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DEVELOPMENT OF SMALL HYDROELECTRIC PLANTS

DP/VIE/86/041

VIET NAM

Technical report: Assistance to the Institute of Electrical Science and Technology for testing and improving water turbine performance*

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

Based on the work of Ivar K. Elstad, expert in small hydropower equipment testing

Backstopping officer: J. Fürkus,
Engineering Industries Branch

United Nations Industrial Development Organization

Vienna

* This document has not been edited.

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CONTENTS

1. <u>Introduction</u>

a) This technical report should be read in connection with the Project Document* and the Project Formulation Framework*. This report will give some additional technical information as well as the other background information obtained.

b) The terms of reference were according to UNIDO job description:

To assist the Government to increase the country's performance and capabilities in the development and application of small hydropower plants (SHP).

- Analyse existing information on SHP development in Viet Nam and review/assess/discuss the concept of establishing a laboratory/test centre for small hydropower equipment.

- Elaborate/define the structure/functions/testing and advisory services/work programme of the laboratory, staffing and training requirements, main equipment, components needed, necessary infrastructure and a programme for implementation.

- Prepare a technical report setting out findings/recommendations on further steps required to set up the required facilities and elaborate, assisted by UNIDO's backstopping officer, an appropriate draft project document for technical assistance following UNDP/UNIOD guidelines on project formulation including project objectives, outputs, activities and modalities of implementation, project inputs (expertise, training, equipment, budget) and work plan.

c) The author arrived in Viet Nam 17 June and left the country on 11 July. In addition, one day was used for briefing and debriefing with the backstopping officer in Vienna.

d) From the Vietnamese side, a project team consisting of the following was formed:

Dang Ngoc Tong, Dr. Sc. Project Director
Director of the Institute of Electrical Science and Technology (IEST)

Luu Long Dac, Dr. Sc. Deputy Project Director
Head of Hydro Division, IEST

Nguyen Viet Phach, Dr. Sc. Project Staff member
Section leader technical group, Hydro Division, IEST

Nguyen Quoc Hai, Interpreter

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* will be issued as separate documents

In addition, the other members of the staff of the Hydro Division, IEST, attended the meetings depending on the subject to be discussed, especially to be mentioned Nguyen Ngoc Duy, M.Sc, Hydraulic machinery.

e) The staff of the UNIDO/UNDP office in Hanoi gave valuable support on several occasions and assisted at the three official meetings with the steering committee. Especially to be mentioned, programme officer Lars S. Adermalm.

f) The work was mainly performed according to the following schedule:

Week 1, obtaining background information, preliminary design of the laboratory.

Week 2, project formulation, writing of the draft project formulation framework.

Week 3, detailed equipment specification, discussion on the project formulation framework, writing the first draft of the project document.

There was a meeting with the project team nearly every day, discussing the various findings or the different proposals put forward by the consultant or the project team.

The last weekend was used to make a very pleasant tour to Halong Bay, otherwise the work was performed in Hanoi or in the near vicinity.

g) The author is in general responsible for the draft of the various documents, the project team role was mainly to serve as a partner for the exchange of ideas, points of view. Much of the information was received orally so misunderstandings/errors could occur. Due to the limited time, it was seldom possible to cross-check the information given. Some additional information was asked for in writing, however the answers were not given in time and so some important aspects are left open in the draft project document and other documents.

h) During the 3 weeks in Viet Nam, there have been 3 meetings with the project steering committee, including among others, representatives from UNIDO, the national Planning Committee, the Ministry of Energy and the State Committee ot Science and Technology.

i) Meeting 18 June, main subject - the work plan, the presentation of initial ideas from both sides.

ii) Meeting 28 June, main subject - the progress of the work and the borderline between the different institutions.

iii) Meeting 7 July, main subject - discussion about the project formulation framework.

There were no special memos prepared from these meetings but the results are as far as possible incorporated in the 3 documents presented:

Draft Project Formulation Framework (PFF)
Draft Project Document (PD)
Draft Technical Report (TR)

i) Before leaving Viet Nam, the draft PFF was discussed thoroughly and the main points of view incorporated in the draft PD, main points being dicussed with the project team. The drafts of all 3 documents were finalized in Norway.

2 Institute of Electrical Science and Technology (IEST)

a) The total staff is approximately 150, divided into 15 technical divisions and additional administrative divisions.

In this connection, the Hydraulic Division is most relevant. The staff is as follows:

Construction	Section	present	staff	3
Hydraulic	"	"	"	3
Equipment	"	"	"	5
Mathematics	"	"	"	4

Among the staff there is one Doctor of Science and two secondary Doctors

The responsibility of the Institute of Electrical Science and Technology, the Hydro Division is described in the other two documents. This institutional framework was discussed thoroughly, as it is very important for the project.

b) A small power scheme consists typically of the following parts:

Intake, power-channel and penstock intake with gate(s), trashrack(s) and additional equipment.
Penstock, valve(s)
Turbine with governor when necessary, drafttube
Tailrace channel
Generator and other electrical equipment
Transmission lines

No survey was presented showing that the major reason for the various difficulties encountered was within the area of responsibility of the Institute of Electrical Science and Technology nor was a survey presented which could pinpoint the turbine wheel shape as the major problem.

This was also the main reason for changing the project title used for the preliminary project document.

Although some efforts were made, it was not possible to visit one of the existing power stations due to transportation problems.

The terms of reference were mainly given by the Institute itself, asking for a laboratory to test turbines.

Due to the limited budget available, training within the other fields of the Institute's responsibility is not foreseen in this project but could be valuable.

c) It was difficult to get a clear picture of the activities of the Hydro Division since this division is still in the building-up stage.

The following was seen by the expert:

- A large handwritten report on the design of a turbine testrig, with comparisons to several foreign test rigs quoted in Russian. This has been used as a background when the preliminary design of the laboratory building was done and when the Institute proposed the present project for UNIDO. The test rig was larger than the proposed one for this project with flows up to 0.6 m3/sec, and not very flexible. However, the work served as an input in a fruitful discussion about the proposed laboratory size, functions.

- A set of standardized civil engineering drawings covering the power station with tailrace, penstock and penstock intake, trashracks and silt sluicing gates for a typical power station with head 30 to 60 m, 1 turbine approximately 100 kW installation.

- A set of installation drawings for the different turbine types produced in the Dong Anh factory, with some characteristic data like main dimensions, weights, typical performance data written on the drawings. The turbines were modified copies of foreign designs and little was known about their real performance, characteristic data.

  For a power station to be built, the procedure now is to select a suitable turbine from the types available and calculate the necessary data like run-away speed, minimum suction head, fly-wheel size and similar.

  In addition, the Hydro Division will approve the mechanical calculations and the detailed design drawings.

  Most turbines were manually regulated. For larger turbines, the calculation of the guide vane closing time, governing stability, waterhammer and similar should also be performed but the staff had little experience within this field. From some control calculations of the main turbine data the feeling arose that the design was in part technically outdated.

