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DRAFT/RESTRICTED REPORT

15 May 1987

UNDP PROJECT NO CPR/85/004/B/01/37

DEVELOPMENT OF NEW TECHNOLOGIES FOR PHOSPHATE  
ENRICHMENT FOR THE FERTILIZER INDUSTRY  
PEOPLES REPUBLIC OF CHINA\*

Assingment Findings and Recommendations  
Terminal Report prepared for  
THE MINISTRY OF CHEMICAL INDUSTRY

and

THE DESIGN AND RESEARCH INSTITUTE OF CHEMICAL MINES

by

Michael H Buckenham

Consultant of the United Nations Industrial  
Development Organization executing agency  
for the United Nations Development Programme

\*This report is a draft only and has not been cleared with  
the United Nations Development Organization which therefore  
does not necessarily share the views presented.

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SUMMARY (ABSTRACT)

Under Project CPR/85/004/B/01/37 of 1½ months approximately 5 weeks were spent at the duty station (the Design and Research Institute of Chemical Mines, Lianyungang, Jiangsu Province) and in the field (Wang Ji Mine of Jing Xiang Phosphate Mines Bureau, Hubei Province). The Consultant lectured and discussed phosphate assessment, beneficiation and development consistent with the Job Description, evaluated the facilities and work of DRICM and visited production centres where the research and design work of this Institute formed the basis of operating mining and beneficiation complexes.

This report backgrounds the project as at mid May 1987, summarises the Consultants activities, records observations and conclusions and makes recommendations in the interests of enhancing the value of the project, the ongoing work of DRICM and the input of consultants who will follow this initial contribution.

KEYWORDS

UNDP Project, Peoples Republic of China, Phosphate development, Phosphate beneficiation, Fertilizer, Design and Research Institute of Chemical Mines.

EXPLANATORY NOTE

As the initial consultant to be appointed to Project CPR/85/004/B/01/37 this report attempts to background the project and its objectives with a view to placing these in perspective. The report is consequently lengthy and general. Reference to it however should ensure ongoing inputs particularly that of consultants may be better prepared and more specifically targeted to the needs of the Peoples' Republic of China, The Ministry of Chemical Mines and the Design and Research Institute of Chemical Mines. (DRICM). In spite of total cooperation from Directors and staff of DRICM and excellent translation/interpretation services some misinterpretation of discussion and matters of detail are inevitable and will appear in this report. While resulting errors and omissions are regretted it is sincerely hoped that they will not detract from the value and future use of this report.

## INTRODUCTION

### Project background

China has defined very considerable phosphate resources spread nationwide but to date concentrated in the Hubei, Yunnan, Sichuan, Guizhou and Hunan provinces. The majority of resources are of low to medium grade in quality (15-25%  $P_2O_5$ ), contain high magnesium oxide and are complex in mineralogical associations. Historically and currently substantial production meets direct application uses having a minimum grade of 24%  $P_2O_5$ . Many deposits require underground mining and effective utilization is dependent upon the development of beneficiation methods capable of upgrading to make feedstock for phosphatic and compound fertilizer production.

To date the Design and Research Institute of Chemical Mines established in 1962 in Lianyungang has been largely responsible for undertaking beneficiation studies, developing processing technology and for the design and commissioning of large scale mining and beneficiation operations. In particular original contributions have been made by DRICM in the development of flotation reagents enabling impressive selectivity between phosphate minerals and the major contaminant dolomite in the sedimentary ores under evaluation.

At the present time China has a shortage of phosphate based fertilizers in particular when measured against nitrogenous production which is nearly four times higher. Heavy emphasis is therefore being given to phosphate rock and phosphate fertilizer development in order to achieve planned agricultural productivity.

### The Design and Research Institute of Chemical Mines

This Institute covers the comprehensive field of research, development and design work associated with the utilization of indigenous phosphate resources and also extends this work into other fertilizer raw materials (potash, borate, sulphur)

and to an increasing extent into other non metallic minerals (clays, diatomite etc). Similar Institutes exist throughout China for the purpose of evaluating other mineral resources and effective liaison between these institutions, various Universities and the Geological Research Institute also under the administration of the Ministry of Chemical Mines is reported.

