under the Project will directly contribute to the development of industrial fields of the country.

3.1 Objective of the Project

The development of the chemical industry which is one of the major industies in Zimbabwe and cultivation of human resource constitute a part of policies stated in the Second Five-year National Development Plan for 1991 to 1995.

The purpose of the Project is to improve and upgrade educational and research facilities of Chemistry Department, aiming at cultivation of human resource and technological improvement of the department which is to play a leadership role in the fundamental division of the chemical industry in

Zimbabwe.

The Government of Zimbabwe has already appropriated the budget of Z$ 12,369,000 (approx. ¥207,000,000) for an additional construction of a school building of the Chemistry Department of the University of Zimbabwe, which is scheduled to be completed by the end of 1993.

However, the existing educational and research equipment to be installed in the new campus are old models and short of quantity. Although it is necessary to provide the latest facilities and equipment, most of them may be obtained only through importing from abroad. However, because of the shortage of foreign currency caused by the stagnated financial condition of the country, the university is now confronted with the difficulty in procurement of new equipment due to its unfavorable financial condition.

3.2 Study and Examination on the Content of the Request

The equipment requested by the Chemistry Department in the beginning include 481 items in 8 sectors. The content was examined based on the results of the field survey and discussion as well as the number of students and curriculum in the department.

3.2.1 Position of the Project

The Ministry of Higher Education in Zimbabwe put the top priority on the Project for the Chemistry Department and promised to take every necessary measure required for implementing the Project.

(1) Effect of Implementation of the Project

The University of Zimbabwe anticipate a great effect of the Project as they are ready to accept the equipment to be installed in a new school building which has been almost completed. It is expected that the following effects will be obtained if the University respond properly.

As a short-term effect, the Project will contribute to the chemical industry sector through joint research, and provide capable human resource.

As a long-term effect, the Project will facilitate formation of outstanding personnel to solve the problem of cultivating human resource.

Therefore, the optimum effect will be obtained in respect to contribution to the chemical industry sector and formation of human resource

from a long-term standpoint.

(2) Relationship with the Second Five-Year National Development Plan

The University of Zimbabwe will conduct the following specific items in the Second Five-Year National Development Plan.

(a) To expand curriculum by forming new departments

(b) To cultivate engineers of experiments

(c) To perform a plan to improve faculty staff

All these issues which were required to be solved urgently will be extremely improved by implementing the Project.

(3) Relationship with Chemical Industry Sector

The Chemistry Department of the University of Zimbabwe holds a formal membership in INCHEM (Industrial Chemical Association of Zimbabwe) which is one of the groups in the chemical industry sector in Zimbabwe. This group which is composed of forty-two leading chemical companies in the country was established in 1989 to make a contribution to the development of the chemical industry. It has been engaged in joint research, collection of updated information in the chemistry sector and providing technical guidance to companies. These are unique activities which are not normally found in universities in Japan. Thus, the Chemistry Department of the University of Zimbabwe plays a leading role in the chemical industry sector. In this respect, significance is found in the Project.

3.2.2 Study and Examination on Implementation and Operation Plan

(1) Conditions at the Chemistry Department to cope with the Project

The faculty system in the Chemistry Department is efficiently working and student laboratories and storage of chemicals and equipment are also well arranged. This shows a high level of administration ability of the University of Zimbabwe.

(2) Faculty and their Effect on Classes and Researches

Educational staff who have obtained doctorates in foreign universities are actively engaged in educational and research work to maintain a fairly high level. However, both departments and graduate schools have faced an obstacle in effective education except for basic experiments due to

deterioration and shortage of facilities and equipment used for experiments and education. Therefore, the supply of requested equipment will greatly prove the situation.