The real number, name of power stations where the above-mentioned procedure was applied, was not given. However, for the 2.1 MW turbine shown in the Dong Anh factory and the 150 kW turbine to be tested in the near future the above-mentioned procedure was followed.

The detailed turbine drawings were in the Dong Anh factory. The contact in the factory was apparently good, as one of the staff had previously worked there as an engineer. It was however, felt that the Hydro Division could have some problems with some of the tasks described above.

- The "Interim Committee for co-ordinating investigations of the Lower Mekong Basin" had started a small project on the selection of suitable micro-hydropower components, and the Hydro Division, IEST, would take part from the Vietnamese side.

- Some consulting services to stations with cavitation problems, bearing problems should be given but further details remain unknown.

- The Hoa Binh power station under construction by the Soviet Union in co-operation with the Ministry of Energy was told to have large testing facilities, mainly for testing of dams, flood dissipation and similar connected to that project and some staff from the Institute received their experience here.

- A wheel-design was apparently not undertaken up to now and the detailed mechanical design was done in the turbine factories.

3. Existing and future premises, existing equipment, library

a) The Institute of Electrical Science and Technology (IEST) has its offices in a 3-storey main building with approximately 500 m2 ground area, and some additional smaller buildings on an approximately 10000 m2 plot. The real area used for offices and dwellings is unknown.

   The Hydro Division has two offices, unseen, but probably some 20 m2 each. The offices seen were the IEST meeting, conference room, approximately 100 m2, the IEST library, approx. 30 m2 and the project office of the same size.

b) Between the IEST building and the premises belonging to the Institute of Hydraulic Research there was an open area, now partly occupied by temporary dwellings and gardens. This was the proposed site for the new laboratory and the outer rim of the building was marked and the ground levelled. A bulldozer, several coils of reinforcement wire, several concreted open boxes for the foundation of the building columns as well as a heap of gravel had apparently been there for a long time.

Several drawings of the site and proposed laboratory building were seen. The main building is approx. 15 x 50m with 3.9m distance between the columns. The test hall is 15 x 15m, 14m total height, 12m between the lowest point of the roof girders and the floor, equipped with an electrical hoist on a central girder. It was pointed out that the test hall should have an overhead travelling crane instead of a one beam hoist and should have several intermediate floors with galleries of steel beams and columns so the equipment configuration could be easily changed.

The rest of the building has two storeys with an external ramp and stairs. On the ground floor about half of the building besides the test hall is occupied by a large room for a fume for testing dams and weirs. On one side of the laboratory building is a storage building whilst on the other side are the foundations for a water tower.

At the front of the building is an open area of approx. 10C0m2 to build dam and river models. The fume and outdoor testing facilities belong to the second building stage.

Below the outdoor test area a future reservoir of approximately 1000m3 is located. In the first stage only some 200m3 reservoir would be built. No cellar or corridors for water pipes is foreseen. It was pointed out during discussions that it would be very convenient to have a pipe corridor at cellar level, connecting the test hall and the water reservoir. The groundwater level is on average 4m below the surface so a cellar would be no problem. This is strange with all the open dams in the vicinity.

The ground floor was designed for a load of 1000 kg/m2 and the foundations of the building had no problems.

The electrical supply for the Institute should be 2 x 250KVA transformers, the initial waterfilling of the reservoirs from the ordinary water supply system. If pumping from ground water is required the usual depth is 12m. Drainage and sewage pipes of adequate dimensions are in the area.

Although no detailed design was available the proposed building is apparently of a reasonable size. Several requests were made for a copy of the drawings but to no avail.

c) A written request was also made to obtain a list of equipment presently belonging to the Institute of Electrical Science and Technology, Hydro Division. Nothing was available.

d) The library belonging to the Institute of Electrical Science and Technology has several Russian textbooks on turbines, hydropower development and similar topics. Some of them are well-known. There were no books in other languages available, nor any periodicals in any language. Apparently, the library has a problem with books and periodicals disappearing.

There should be a central technical library in Hanoi which is well equipped. A request for a complete version of IEC 193 could not be met. The new laboratory should have a small library of periodicals and relevant books.

4. Technical details for the proposed laboratory

a) The technical details of the laboratory are in general described in the project document but some will be further elaborated here. It should however be mentioned that the final design and hence the laboratory's performance and selected equipment is a part of the future design.

b) As a basis for the minimum laboratory requirements, the various standards from the International Electrotechnical Commission are used. These are approved by all major countries in particular the USSR and Japan.

In this case the most relevant standards are:

IEC 193, International Code for Model Acceptance Tests of Hydraulic Turbines, 1965, with first supplement 193 A 1972 and Amendment no. 1, 1977.

IEC 497 International Code for Model Acceptance Tests of Storage Pumps, 1976.

IEC 41, International Code for the Field Acceptance Tests of Hydraulic Turbines, 1963 and

IEC 198 International Code for the Field Acceptance Tests of Storage Pumps, 1966, and the complete draft for the revision of the two above-mentioned standards.

Further, the IEC standards on Cavitation Pitting Evaluation (IEC 609), on Testing of Speed Governing Systems (IEC 308), Guide for Commissioning etc., (IEC 545) can be mentioned.

Flow metres are covered in various ISO standards and also pump testing in general.

c) To compare with the existing laboratories, the survey performed by the National Engineering Laboratory, East Kilbride, Scotland in 1970 as well as information from the laboratories of Kvaerner Group, the Sulzer Group, Voith, French and the Scandinavian National Laboratories was used. In addition, the Institute had a detailed survey on laboratories in the USSR and some other countries quoted in Russian textbooks.

The discussion which took place focussed mainly on the fact that the Institute wanted a laboratory with model size minimum 350 mm, and heads according to what is in common use in the USSR, whilst the consultant tried to use the minimum requirements whenever applicable in order to keep the costs within the indicative budget.

The result is a reasonable compromise with performance data and flow system being given in the annex in addition to characteristics being shown of some typical models to be tested and the limitations for prototype testing.

d) According to the Institute of hydraulic Research, the ordinary tap water was not very corrosive. However, they recommended a quality corrosion protection of the water carrying parts. Hence, all parts should be sandblasted to Sa 2.5, and protected with 2 component epoxy paint, 300 um thickness or a similar treatment.

5. <u>Comparison, relations with other institutions</u>

a) The Institute of Electrical Science and Technology and its Hydro Division is described in chapter 3, some important related Institutions in chapter 8, 9 and 10.

The two important ministries are the Ministry of Energy and the Ministry of Water Resources. The other institutions within this field like the Power Companies or the National Mekong Committee are affiliated to one of the afore-mentioned ministries.