The staff of DRICM exceeds 1000 with approximately 400 at the professional/technical level. Included are 35 mineral processing and 25 chemical engineers concerned primarily with the major aspects of Project CPR/85/004/B/01/37 - beneficiation research, pilot plant testing, chemical reagent development, and the supporting physico-chemical and environmental sections. The work in these areas is integrated and translated via consultation with other Institute sections such as planning, geological, mining, civil, mechanical, electrical, and economic into detailed project and plant design, prior to implementation at the resource location.

Technical and engineering work of this kind is supported by information sections, computing services, economics and costing, printing and administration sections. Input into projects is stated to be actively maintained at the site during development, construction and commissioning of new projects and subsequently to ensure performance standards are reached and plant improvement programmes pursued. For this purpose many technical/engineering staff are located for extended periods in the field.

Project CPR/85/004/B/01/37 to date (May 1987)

This project is planned to cover a 4-5 year period and to incorporate short term visiting consultants at DRICM, fellowships for overseas study by DRICM staff members, two overseas study tours by technical and management staff and an equipment component. The present Consultant was the first to be appointed and it has been indicated that a second from USSR (Ms Vdovichenko) and a third from USA (Dr J Lawver) are expected commencing June 1 and July 1 respectively. These visitors will cover

the development of flotation reagents and mineral engineering practice as applied in the phosphate industry. Further Consultant appointments will follow relating to environmental and quality control.

One study tour (5 participants; 3 from DRICM) was completed in June 1985 involving technical visits to USA, Finland, France and India and a meeting in Vienna to complete project details and documentation. A second study tour (5 participants, 4 from DRICM) departs early June for an extended tour of USA and Canada.

Fellowships have been initiated and two DRICM engineers left in April to take up 12 month appointments with the Tennessee Valley Authority, (beneficiation) and the International Fertilizer Development Centre Muscle Shoals Alabama USA (characterization). Arrangements have been made for a further engineer to work with COFAZ in France for 6 months and enquiries made without success to place another in a laboratory where phosphate industry related environmental studies may be undertaken. Assistance is required in placing three more fellows in suitable training establishments.

Equipment requirements have been defined for Chinese Government input and for overseas purchase. None of the former has yet been obtained but two items from the latter listing are on hand and two other items have arrived in China. In general the local and imported equipment is directed at updating and extending the existing beneficiation and supporting facilities of DRICM. It should be noted that Project CPR/85/012/11-04, "The Production of Wet Process Phosphoric Acid" based at the Shanghai Research Institute of Chemical Industry has an equipment component and that a World Bank project currently active will provide X-Ray diffraction and a computer aided design (CAD) system for DRICM together with fellowships in phosphate beneficiation and other fields.

The Chinese Government building input at the DRICM site is substantially completed and appears to be of a high standard.



CONSULTANT PROGRAMME

Objectives

1. Assess the status quo of beneficiation research for sedimentary phosphate rocks and phosphate production.
2. Review the development of various flotation circuits for sedimentary phosphate rocks.
3. Explain the pretreatment methods for various types of low and medium grade phosphate rocks.
4. Review research on equipment for grinding, flotation and dewatering of phosphate rocks.
5. Advise DRICM on phosphate rock beneficiation programmes.
6. Report on project findings with recommendations.