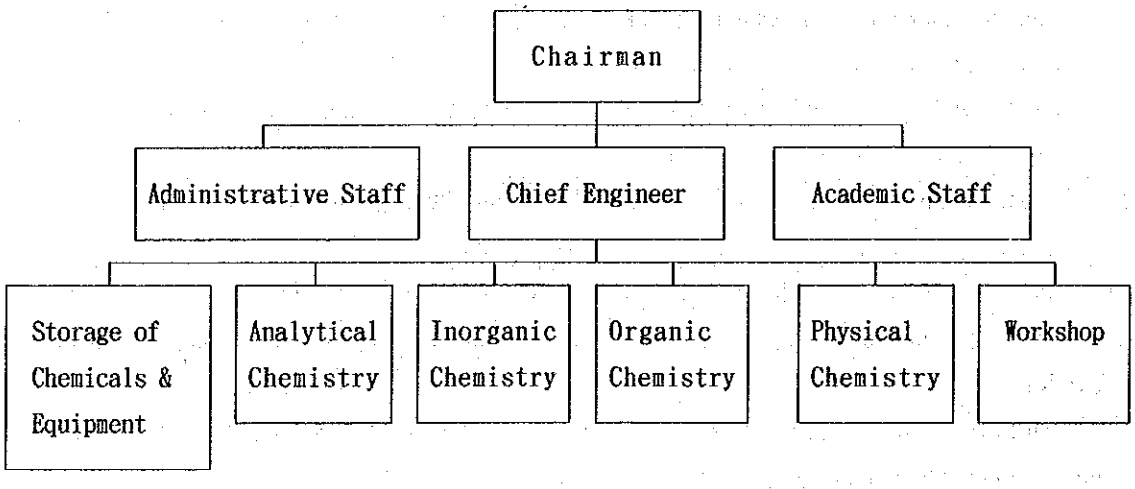
(3) Assignment Plan of Equipment Engineers

Three professors, Dr. Duri, Dr. Tindwa, and Dr. Hove, will be exclusively in charge of requested equipment of FT-NMR, GC-MS and FTIR. Besides, six assistants will be assigned to each professor to help with each equipment. Furthermore, seventeen engineers including Mr. Unjagu will be assigned to each equipment.

(4) Maintenance and Operation System

Experiment facilities and equipment in the Chemistry Department are maintained and operated in a system which is run by technical staff. Chief engineer under the chairman of the department is in charge of each course and the storage of chemicals and equipment. Organizational chart is shown below.

Figure - 5 Organizational Chart of the Chemistry Department



* Eighteen engineers in total including three to ten engineers under chief engineer of each department and field are in charge of operation and maintenance of the equipment.

(5) Quality and Number of Technical Staff

They take good care of old-fashioned equipment, and eighteen engineers procure spare parts to repair defective equipment.

Some of the equipment such as the chemical balance which was purchased twenty-seven years ago are too old to secure spare parts for repair from the maker as one agent dealing with chemical balance says that they can provide spare parts for twenty-five years after the purchase.

Facilities are designed elaborately to meet the needs of users. As expendables and spare parts are sufficiently provided, there will be no problem in the operation.

(6) Spare Parts and Expendables of Facilities and Equipment Required for Operation

Power and water supply has sufficient capacity to cope with the situation. At power breakdown, power will be supplied by a diesel generator for emergency with considerably large capacity (57KVA, 84.3AMP, 50Hz, 220V 1ϕ & 380V 3ϕ) which is installed in the Faculty of Veterinary Studies. Equipment parts, expendables, glass tools, and chemicals are stored in the storage of the Chemistry Department and each field, and they are controlled by computer.

(7) Agents

There are six agents of leading makers in the world dealing with analytical equipment in Zimbabwe, but all of them are not offering sufficient after sales service. Regarding production and repair of glass tools, a glass work company with a manager and six skilled workers are engaged in production and repair of complicated glass tools.

3.2.3 Appropriateness of Request Field

Out of eight sectors written on the request form, chemical processing textile chemistry and polymer science are on a planning stage for which no specific plan has been formulated such as staff and laboratories. There is no independent course for general chemistry which is a basis of all the sectors. Therefore, the object of the Project includes four sectors of analytical chemistry, inorganic chemistry, organic chemistry and physical chemistry. The equipment commonly used in each course is classified in a separate category as

common equipment.

3.2.4 Study and Examination on Content of Requested Equipment

(1) Content of Equipment

At the beginning, 481 items of equipment in 8 sectors were requested. As a result of discussion with the Chemistry Department at the basic design study, the request sector was reduced from eight to four, and the Chemistry Department submitted a revised list of request equipment. However, as the list was formed for each sector based on priority, it was difficult to understand priority as a whole due to duplication of equipment. After further discussion with the Department, another list was prepared based on priority in consideration of use of major request equipment. A request equipment list based on priority of the University of Zimbabwe and use of major request equipment are attached in the appendix (See Appendix 10, 11).