Some potential manufacturing shops like the Hanoi Metal Works pump factories belong to other ministries, this is of minor importance in this context.

b) The relationship with the turbine factories can be in various ways depending on the responsibility of the various institutions, the Dong Anh as described in chapter 8 is an example.

i) The project document is written under the assumption that the manufacturer in the future will only be responsible for the detailed mechanical design of the turbines. This detailed design is necessary to adapt the general design to the production facilities.

The selection of a suitable turbine type, general design with main dimensions, the vane profiles, the turbine characteristics and performance data as well as quality standards will be the responsibility of the Institute of Electrical Science and Technology and they will also approve the detailed drawings, calculations, perform the necessary acceptance tests. The laboratory will besides the testing of existing turbine types actively do research work to improve the different turbines on their own.

The Institute can theoretically use various factories as it is not necessary that the manufacturer has a special turbine knowledge.

The Institute should be well qualified in general mechanical design in addition to turbine technology.

If bilateral or multilateral aid is received this will be directed through the Institute.

ii) There have been some talks about a co-operation agreement between a foreign turbine manufacturer, Neyrpic, and the Dong Anh factory. This is one practical solution if an alternative approach is selected. In this case, the factories are responsible for the total delivery and that the guarantees given are fulfilled.

The Institute will act as a representative for the different clients, the Institute of Energy, the different Energy Boards. They will write the general specifications, perform the selection of the suitable turbine type, control the delivery according to the specifications and similarly operate like an ordinary consulting firm.

In this case, the manufacturer either directly or through a cooperation agreement has to have specialised knowledge in turbine technology and design, as well as in mechanical design. The Institute shall have a broad general knowledge within the turbine technology mechanical design. The laboratory will test and approve smaller prototype turbines and can do more advanced research work on behalf of the industry.

A clear idea of the future role of the Institute and the Laboratory is necessary before the detailed design starts, as this also will influence the subjects and location for fellowships.

c) There should be no reason for conflict between the proposed laboratory and the Polytechnical College, described in chapter 9. The first will have responsibility for obtaining practical results within reasonable economical limits. The second will have responsibility for training, teaching and university-type research. Sound co-operation should be possible to strengthen both as the institutions would not be competing for funds within the same field.

d) The relations between the proposed laboratory and the Institute of Hydraulic Research described in chapter 10 needs careful consideration. There is no sense in duplicating the activities and UNIDO/UNDP should not support competition between the institutions. In the first stage however, there is no special conflict as the UNDP support to the Institute of Hydraulic Research will restrict itself to the pumps and the UNIDO support to the Institute of Electrical Science and Technology will be related to turbines.

However, both pumps and turbines are types of hydraulic machinery, it is mainly the same theory, the subjects are in most places taught in the same institutions and the same type of equipment is needed for testing and investigations. A versatile pump test rig can also be used for testing turbines and the other way around.

Furthermore, according to the long term plans of the Institute of Hydraulic Research, they will continue within the field of turbines. In the same way, the Institute of Electrical Science and Technology have the intention to start with the testing of dams, intakes, spillways and similar.

The two institutions are located side by side.

The ideal solution would be to have one institute for hydraulic machinery, with a pump and a turbine section, one for fluvial hydraulics and hydraulic structurs.

Being an old and large research institute, the Institute of Hydraulic Research has an experienced staff and this infrastructure will simplify the erection of a turbine laboratory. Even so, it is sometimes challenging to start from scratch if sufficient funds are available. Apparently qualified people can be obtained.

The various project documents are now written from the presupposition that there has to be a split between the Ministry of Energy with the Institute of Electrical Science and Technology - turbine technology and the Ministry of Water Resources with the Institute of Hydraulic Research - pump technology. In which case, with the limited project funds and strain on the Government economy, the borderline between the two institutions should be carefully considered before any change and closer co-operation between them promoted.

6 The economic basis for the new laboratory

a) The economical situation in Viet Nam is difficult and the Government is trying to use the money available as efficiently as possible. The Government will apparently, only provide funds to institutions for the basic staff and basic research if these are justified. Funds will not be provided on a long term basis even if budgetted for, this has to be approved each year and the institutions have to prove that they are utilising their money in an efficient manner. Funds for the new laboratory will only be provided after the project is signed, any build-up of staff or premises beforehand is difficult.

b) If the new laboratory is to survive after the project period, it has to obtain sufficient funds for maintenance, operation and further development, not only for staff wages. From experience with other institutions the general policy appears to be that the Government will provide funds for the basic staff but the rest should be obtained from the various clients.

c) The project budget is so small that it will only provide the most necessary equipment. Hence the laboratory from the first day will have to have economic relations with institutions outside both in order to get the necessary external services and the funds to provide for these services and further development.

d) This can be done in two ways:

   1) The laboratory will operate within a certain legal framework ensuring a basic activity. This can be ensured with the regulations set forward by the Government, the Ministry of Energy and it is important that the institutional framework described in the project document is not changed.

      The activity will only depend slightly on the progress of the different new power plants as the field testing, standardization and initial testing plus related activities will be an important task during the first few years.

In the build-up stage the laboratory should be protected from competition with other institutions.

2) The staff should be sufficiently qualified and the laboratory sufficiently equipped to be recognized as such and thus operate as qualified consultants so that various institutions will give away some work. In this way the relation with the manufacturing industry can be strengthened. Moreover, it will improve the relations with the different provincial and local energy boards and last but not least, the three central networks. They apparently have a fairly qualified staff and will probably only use the laboratory if it is "good enough". The aim of the project should be that the technical level of the laboratory staff is at a sufficient level for them to act as consultants before the end of the project period.

7. Other information, considerations for the project

a) The project is designed for the use of a Chief Technical Adviser and individual consultants engaged by UNIDO. It calls for close contact between the CTA and these various consultants as the total man months provided is rather low and the different subjects closely related. One suggestion would be to select the CTA and consultants from within the same organization thus giving the organization some extended responsibility for co-operating the arrangements.

b) Subcontracts for large parts of the equipment, including the design, delivery and training, is not recommended.

The reason is mainly that the equipment part is not well defined at the moment and the subcontracting of larger parts would hinder fruitful co-operation between UNIDO and the Vietnamese counterpart.

A detailed design of the laboratory is one of the first tasks after the project starts. After that, it can be decided whether the equipment should be purchased individually as indicated in the present project document or whether larger lots could be subcontracted.

c) Some of the equipment like header and receiver tanks and main pipework can be preferably produced locally if the detailed design, control and supervision is done by the project team. The transportation of tanks of large volume is expensive and by paying in foreign currency the factories can obtain the necessary material. For example, the Dong Anh factory is sufficiently equipped for such work and such a solution would also improve the relationship between the laboratory and industry.

In general, locally produced equipment should be preferred if the quality could be ensured even though costs might be higher. However, the project document does not at the moment provide additional time for the guidance of local manufacturing.