Assignment Schedule

April 4 - 19 May (1½ months)

April 4	Depart New Zealand
April 6	Arrive Vienna
April 7/8	Briefing UNIDO
April 9	Depart Vienna
April 10	Arrive Beijing-report UNDP office
April 11/12	Free weekend Beijing
April 13	Briefing & assignment arrangements UNDP
April 14	Travel to Lianyungang
April 15 / May 1	At DRICM Lianyungang
May 2/7	Visit Wang Ji phosphate mine, beneficiation plant and complex Hubei Province
May 9/10	Free weekend Xian
May 11	Return DRICM Lianyungang
May 12/14	Terminal report preparation and discussion
May 15	Travel Beijing

May 16/17      Report editing & weekend free  
May 18          Debriefing UNDP Beijing  
May 19          Depart for New Zealand

Note      Air travel is possible each way Beijing - Lianyungang on Tuesday and Friday only. Lack of information and time zone changes meant in this instance less than 5 weeks of the assignment were spent "on site".

Details of activities and comments

Briefing Vienna

In the absence of Mr Sasanov (Substantive officer of the project) Chemical Industries Section, Industrial operations Division, UNIDO technical briefing was completed by Mr Volodin. Personal and administrative details were handled by Ms Mazue and Ms Pinggera (Administration Assistants) Ms Taylor (Recruitment Officer) and Mrs Zeilmeyer (Briefing Co-ordinator).

Personal and administrative affairs were dealt with promptly and efficiently and time usefully spent in backgrounding the and related projects via tapes, reports and publications held in UNIDO offices, library and information sections. Publications useful to the Consultant and to DRICM in relation to project work were collected.

Project briefing was however disappointing in view of the project substantive officers' replacement and little useful information other than that in project papers and documents was obtained on the project, its environment and its implementation. It is for this reason the present report is written broadly so as to provide background useful to subsequent consultants. This should ensure that their time is spent most constructively in furthering the project and the work of DRICM.

Briefing Beijing

Again personal and administrative details were dealt with most effectively but little information of professional/technical value on implementation of the project could be provided by

the Senior Industrial Development Field Adviser, Mr Sissingh. However by this time it was evident by contact with staff of DRICM that lecturing & discussion was to be the main activity of the Consultant. To this end it became immediately disappointing that advance advice had not been possible so that written preparations could have been made and much more scientific and technical material assembled and brought to DRICM. For this reason better communication should be made with consultants possibly in future directly between DRICM and consultants (copy to UNDP). It is pertinent that Barry Crozier in his report on Project CPR/85/012/11-04 based in Shanghai recommended similar action.

#### Work at DRICM

The major activity of the Consultant was delivering general and specific lectures to technical/engineering staff members and specific interest groups together with seminars and discussion as appropriate. These covered topics considered to be important following Directors' reviews, a comprehensive inspection of the work and facilities of DRICM, discussion with senior management and section heads, review of DRICM reports, requests from DRICM staff and the terms of reference for the project. Meetings were consistently well attended generating many questions predominantly of a specific nature and not confined to the field of beneficiation. Staff were invited to discuss work directly with the consultant and a number took the opportunity of doing so.

Time was required to prepare for these meetings and it was unfortunate that written preparation was not possible much earlier to facilitate translation. In some instances however publications brought by the Consultant could be made available on subjects discussed.

Briefly these sessions covered an overall review of the phosphate industry world wide, current trends and developments, beneficiation and manufacturing technology, integrated development, planning and economic assessment and feasibility studies. Beneficiation principles and practice, flotation reagents;

equipment testing, design and result assessment, pilot plant and plant operations. DRICM reports, procedures and specific test results, pretreatment options, equipment needs and non metallic mineral beneficiation.

As it soon became evident that one area of major concern was translating DRICM laboratory data into plant design a request was made to visit production sites. A visit to the local Jing Ping mine followed and arrangements made to visit Wang Ji mine in Hubei Province. These visits proved invaluable in putting the work of DRICM in proper perspective. In particular the Wang Ji visit provided insight into geological, structural, and mineralogical aspects of the deposit, the mining practices, the plant layout and construction and the project infrastructure and services.

#### THE JING PING AND WANG JI MINES

The Jing Ping mine was discovered in 1919 reaching full scale production of 1.12 mta ROM in 1958 and resulting in the establishment of DRICM nearby in 1962. Standard flotation practice is followed in this plant to yield 0.3 mta of 30% P<sub>2</sub>O<sub>5</sub> product. Inadequate mine production arising from the need for further underground development resulted in the beneficiation plant operating at 50% capacity.