(2) Equipment Layout

A new school building of the Chemistry Department is under construction and a part of the existing buildings are being renovated in line with the implementation of the Project. According to the layout of laboratories in a new building and existing buildings at the time of 1994 when the equipment will be provided, an installation plan of equipment was specifically studied.

(3) Appropriateness of Request Equipment

The request equipment initially included 481 items of 8 sectors, but the minimum number of 55 items of 4 sectors were selected to avoid duplication with existing equipment. Appropriateness of each equipment was studied, and here is a description of appropriateness of three major equipment.

The current technical level of the Chemistry Department has been highly evaluated in the world as is shown in the extracts of major research thesis (See Appendix 12). Supply of equipment under the Project will further expand curriculum and help graduates of the department to take leadership in research and development activities in private companies in Zimbabwe.

① Fourier Transform Nuclear Magnetic Resonance Spectrometer
{FT-NMR (400 MHz)}

Since 1984, structure analysis on natural products has been jointly studied using FT-NMR, and an analysis of response and structural formula of derivative of Gibberellin used for facilitating flowering or germination and adjusting growth of plants has been reported. In the field of inorganic chemistry, it has been already used for analysing synthesis and response of Layered hydrogen phosphoric acid like Zr (HPO4)2 . Curriculum such as Bsc of physical chemistry, Honours of inorganic chemistry, Bsc of organic chemistry and analytical chemistry include the equipment. Therefore, it is considered to be sufficiently appropriate in terms of education and research.

Besides, the Chemistry Department requires the following conditions as it is commonly used in each field.

(a) Both solid and liquid samples can be measure by one unit.
(b) Excellent sensitivity is required to measure a very small amount of substance in a plant.
(c) Chemical shift must be wide to conduct detailed structure analysis.
(d) Ability of rapid data processing is required.

(Compared with 200 MHz, more than 5-7 times for (b), and twice for (c) is required.)

At present, 500 MHz is mainly used for structure analysis of natural products and various latent chemical substance a very small amount of which is found in plants.

② Gas Chromatograph Mass Spectrometer {GC-MS}

As it is essential for separation and analysis of unknown samples and measurement of mass of each separated substance, a certain high grade seems to be required. It is also used for analysis of damages caused by agricultural chemicals which has been increasing in Zimbabwe, structure analysis of natural products in collaboration with FT-NMR, and measurement of mass of substance (molecular weight). Currently, it is included in the lecture of the Chemistry Department, but it cannot be used for experiments.

③ Fourier Transform Infrared Spectrophotometer (FTIR)

Currently, the Chemistry Department is not equipped with this type of high resolution FTIR. It is required for analysis of structural formula of unknown samples of solid, liquid and gas, and investigation into harmful gas causing air pollution. As various kinds of harmful pollutant gas is analyzed, FTIR with high resolution is required. It is indispensable for education and research as one of components of curriculum.

④ Ultraviolet/Visible Spectrophotometer (UV/VIS Spectrophotometer)

The relation between absorption spectrogram and its strength is given by atomic group, and it gives many useful imformation to analyze structure and to identify compounds.

If a sample does not give a spectrogram, some special reagents are added for coloration, and then the sample is measured with light of special wave length.

The equipment is used to determine anion and kation. Environmental pollutants, especialy, water pollutants are measured by this equipment. When suspendoids cannot be measured by a normal method, integrating sphere apparatus is used.

⑤ Gas Chromatograph

At present, gas chromatograph is necessary and indispensable to analyze and separate some multi mixed materials.

In the Chemistry Department, pollutants in river and atomosphere in Zimbabwe are analyzed, so the equipment is needed.

⑥ High Performance Liquid Chromatograph

It is posible to analyze some thermal unstabilized and unvolatilized samples.

In the chemistry department, they are studying degradation of pesticides in water. So the equipment is necessary and indispensible to analyze pollutants in water as well as gas chromatograph.