Viet Nam is also producing larger pumps. However, requests for reference lists, production and test facilities remained unanswered. Hence, pumps of foreign origin will be considered unless new information is received in the detailed design phase.

d) There was some discussion about the laboratory crane now placed under the governmental unput. It might be that the hoist with equipment has to be purchased abroad, in which case it will probably have to be a UNDP/UNIDO delivery, although the rails, bridge and similar should preferably be produced locally.

e) There has also been discussion about the model turbines, now placed mainly under the governmental input. The project is designed in such a way that there is no expertise provision for the wheel design although other expert help can give assistance in the practical design of the components around, this is a necessary part of the laboratory design.

The idea is that the project shall enable Viet Nam to test and to improve the Vietnamese turbines, turbine design. If the idea is also to improve wheel design with foreign aid, an arrangement has to be found with a recognised turbine manufacturer or research institute, providing the initial models with all the necessary test data. Experts designing a good Francis, Kaplan or Pelton turbine from scratch without utilising experience and test results belonging to a factory or another research institution can hardly be found. For crossflow turbines however, several design manuals are available.

f) It has also been proposed that the manufacture of the first models to be tested, the turbine casings should be financed by UNDP. However, this is not foreseen in the present project design.

g) In the project document reference is made to other national institutions sometimes with a UNIDO project number. References and data were obtained from a superficial search in the files of UNIDO in Hanoi, the time was insufficient to get direct answers to requests. Examples are the information regarding calibration services and maintenance possibilities for the instruments.

h) The plans for the development of small hydropower given in the preliminary project documents issued by the Institute of Electrical Science and Technology is not used in this document. The reason being that they should be revised. A written request for new data remained unanswered. All the planned power stations above 100 Kw listed in the preliminary documents are shown on a map in the Institute. The majority of the stations to be built is in the middle of Viet Nam.

8. Visit to the Dong Anh factory

In addition to the team was Mr. Nguyen ba Vinh, State Committee for Science and Technology, Industrial Department.

We were kindly taken care of by Mr. Hoang Thai An, General Director, the Union of Electrical Technical Equipment Manufacturers, the Ministry of Energy, as well as by the employees.

The factory is in general manufacturing and r?pairing all types of heavy electrical equipment, transformwers up to 16,000 KVA, circuitbreakers, insulators 6 - 10 KV, generators and motors. In addition come water turbines and related equipment. The factory is deliverying the products to the Ministry of Energy and is making sub deliveries for other factories in Viet Nam and the turbines are made to orders from local communities or other customers, after central approval.

Since 1979 approximately 200 turbines have been delivered, among them:

> 20 Francis turbines with a total capacity of 4250 Kw, average 212 Kw.
>
> In addition, comes the largest to date, a turbine with 2100 Kw output standing assembled in the factory.
>
> 72 propeller turbines with a total capacity of 2350 Kw, average 32 Kw, including several 0.35 Kw turbines used for charging 24 V batteries.
>
> 10 Pelton turbines with a total capacity of 1299 Kw, average 86 Kw, as well as several microcrossflow turbines.

A subsidiary in Yen Vien will now concentrate on the smallest turbines and this year they will deliver approximately 40 of them. The main factory will concentrate on the larger ones.

Generators of up to approximately 250Kw are tailor made to the different turbines. Due to the general lack of materials, the larger turbines are made to fit existing generators. As an example, for a 2100 Kw turbine a generator from an old, wrecked diesel generating set was used, repaired and reinforced to withstand the high run-away speed. The original turbine designs came from Czechoslovakia but were modified according to the material available.

Most smaller turbines are manuallay regulated. With the help of the Polytechnic College a prototype of an electric loadcontroller (load dissipator) has been developed. This will in the near future be tested at the site.

The large turbines have mechanical/hydraulic speed governors. The 5 Kw turbine tested in the Polytechnic College as also manufactured at this factory and the intention was that they should also manufacture the necessary models for the new laboratory.

For site testing, a primitive flowmeter was available together with an electric water-resistance. The tests were however, inaccurate because of a lack of suitable instruments. The tests were made with the Institute of Electrical Science and Technology. A new test will be made in the near future on a 150 Kw turbine.

Steel plates were in general difficult to get because they had to be imported, therefore as many parts as possible were cast locally. In the factory itself is a small foundry with an induction oven, sand and centrifugal casting equipment which casts such pieces as guidevanes and runner blades. Runner hub/rim was cast in the neighbouring larger foundry and the complete runner welded together.

Some smaller Francis turbines in the factory had scroll casing cast in two parts, split vertically and bolted together. The larger ones had composite stay-rings made of cast covers and stay vanes welded together, welded to the scroll casing made of conically rolled steel plate sections. X-ray and utrasonic testing equipment as well as ordinary equipment for determining the material yield strength were avaialble. Wear rings, labyrinth seals, bronze bushings as well as white metal bearings were cast in another foundry belonging to the group.

The general impression is that if adequate material is available, the factory has the production facilities and the work force necessary to produce the turbines foreseen in the plans for small hydropower development.

In order to improve the efficiency the clearance between the rotating and stationery parts should be reduced. This will, however, make a precision assembly and erection necessary.

The surface finish of the water conveying parts could be better, as well as the geometrical accuracy of stay, guide and runner vanes.

The production method of the runner vanes will apparently present a problem. They are very thick compared to the runner size, reducing the efficiency as well as increasing the sensitivity to cavitation.

In addition to the turbines under production, a turbine runner with repaired wear rings was seen and this work appeared to be well done.

Steel penstocks, expansion joints, conical draught-tubes were also being made in the factory. Further, a small gatevalve with mechanical seals for an axial turbine was seen. For the larger turbines, several butterfly valves with diameters up to approximately 1 m. were under production. The valve body, as well as the casing with flanges were cast-steel. A completely assembled valve was however, not in the workshop at the time.

The diversity of products made in Dong Anh factory can make a specialized turbine production difficult. The fact that turbines were made to order, the material situation will make mass-production difficult. In Yen Vien factory the turbines represent an even smaller part of the total production.

9. Visit to the Polytechnical College

The Polytechnical College with a capacity of 3000 students has taught the subject of hydro-machinery for 15 years, 13 courses have been completed with 15 students each.

The relevant section, also dealing with subjects like pumps, hydrostatic transmission, wind turbines, has among others, a staff of 12 secondary doctors, 15 science trainees and is headed by Mr. Huynh.

As part of their education or research work, the students have designed and tested over 10 different turbine types, maximum efficiency up to 85%. Some of the turbine types have also been manufactured to a small scale and installed at several places, as examples 5 turbines with approx. 200 Kw at approx. 80 m head and several smaller 0.6 and 1 Kw axial turbines mainly for battery charging.

Drawings shown were large mm-paper, drafting machines were not in use.

Their former test facilities, consisting mainly of larger fumes with associated pipework, pumps and an outdoor flat area for installing river or coastal model structures had been taken over by the Construction College. With a 4 m head test loop the facilities were also used to test a turbine.