The Wang Ji mine and associated beneficiation plant is the first to be based on the utilization of the difficult phosphate/dolomite collophane ore on which considerable basic and design work commenced in 1974 had been completed by DRICM after confirmation of substantial reserves in 1966 and discovery in 1957. Mine design commenced in 1981 for underground production of 1.5mta ROM to produce 0.73 mta of concentrate following fine grinding and all flotation treatment. Final plant design was established after three years of on site pilot plant testing in a unit constructed specifically for this purpose at a scale of 60 tpd. Plant construction commenced in 1983 and by late 1986 plant performance trials were initiated. These are still continuing with the plant yet to achieve design performance.

Adjacent to Wang Ji the open pit Darukou mine project is under development with World Bank assistance. DRICM has completed detailed beneficiation test work on this property which is based on an extension of the Wang Ji orebody. Other developments (Liu Chong) and many small scale "private" mines in the immediate area contribute a very significant output of direct application and processed phosphate ore (above 24% P<sub>2</sub>O<sub>5</sub>).

This field and particularly the Wang Ji mine is of considerable importance to China and of considerable interest to DRICM. Its location, large production, favourable logistics and reliable services make it nationally significant - the full scale application of new technology and research and design to the role of DRICM. The six parallel treatment circuits have all now been commissioned with lack of operating control and experience contributing largely to lower grade and recovery than indicated by laboratory and pilot plant test work. Plant design and layout appeared most satisfactory and the total complex impressive. A need for more intensive plant evaluation in order to upgrade performance was evident together with a need for improved onsite facilities and equipment to monitor plant performance and to assess a plant improvement programme. The long period required to bring this project to satisfactory completion is note worthy, this being one of the problems associated with DRICM work - the translation of research and design work into successful commercial operations.

#### DRICM AND ITS FACILITIES

This research and design Institute is quite well equipped in those areas in which its work is primarily directed viz the development of beneficiation techniques for difficult ores via analytical/mineralogical work, reagent development and flotation experimentation. Concern was expressed and was confirmed on the age and adequacy of much of the equipment and as a direct result the rate of research and experimental progress. Nevertheless inspection suggested that while slow the work was meticulous and of a consistently high standard lacking perhaps in imagination, scope and critical economic evaluation. Without doubt equipment replacement and extension

is necessary particularly for instrumental analysis, mineralogical analysis and characterisation, continuous and pilot plant testing and to widen test work capability within the Institute.

To date work has concentrated perhaps unduly so on all flotation treatment of all ores and the assessment of various flotation reagents, conditions and circuitry. Some encouraging work has been completed on optical sorting and currently attention but no work is being directed toward the possible application of dense medium separation. In spite of reported high mine recovery, low mining dilution and complex mineral associations laboratory and field observations indicate a potential for this as a pre concentration approach for example using the Sala DWP process. Equipment for this purpose is included in the purchase list for Project CPR/85/004/B/01/37. However bench scale laboratory work should be undertaken and cost/benefit analysis applied. Rejection of this approach to date would appear to be due to an over emphasis on  $P_2O_5$  recovery and a commitment to demanding product grade specifications.

Careful evaluation of alternative processing routes to all flotation was encouraged as was the relaxation of the laboratory commitment to demanding recovery and product specification levels. A better integration of effort between mine, beneficiation and fertilizer manufacture could well result in better overall utilization of phosphate resources. With this in mind more work on product evaluation and integration of DRICM work with Project CPR/85/012/11-04 at SRICI was emphasised. This cooperation too should be extended to the development of Dayukou under World Bank support. Duplication of work in these programmes should be minimised so maximum overall benefit results.

Pilot plant facilities and operation are of concern to the Institute and are in need of upgrading and better integration to serve a useful purpose including continuous operation at 3-5 tpd. With the availability of the 60tpd pilot plant at the Wang Ji mine site the role of the DRICM pilot plant warrants review.