⑦ Fluorophotometric Analyzer

The equipment is necessary and indispensible to analyze fluorescent materials, especialy, vitamine. Furthermore, in the case of measuring fluorescent materials, the quipment is sensitive more than a thousand times comparing with UV/VIS spectrophotometer.

⑧ Atomic Absorption Spectrophotometer

The equipment is necessary and indispensible to analyze various metal samples.

In the Chemistry Department, they are studying evaluation on relation between atomizing and ionizing of metal elements in atomizer.

⑨ Polarograph

The equipment is necessary and indispensible to analyze various metals, anion and organic compounds, and to measure oxidation-reduction potential and reversible reaction on electrode. In organic chemistry sector, a research on oxidation-reduction potential of electric chemistry in folic acid is being conducted.

⑩ Thermal Analyzer

The equipment enables analysis of thermal degradation process of polymers and to identify materials. In the Chemistry Department, experiment is not currently conducted because of lack of equipment.

⑪ Liquid Nitrogen Plant

The equipment is necessary and indispensible to supply liquid nitrogen for maintenance of FT-NMR and other equipment.

⑫ Ion Chromatograph

The equipment is necessary and indispensible to analyze inorganic ion, alkali metals, alkali earth and ammonium ion.

⑬ Coulometer

Recently we face a problem of environmental pollution by chemicals. The equipment is necessary and indispensible to estimate biodegradation of chemicals and environmental pollutants as a means to prevent soil pollution.

⑭ Droplet Counter Current Chromatograph and

⑮ Rotation Locurar Counter Current Chromatograph

The equipment is necessary and indispensible to separate and refine amino acid, nucleotide, amine and antibiotics. Furthermore it is used for determination of chemical equivalent to determine molecular weight.

⑯ Glassblowing Equipment

In the Chemistry Department where they use many various glass apparatus in experiments of chemical analysis, glass apparatus are very valuable goods for them. So, the equipment is indispensible to repair their broken glass apparatus.

⑰ Micro Stopped Flow Spectrophotometer

The equipment is used to measure a reaction speed. One or more sampls of solution are mixed rapidly, the mixed solution is measured to obtain absoption rate components and concentration and then the dada is analyzed with theory of reaction velocity. So the equipment is used to measure speed of complex formation in metals and enzyme reaction.

⑱ Circular Dichroism Optical Rotatory Dispersion

The equipment is necessary to analyze, identify and determine stereo-structure of optical active moleculars.

Considering that the Ministry of Higher Education will provide assistance in all aspects of maintenance and operation, the content of the requested equipment is considered to be appropriate.

(4) Appropriateness of Equipment Location

When the new building is completed, allocation of use in the new building and existing buildings will be as follows.

New Building	1st Floor :	Computer Room, Library, Glass Tool Storage, Workshop, Office
	2nd Floor :	Analytical Chemistry Laboratory, Preparation Room, Balance Room, Darkroom, Engineer´s Room, Office
	3rd Floor :	Physical Chemistry Laboratory, Preparation Room, Heat Control Room, Darkroom, Engineer´s Room, Office
Existing Building (I)	1st Floor :	Organic Chemistry Laboratory (for grade 2 & 3)
	2nd Floor :	Organic Chemistry Laboratory (for graduates), Organic Chemistry Research Room, Chairman´s Room, Teacher´s Room
	3rd Floor :	Organic Chemistry Graduate Research Room
Existing Building (II)	1st Floor :	Organic Chemistry Storage
	2nd Floor :	Analytical/Inorganic Chemistry Graduate Laboratory
	3rd Floor :	Analytical/Inorganic Chemistry Laboratory Physical Chemistry Graduate Laboratory
Existing Building (III)	1st Floor :	Organic Chemistry Laboratory (for grade 1 & 2)

As indicated above, classrooms which were used for several fields will be distinctively classified. In addition, large scale equipment will be shared by all fields, and the equipment owned by each field will be effectively used. Furthermore, curriculum will be efficiently provided in scheduling experiments for students.

(5) Appropriateness of Quantity of Equipment

The requested quantity was reviewed so that equipment may be provided to each laboratory of four courses including Analytical, Inorganic, Organic and Physical Chemistry. Based on class type, number of students, use of laboratory and equipment room as well as above-mentioned relationship with existing equipment and curriculum, the minimum number was determined, basically one for each field.