The existing test facilities were located outdoors by connection to the machine shop, and had an open loop with two pumps delivering approx. 0.1 m3/sec to a header tank. The flow was mainly measured with a weir, the turbine output measured electrically max. rating approx. 2 Kw. max head approx. 3 m. No advanced or accurate instruments were available but several water columns showed the usual measuring technique. Several turbine models of different types with runner diameter 250 mm were in the shop. Amongst other interesting things a spiral casing with parallel side plates and an outer band welded to the sideplates. A self designed hydraulic speed governor was shown and had been tested.

Recently a 2 Kw electronic governor load dissipator was developed in co-operation with the Dong Anh factory and should be installed at a site in the near future. The design could be used up to approximately 4.5 kw.

Sufficient funds for maintenance and further development were apparently missing.

10. Visit to the Institute of Hydraulic Research

Present among others

Nguyen Thanh Nga, Prof. Dr. UNDP project Director.

Quan Ngoc An, Dr. Head of Coastal Engineering Department, Secretary of UNDP project.

Phan Van Thu, Dr. Head of the Turbine Section

The Institute of Hydraulic Research is a major research institute founded in 1959 and belonging to the Ministry of Water Resources. It is closely connected to the Institute of Water Resources which does teaching. Its 10 ha. premises is adjacent to the Institute of Electrical Science and Technology. The total staff numbers approximately 300, their main activities being:

Fluvial Hydraulics

Hydraulic structures

Coastal Engineering

Hydromachinery

The facilities of the first two sections are now upgraded by large UNDP funds (VIE/80/021) for equipment and all sections are granted a large number of study tours and fellowships.

The coming UNDP budgets will probably also upgrade the other sections. In the hydromachinery section a new test rig for pumps with a 20 Kw dynamometer is foreseen.

The hydromachinery section has a scientific staff of 12, many educated abroad and covering both turbines and pumps. On the turbine side, they have designed and built their own open/closed loop test stand with a vertical, watercooled brake 7 years ago. The waterflow was measured with a venturimeter, and the 75 kw pump had a maximum head of 25 m, a maximum flow at low heads of approximately 0.5 m3/sec.

Several different turbines have been tested, both Francis and Propeller types of their own design. The wheels were made in their own workshops or outside, mainly in the Hanoi Metal Works. Different wheels with runner diameter 250 mm, scrollcasings and related equipment were around. The installed turbines were produced by the institute in the Hanoi Metal Works or in several of the local factories. Since 1985 the activity of the turbine section has been low and most of the equipment around could be difficult to bring back to a proper operating condition.

The activity of the pump section was higher, they were even making castiron pump impellors of their own design as subcontractors for an outside pump factory. The flow of the larger pumps tested was measured by a weir in the open concrete channels, the power as electrical input to the motor.

Besides the technical sections with the different laboratories they had a large supporting "infrastructure", administrative, mathematical sections, workshops for metal and wood, paint shop for the equipment to be mentioned. Further there was a smaller subsidairy in the Ho Chi Minh City and some outside test stations.

Of the yearly budget about 22% came from the Government for basic wages and research grants the rest from contract research.

In the opinion of the people of the Institute of Hydraulic Research, the Ministry of Energy is responsible for hydropower in general but the Ministry of Water Resources is still responsible for most smaller scale hydropower schemes and in particular those connected to irrigation schemes. They expressed the view that both sides could profit from a certain overlapping of the research work and that closer co-operation is possible.

11. Visit to UNIDO/UNDP in Bangkok

a) UNIDO/UNDP in Thailand has not been involved in a project similar to the present project or projects concerning small or rural energy schemes, small hydropower in Thailand. UNIDO/UNDP is however financing only a minor part of the foreign aid to Thailand and it might be that other international agencies have promoted similar projects.

There is a well-equipped hydro power training centre in Thailand and most of the smaller turbines are imported.

b) UNDP is together with ESCAP (Economic and Social Commission for Asia and the Pacific) and other affiliated bodies, maintaining a series of different projects under the main heading: Regional Energy Development Programme. Of these, the project "Regional Network for Small Hydropower" RN-SHP, is important for the present project. Phase III will continue to 1989 with an intermediate conference in July 1988 on the Fiji Islands. Until now 10 different developing countries are participating.

Viet Nam intends to take part from mid-1988 and is now sending a delegate from the Institute of Energy and Electrification, Ministry of Energy, to the conference on the Fiji Islands.

c) UNDP has partly financed Hangzho Regional Centre for Small Hydropower in China, where the RN-SHP secretariat was until recently located, it is now in the Philippines. The different activities are published in the various conference papers and SHP News as well as in the various volumes of the UNDP publication "Small Hydropower Series". Among the publications, is a further survey of experts from the participating countries.

d) The UN Library had no specific information about small hydropower or rural energy programmes for Viet Nam.

e) The main office of the Interim Committee for co-ordination of investigations of the Lower Mekong Basin is situated in Bangkok where Thailand, Laos, Cambodia and Viet Nam are pariticpating. Each country has its local co-ordinating office and in Viet Nam the administrative office is under the Ministry of Water Resources.

Besides studies of larger hydropower projects in Viet Nam, like the Yali Falls scheme the committee have from the beginning taken an interest in the development of small scale hydropower for the rural areas. Besides the identification and evaluation of the power potential, the committee is also interested in the equipment.

A previous study, "Standardization of micro-hydropower components in the Mekong riparian countries" was finalised in 1983. At the moment an interim study "Selection of suitable micro hydropower components for riparian countries" is being undertaken by Leyland Consultant Ltd. after an initial grant of US $ 30,000.- from the government of New Zealand. The Hydro Division of the Institute of Electrical Science and Technology is the Vietnamese counterpart.

12. Criteria for sending people to conferences, seminars

According to the Project Document, A.4, Institutional framework for the subsector, the following should apply:

- General energy planning, energy policy and similar topics:

  Institute of Energy and Electrification, Ministry of Energy.

- Hydrology, calculation of power potential, power production as well as civil engineering design, operation and maintenance of civil engineering components:

  Company of Electrical Survey and Design, Ministry of Energy.

- General layout and design of the electrical and mechanical equipment, operation and maintenance.

  Institute of Electrical Science and Technology, Ministry of Energy.

- Production of electrical and mechanical components, detailed design of the equipment:

  Factories, mainly Dongh Anh for equipment above 100 Kw
  Yen Vien for equipment below 100 Kw

  both belonging to the Ministry of Energy

Conferences on highly theoretical subjects within the field of hydrodynamics could be attended by the staff from the Polytechnical College.

Conferences on irrigation, flood prevention and protection and similar as well as pumps could be attended by the staff from the various institutions within the Ministry of Water Resources.

For topics on the borderline between the responsibility of two institutions, one should try to have one representative from each institution.