The substantial equipment grant from the Chinese Government and from overseas purchase (Project CPR/85/004/B/01/37) together with World Bank assistance should substantially upgrade and widen DRICM capability but more support of this kind is desirable both at Lianyungang and at the Wang Ji and probably other mine sites.

### CONCLUSIONS

During the comparatively short period involved in Project CPR/85/004/B/01/37 it was not possible to obtain a clear understanding of the phosphate resources, development planning, extraction operations, fertilizer production technology, agricultural practices and research and development activities in China. Nevertheless through total cooperation during the period of the assignment it was possible to place the role and work of DRICM within the wider framework of the Ministry of Chemical Industry and the overall development plan for indigenous phosphate utilization. It is within this context that the following conclusions and subsequent recommendations are made.

1. Subsequent consultants and visitors under CPR/85/004/B/01/37 must be as fully briefed as is possible before arrival at the duty station and preferably before departure from home base. For this reason their attention should be drawn to this initial Terminal Report.
2. Consultants/visitors should bring the maximum possible amount of published material and prepare written lecture material in advance of taking up duties. Lecture material should if at all possible be forwarded to DRICM for translation so as to better facilitate information and technology transfer and more active discussion.
3. Particular areas of information need identified or requested include : experimental procedures, design and interpretation; pilot plant testing and scale up procedures; test work programmes mathematical modelling, simulation, optimisation and control; alternative beneficiation technology; instrumentation; plant practice and tailings disposal and dewatering.
4. DRICM is competently staffed and moderately well equipped to carry out its prime functions of research and design for the development of complex low to medium grade phosphatic materials. Generally however much of the equipment is out



of date too much is concerned with flotation work and too little capable of evaluating alternative beneficiation strategies.

5. The equipment provided/requested under Project CFR/85/004/B/01/37 will greatly assist together with that from World Bank support. It would be advisable if possible to review the equipment needs both at DRICM and 'on site' with conclusion 4 in mind.

6. The published work of DRICM appears thorough, reliable and most successful at bench laboratory scale in achieving effective beneficiation of difficult ores.

7. The pilot plant requires upgrading as it would appear difficult to maintain continuous controlled operation. For this reason and its small capacity it has limited design application and its role should be reviewed.

8. The Information Section (Library) of DRICM appears well stocked with journals, reports, translations and Russian texts and serviced by an interloan system. It would benefit from upgrading with the many Western texts available in all areas of DRICM activity (eg those available through AIME/SME Denver, Colorado) and publications such as reports, bulletins and circulars from the US Bureau of Mines. Conference proceedings should also be more widely available although these are appearing as a result of more DRICM staff attending international meetings. UNIDO publications of interest could be sent on a regular basis.

9. DRICM test work and its objectives appear overly concerned with technical solutions and maximum performance without due attention to economic and the more practical objectives of work of this kind.

10. The two areas of greatest concern identified would be (a) the difficulty of translating small scale and somewhat unreliable pilot plant work into full scale plant operations and (b) the rate at which this laboratory work is reflected in a fully operational and metallurgically successful plant.

The latter illustrated by Wang Ji experience may reflect an overly conservative attitude to process scale up and perhaps a lack of confidence in the excellent and original work of DRICM.

11. Considerable difficulty is and will be encountered in satisfactorily placing well qualified candidates under the Project fellowship component. Action is and should be taken by Consultants, the USA/Canada tour group in June and UNDP using personal contacts wherever possible. A list of suggested locations is attached to this Report (Appendix 1-Fellowship Locations).

12. Within the Fellowship programme consideration should be given to less specific objectives (particularly for 12 month tenure), practical industry experience, more than one venue and the achievement of expertise and information by working on materials provided from Chinese locations.

13. The Fellowship programme should be reviewed so as to effectively integrate with that under Project CPR/85/012/11-04 and the World Bank programme. The latter within 9 Fellowships includes 3 directly concerned with phosphate beneficiation.