The number of small equipment is more than one, but it must be approved because they are required due to characteristics of analytical equipment and curriculum. For example, gaschromatograph requires several kinds of detectors such as thermal conductivity detector(TCD), flame ionization detector(FID), electron capture detector(ECD), flame photometry detector(FPD), nitrogen/phosphorus detector(NPD), atomic emission detector(AED), photo ionization detector(PID). Normally, eight units are required, but the quantity was determined to avoid duplication with existing equipment.

(6) Operation Ability

Most of existing equipment such as atomic absorption spectrophotometer, ultraviolet/visible spectrophotometer, analytical balance old model with low performance. However, they are well maintained for use, and there would be no problems.

Normally, difference between a low performance unit and a high performance unit lies not in principle and structure but in the model and electric treatment (amplifier) of a thermal or temperature-programmed unit and detector, computer processing of data, etc.

The University of Zimbabwe is conducting a joint research with other colleges and institutes. Therefore, they have sufficient experience in dealing with equipment for creating data. It is expected that they can acquire operation ability if instructions are given by manuals for the requested equipment. However, some of the requested equipment require higher technical skills, and it is desirable to send experts for a short time to provide training.

3.3 Outline of the Project

3.3.1 Executing Agency and Operational Structure

(1) System in Charge of Equipment Use

The University of Zimbabwe has adopted an English style of educational system since its establishment in which faculty staff is engaged in lectures and experiments and technical staff is engaged in operation and maintenance of equipment. Both staff are functioning very well, and faculty members listen to technical staff and follow their advice. Technical staff who attended at the meeting held in the University expressed their opinions powerfully as an equal partner of faculty staff.

Faculty staff is responsible for the use of equipment, and technical staff assigned to each equipment and chief engineer are responsible for maintenance and repair. As was stated previously in the section 3.2.2 (4) Maintenance and Operation System, Chairman of the department is in charge of final decision making.

(2) Budgetary Measures

Operation and maintenance budget in the Chemistry Department is approximately Z$242,000 (about ¥3,926,000) for 1993-94, which is an increase by nearly 22 percent from the actual for 1992-93. Expenses for operation and maintenance will be about Z$217,000 (about ¥3,521,000). This was estimated as operation and maintenance for general education in the Chemistry Department.

Besides, research expenses for annual educational and research activities for graduates and researchers will be provided separately by the University or a joint research institute. The total amount of the budget will be approximately Z$5,500,000 (about ¥89,240,000) for 1993-94.

3.3.2 Plan of Operation

The implementation of the Project will improve contents of activities and researches which could not be conducted due to shortage equipment, and the effect of equipment supply will be enhanced.

(1) Content of Activity

As is shown in the content of activities and required equipment in each sector of the Chemistry Department described in Appendix 7, there are about twelve items of activities. Especially in the activities including

1) environmental chemistry,

2) natural product, and

9) composition and structure of new chemical substance,

a range of activities will be expanded widely to enable a high level of activities. In addition, as the content of educational curriculum shows in Appendix 8, equipment such as FT-NMR, GC-MS, FTIR, etc. will be provided for experiments which help students go one step forward from learning of theories and expand the width of curriculum.

(2) Content of Research

As major research papers in the University indicate, researchers used to go to neighboring countries and European countries such as England, U.S.A., Germany, Switzerland, Canada, etc. to collect data. Now they can conduct research and collect data for themselves in the University of Zimbabwe. This will enable continuous research and give a good effect on future education. It will also strengthen cultivation of importance human resource to succeed research

Contracts from major research thesis are attached at the end of this report (See Appendix 12).

3.3.3 Outline of Facilities and Equipment

Mainly educational equipment were selected to avoid duplication with existing equipment. Specially, large units were requested such as Fourier Transform Nuclear Magnetic Resonance Spectrometer (FT-NMR), Gaschromatograph Mass Spectrometer (GC-MS) and Fourier Transform Infrared Spectrometer (FT-IR). FT-NMR included two units of 60 MHz and 200 MHz at the discussion for initial request, but one unit of 400 MHz was selected for the following reason. As a result of hearing survey for long hours, analysis of curriculum and research papers, it was selected because it can be used for experiments for undergraduates and analysis of structure of samples with very complicated structural formula which are being studied in a joint experiment in the department now.