RECOMMENDATIONS

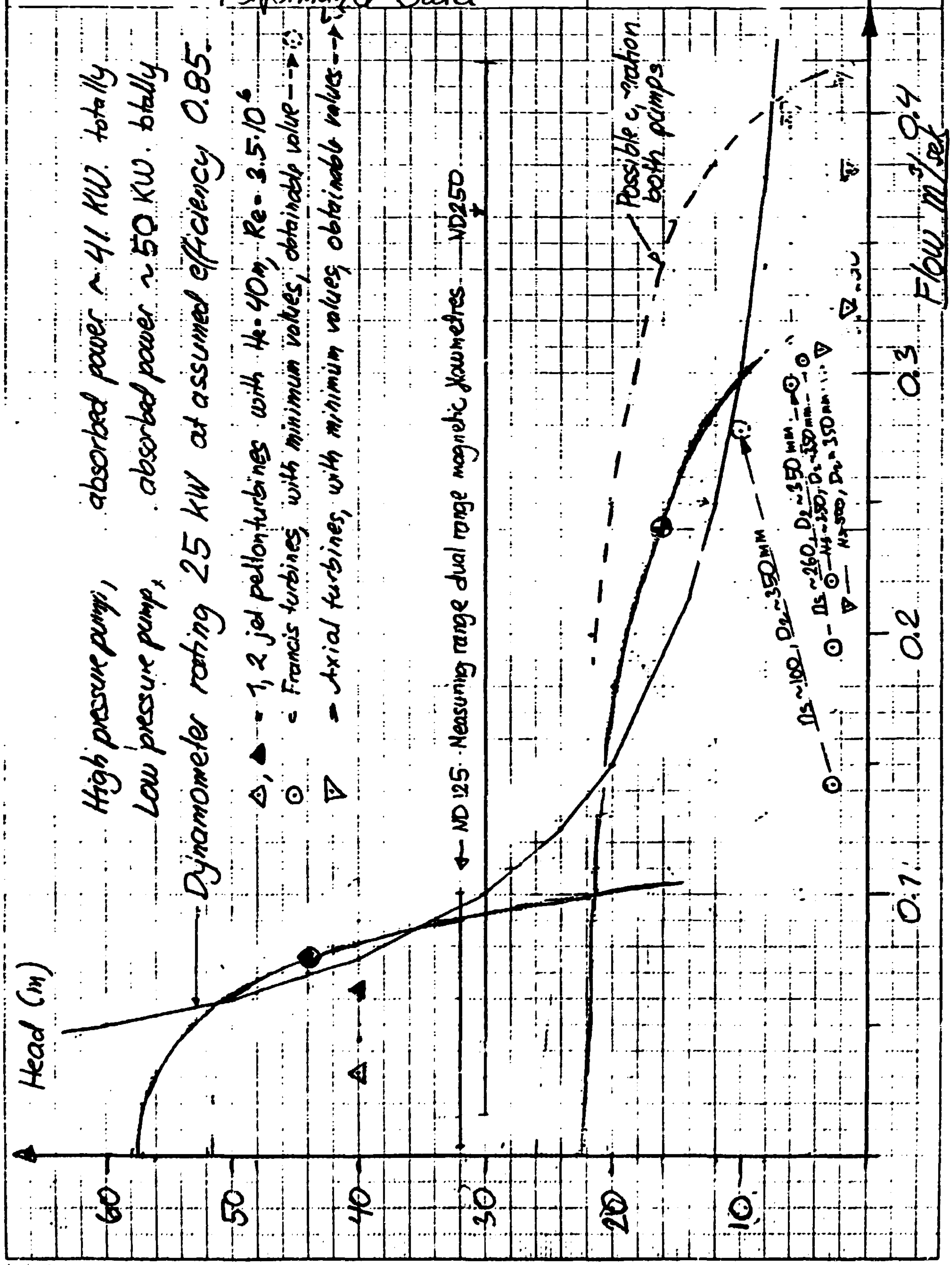
1. Following the outcome of the preparatory assistance assignment it is proposed that a laboratory on SHP equipment testing and related services be established as an extended part of the present Hydro Division of the INstitute of Electrical Science and Technology (IEST) as outlined in the respective drafts of the Project Formulation Framework and Project Document.

2. In order to guarantee the necessary co-ordination and a sound management of the project it is suggested that the proposed institutional framework be arranged including a Project Committee under the IEST and a Steering Committee consisting of members from various universities and institutions involved in the development of SHP and the project concerned.

3. Because of the specific nature of the project it is proposed that the expertise services preferably be arranged under a subcontract.

UNIDO
VIE/86/041
Laboratary
Performance Data

23/6-88
Annexe 1



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Sak: Laboratory	Annexe 2		
Caracteristics of typical models			

++++++ GOVERNEMENT OF VIETNAM, SMALL WATER TURBINE LABORATARY ++++++
+++++ MINIMUM REQUIREMENTS ACCORDING TO IEC 193, PARAGRAPH 2.1 +++++

+++

FRANCIS TURBINES

+++ Requirements: He min. 2.0 m, Ds min. 0.25 m, Re min. 2.5*10^6 +++

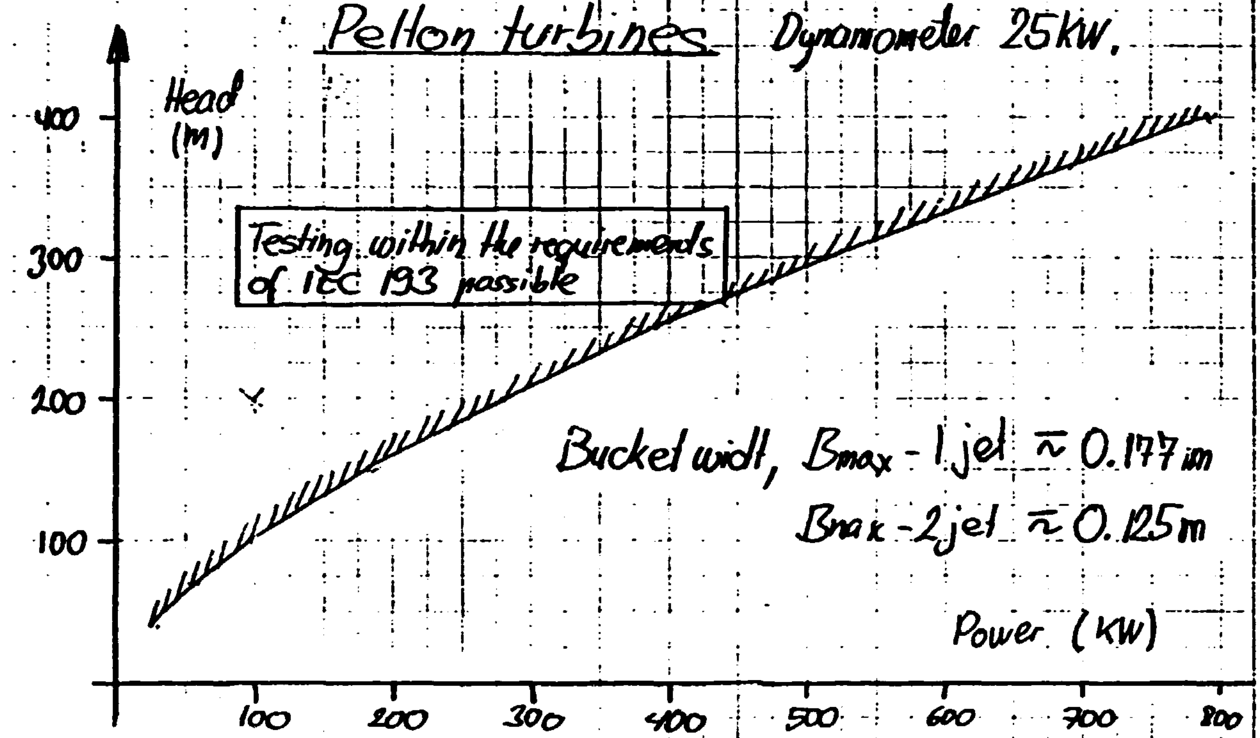
Typical prototype head m:	320	180	95	60
Speed number, selected :	0.30	0.50	0.80	1.18
U2/(19.62 * H)^0.5, by experience:	0.450	0.670	0.930	1.160
Model diameter, selected m:	0.25	0.25	0.25	0.25
Model best flow, selected m^3/s:	0.070	0.087	0.116	0.162
Model best speed, calculated rpm:	345.96	510.90	711.64	886.46
Model best head, calculated m:	5.16	5.08	5.11	5.10
Model best power, calculated KW:	3.19	3.90	5.24	7.29
Model best Re number Re*1.0^6:	2.52	2.50	2.50	2.50
Model max flow, approx. m^3/s:	0.102	0.122	0.157	0.211
Model max power, approx. KW:	4.63	5.46	7.07	9.48
Q11 at best point m^3/s:	0.493	0.618	0.821	1.148
n11 at best point rpm:	38.07	56.68	78.68	98.14
Model suction head, approx. m:	-9.03	-8.65	-7.95	-6.94