14. The established 60 tpd pilot plant at Wang Ji mine should form the basis for extending the work of DRICM for final plant design purposes more so than the smaller unit located at Lianyungang.

15. DRICM has a most important role to play in plant commissioning, operating, plant improvement programmes and operator training. More involvement of engineers/scientists 'on site' should prove rewarding.

16. DRICM policy and staff may benefit from a broader philosophy in its/their work - the attention to concepts rather than detail, principles rather than practice and processes rather than equipment. This should provide a better basis for overall project and plant development and interaction between units within the Institute.

17. With a sound understanding of Project CPR/85/004/B/01/37, the project environment and the work and objectives of DRICM, the Consultant will maintain an ongoing interest and an active contact. To this end participation in the Project technical review and mid-term evaluation would be mutually beneficial.

RECOMMENDATIONS

Arising from this review and the conclusions drawn the following recommendations are made:

1. This Terminal Report should be issued and distributed immediately to assist with the briefing and work programmes of following Consultants and to maximise the value of their inputs to Project CPR/85/004/B/01/37.
2. Particular note should be taken of the areas of input needed (Conclusion 3) and communication on these and other matters would best be carried out between DRICM and Consultants (copy to UNDP).
3. The equipment component of the Project is vitally important and through revision, further \$US input and coordination with World Bank and Project CPR/85/012/11-04 could enhance its value. Updating and a broadening of laboratory capability at DRICM and enhancement at plant sites are necessary. A review of pilot plant facilities and function should be included.
4. Enhancement of the Information Section (Library) at DRICM is desirable and this should be better clarified and inputs made by ongoing involvement of Consultants and by UNDP support as the Project proceeds.
5. DRICM and the Ministry of Chemical Industry through the Project must address their capability of planning and thus accelerating the translation of basic test work into effective operating plants and optimizing resource utilization by integrating mining, beneficiation and fertilizer manufacture.
6. In view of the capability and experience of DRICM technical/engineering staff DRICM should become more actively involved in training, operating, commissioning, assessing and improving plants resulting from their research and design input.

7. As considerable effort is required to ensure the success of the Fellowship programme Conclusions 11-13 and Appendix 1 - Fellowship Locations should be seriously and promptly addressed.

8. As initial Consultant to Project CPR/85/004/B/01/37 concerned with on site assessment work, formulation and implementation and involvement in ongoing activities the opportunity should be provided for participation in the mid term Project evaluation and technical review.

ACKNOWLEDGEMENTS

The Consultant acknowledges the cooperation of many staff members of DRICM, visiting counterparts, translators and interpreters and Directors at the mining sites visited. The consideration and kindness afforded and the willingness to meet all requests is very much appreciated as is the hospitality extended throughout the period of the assignment. The Consultant looks forward to an ongoing relationship with the DRICM and to developing further the contact between China and New Zealand and China and UNDP/UNIDO through Project CPR/85/004/B/01/37.

Particular thanks are extended to the following with whom the consultant worked most closely during the assignment.

Huang Da Yu    Director of DRICM and National Project Director for Project CPR/85/004/B/01/37.

Huang Zu Fan    Deputy Director    DRICM.

Deng Yu Gui    Deputy Chief Engineer (Beneficiation), DRICM.

Hu Hsi-Keng    Professor/Consultant to DRICM, Central South University of Technology, Changsha.

Ma Yu Cong    Interpreter/Engineer    Research Institute of Mines, Maanshan.

Qian Shang Kui    Engineer (Beneficiation) DRICM.

Chen Ting Sheng    Interpreter/Translator    DRICM.

APPENDIX 1 - FELLOWSHIP LOCATIONS

\*\*\*\* United States Bureau of Mines Research Centres (USBM), Twin Cities, Minneapolis and Albany, Oregon, USA. (Flotation and laboratory testing).

Mineral Resources Research Centre, University of Minnesota, Minneapolis, USA. (Flotation and beneficiation testing, QEM\*SEM. Dr Iwasaki).