Likewise, GC-MS and FTIR are considered to be necessary for experiments for undergraduates as well as analysis of agricultural chemicals and analysis of separation and structure of bio-chemical compounds such as Vitamin B.

3.3.4 Operation and Maintenance Plan

Ten percent of research expenses which is equivalent to approximately Z$ 550,000 (about ¥8,920,000) of the University of Zimbabwe will be appropriated for operation and maintenance expenses of equipment. Consequently, approximately Z$ 770,000 (about ¥12,490,000) will be spent for operation and maintenance cost for equipment in the Chemistry Department.

Expenses required for operation and maintenance for the equipment provided under the Project is estimated to be approximately Z$500,000-700,000. The University of Zimbabwe has taken budgetary measures to meet activity plan in each department, and promises to include in the budget operation and maintenance expenses required for implementation of the Project. Furthermore, some of the above-mentioned research expenses and travel expenses for using overseas equipment which was approximately Z$500,000 for 1993 actual will be appropriated.

The Ministry of Higher Education in Zimbabwe put the top priority on the Project, and they also promise to take all budgetary measures required for the implementation of the Project.

3.3.5 Method of Storage and Treatment of Harmful Substance

In the Chemistry Department of the University of Zimbabwe, chemicals used for experiments are computer controlled and stored in the storage. When a professor or a student need chemicals, he should talk to the person in charge of the storage and receive and return them after use. At that time, weight (volume) received and returned is recorded and filed as well as date, section, curriculum, name of the person.

Harmful chemicals discarded experiments such as organic solvent, heavy metals, acid and alkali are temporarily stored in bottles following instructions of experiment staff. Then, acid and alkali will be drained to public sewerage after being neutralized. Organic solvent is recovered by a large extract apparatus to be recycled heavy metals are collected by treatment

vendors and disposed to avoid causing pollution. These methods are stated in school rules and instructed to students by instructors who understand them properly. In case of experiments conducted in the university, these treatment is sufficient because amount of chemicals used is small. Therefore, special treatment facilities of wastes are not provided in each department.

In addition, the environmental protection regulations in Zimbabwe are attached at the end of this report (See Appendix 13).

3.4 Technical Assistance

As some of the requested equipment yield high performance, two experts for short-term training for operation and maintenance of chemical equipment are requested now. It is desirable to send them if such experts are available in Japan side.

CHAPTER 4

BASIC DESIGN

Chapter 4 Basic Design

4.1 Design Policy

Since the University of Zimbabwe is the only university in the country, it has a substantial influence not only on education and research sectors but also on industrial and economical sectors. Progress of industry and technology of Zimbabwe depends on the level of education and research of the University. It is greatly significant that the implementation of the Project will improve the facilities and equipment in the Chemistry Department of the University, and thereby supply capable persons who acquired wide knowledge and training with many sectors of industry, education and research.

Based on this acknowledgement, the design policy was planned to supply equipment complying with educational and research activities of current teaching faculty in consideration of necessity and minimum convenience in line with the improvement plan of the facilities and buildings of the Chemistry Department.

4.2 Conditions of Basic Design

The object of the Project includes four sectors of analytical chemistry, inorganic chemistry, organic chemistry and physical chemistry, and excludes new fields. The Chemistry Department is also under construction of a new building and renovation of existing buildings to upgrade the facilities in each field.

4.2.1 Condition of Equipment Selection

The equipment is to be selected based on the basic design policy under the following conditions.

① Equipment which meet the level of the technology and education will be selected in consideration of the current situation in Zimbabwe.

② Equipment which require special expendable supplies and chemical unavailable in Zimbabwe will be excluded.

③ Equipment which do not require a large amount of operation cost will be selected.

④ Equipment which can be easily maintained and for which repair service system is provided will be selected.

⑤ Equipment which produce wastes too dangerous to be disposed in the country will be excluded.

⑥ Equipment which require a large modification in construction planning for installation will be excluded.

4.2.2 Conditions of Equipment Scale

(1) Equipment Scale Flow Chart

The flow chart is illustrated below.

Figure - 6 Equipment Scale Flow Chart