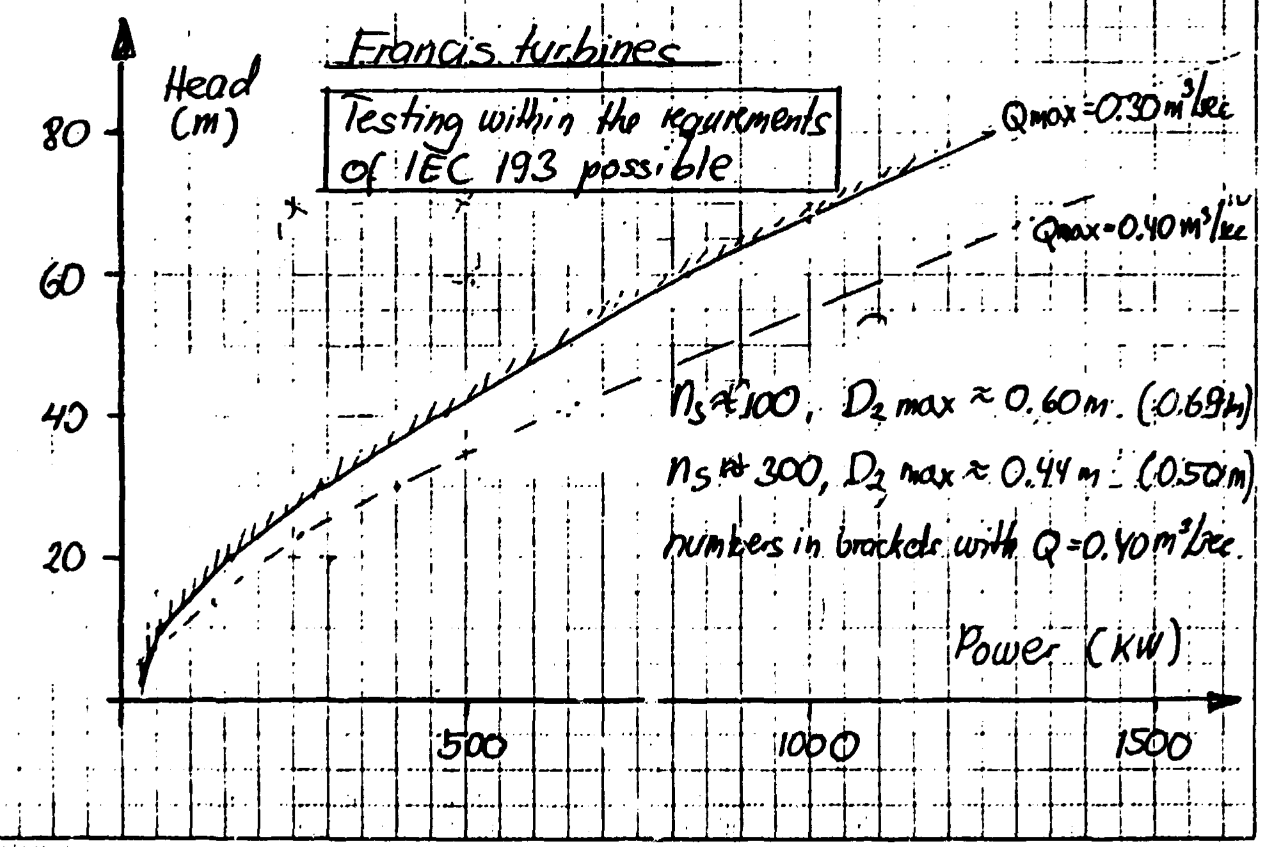
KAPLAN, BULB TURBINES

+++ Requirements: He min. 1.0 m, Ds min. 0.25 m, Re min. 2.0*10^6 +++

Typical prototype head m:	50	30	20	15
Speed number, selected :	1.000	1.500	2.000	2.600
U2/(19.62 * H)^0.5, by experience:	1.25	1.57	1.84	2.06
Model diameter, selected m:	0.25	0.25	0.25	0.25
Model best flow, selected m^3/s:	0.081	0.115	0.149	0.200
Model best speed, calculated rpm:	772.24	965.49	1132.70	1262.47
Model best head, calculated m:	3.33	3.30	3.31	3.28
Model best power, calculated KW:	2.38	3.35	4.35	5.79
Model best Re number Re*1.0^6:	2.02	2.01	2.01	2.01
Model max flow, approx. m^3/s:	0.121	0.173	0.223	0.300
Model max power, approx. KW:	3.58	5.03	6.53	8.69
Q11 at best point m^3/s:	0.710	1.01[illegible]	1.311	1.767
n11 at best point rpm:	105.75	132.8[illegible]	155.66	174.28
Model suction head, approx. m:	-6.51	-4.66	-2.60	-0.20