\*\*\*\* Henry Krumb School of Mines, Columbia University, New York, New York, USA. (Fine particle technology. Professor Somasundaran.)

\*\*\* International Minerals and Chemical Corporation (IMCC), Bartow, Florida, USA. (Research & Development, practical operations. Dr Lawver).

Tennessee Valley Authority (TVA) and International Fertilizer Development Centre (IFDC) Muscle Shoals Alabama, USA. (Beneficiation and characterisation etc).

\* Warren Spring Laboratory, Stevenage, Hertfordshire, England. (Flotation reagents and laboratory testing).

Norsk Hydro Fertilizers, Levington Research Station, England. (Phosphate assessment and fertilizer production. Mr Crozier/Mr Robinson).

\*\*\*\* Centre for Mineral and Energy Technology (CANMET), Ottawa, Canada. (Beneficiation testing, plant design).

Geological and Mineral Research Institute & Centre for Mineral Research (SOFRECO-SOFRECHIM-CERPHOS), Nancy/Paris, France. (Research, reagents, beneficiation etc).

Institute of Minerals, University of Cagliari, Cagliari, Italy. (Research).

- \*\* Institute of the Ministry of Chemical Industry, Ministry of Chemical Industry (and elsewhere), Moscow, USSR. (Flotation reagents).
- \* Australian Mineral Development Laboratory (AMDEL), Adelaide, Australia. (Testing, pilot plant and design. Mr Cameron & Mr Ashton).
- \* Julius Kruttschnitt Mineral Research Centre (JKMRC), University of Queensland, Brisbane, Australia. (Modelling, control, optimization and computer applications. Professor Lynch).
- \* Commonwealth Scientific and Industrial Research Organisation (CSIRO), Mineral Engineering Section, Melbourne, Australia. (Mineral and association definition, QEM\*SEM. Dr Reid).
- \* Department of Mining Engineering, University of Auckland, Auckland, New Zealand. (Processing, testing, modelling and mining. Professor Buckenham).

Those institutions marked \* will be approached by the Consultant. Those marked \*\* (and others) should be approached by Consultant Ms Vdovichenko and those marked \*\*\* by Consultant Dr Lawver. Those marked \*\*\*\* are to be visited by the June study tour to USA and Canada and with others should be approached at that time. The remainder should be contacted through UNDP/UNIDO or through contacts already established.



APPENDIX 2 - FINAL DISCUSSIONS

Final discussions on Project CPR/85/004/B/01/37 and this draft Terminal Report were held at DRICM Lianyungang immediately prior to the Consultants departure. Discussions included sub-contract budget item of \$100 000 US "For investigation on improved techniques for flotation beneficiation of a number of phosphate rock types" which had not been addressed in the report. In the Consultants view following clarification of the purpose of this input the imported component of the project equipment listing should be reassessed. In particular the heavy medium DWP unit from the Sala Company of Sweden at a budgeted cost of \$300 000 US or over 60% of the total allocation.

Consistent with conclusions 4 and 5 the evaluation of potential for this specific unit may be best covered under the sub-contract "investigation" budget freeing substantial funding for alternative laboratory equipment to include more versatile and a less specific laboratory heavy medium item than the DWP. (Refer conclusion 16). Should reconsideration confirm the need for the Sala DWP unit then it should be made available by DRICM for national mineral test work where it would have many potential applications on a contract basis.

In further considering this "investigation" budget item advice was requested on where such work might be most satisfactorily undertaken. There are many company, commercial and research and development laboratories/centres for this purpose. In principle these should be chosen where fellowship placements/requests have been made (eg AMDEL in Australia) and the work should be conducted during the fellowship tenure to maximise the value of this work to the project and to the training and capability of the fellows concerned.

Finally on the Project equipment component in view of need and importance to the work of DRICM the attention of UNDP is drawn to the serious erosion of the \$492,025 US since allocation due to the declining \$US exchange rate.