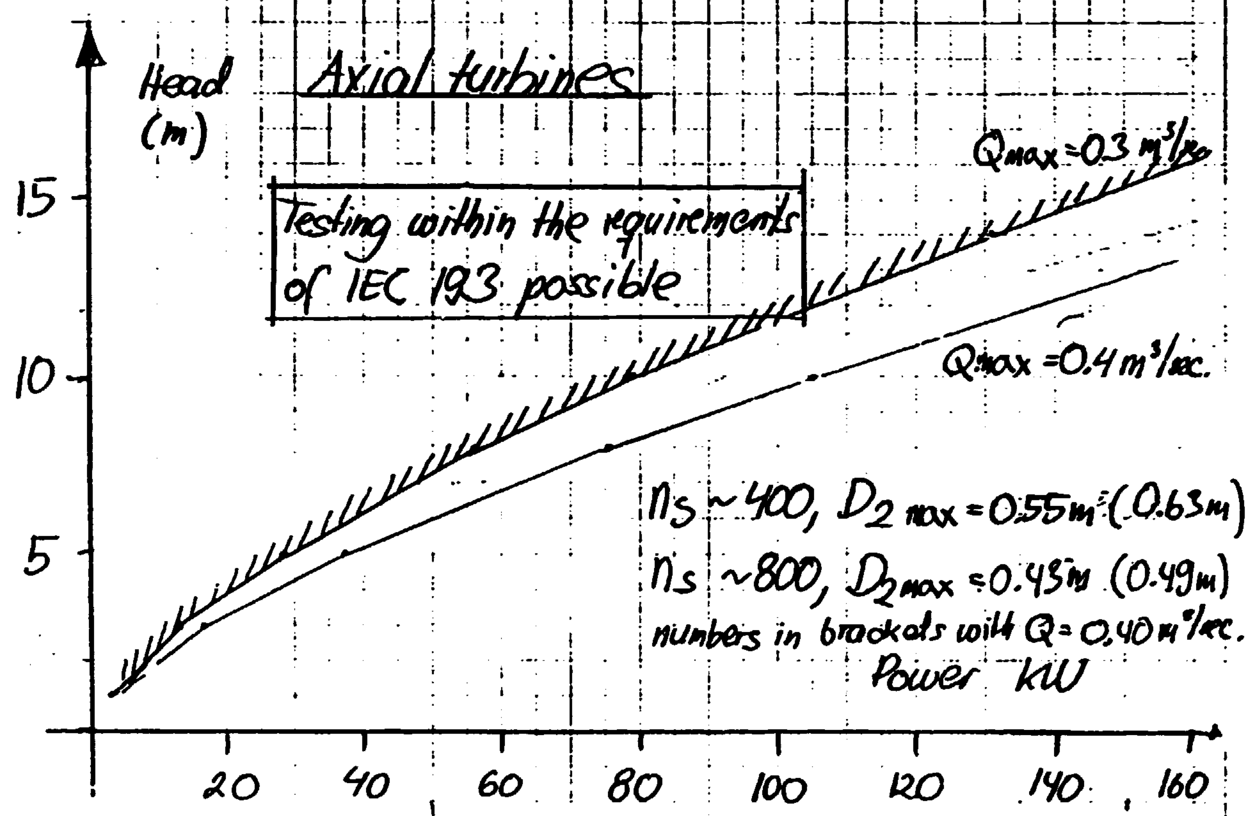
UNIDO VIE/86/041 Laboratory Prototype testing	22/6-88 E Annexe 3





UNIDO
VIE/86/041
Laboratory
Prototype testing

22/6-88 E
Annexe 4



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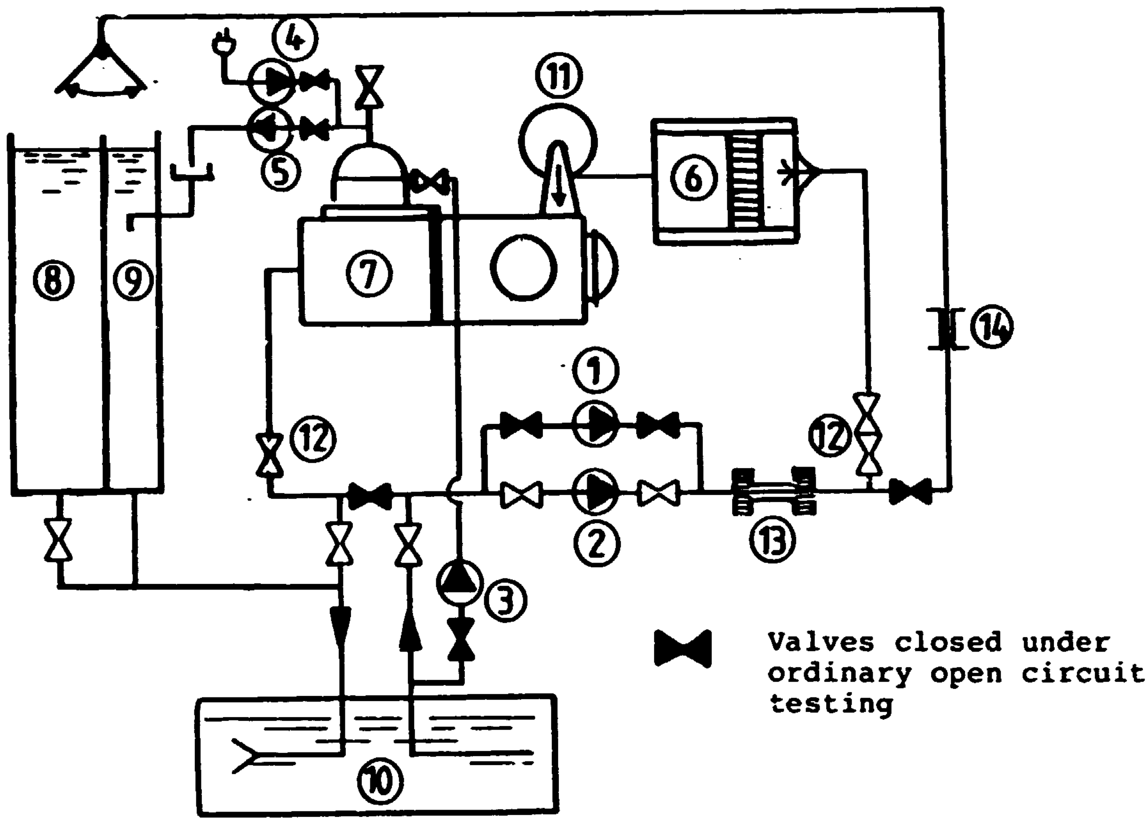
VIE/86/041

ANNEXE 5

LABORATORY

FLOW SYSTEM



1. High head pump
2. Low head pump
3. Make up pump
4. Pressurised air system
5. Vacum system
6. Header tank
7. Receiver tank
8. 40 m^3 tank
9. Bypass tank
10. Water basin
11. Turbine
12. Regulating valves
13. Flow meters
14. Test flowmeter