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ESTABLISHMENT OF MINI/MICRO HYDEL PROJECTS*

by

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International WORKSHOP
On
Technology Transfer Problems in the establishment of Mini/Micro Hydro Units

1. Present position with regard to mini/micro Hydro-electric Plants in India:-

Development of microhydel schemes in India dates back to 1897, when a microhydel scheme was constructed near Darjeeling. This was followed by several schemes to provide power supply to isolated towns, specifically to Hill resorts.

As power development gained momentum in thecountry, attention concentrated not only on development of major hydro-electric and thermal projects and extensive transmission and distribution systems in order to provide power supply at economical tariffs; but interest was taken in the development of micro-hydel schemes as well.

In recent years, attention to provide power supply in remote parts of the country, which cannot be supplied power economically from the main transmission grids, or from other sources like diesel power, has gained urgency in the development of microhydel schemes. These recent developments are mainly concentrated along the Himalayan Ranges in J&K, Himachal Pradesh, U.P., Sikkim and Arunachal Pradesh; and in the hilly regions in Nagaland, Manipur and Meghalaya.

Among the various regions in the country, the Himalayan Region affords considerable scope for microhydel development. The streams in this region carry perenial discharges, assuring dependable availability of power all through the year. They also descend down rapidly, enabling concentration of high heads with relatively short water conductor systems. ANNEXURE I presents a list of microhydel schemes in operation in the various parts of India. It would be seen that the size of the schemes is mainly in the range of 5 KW to 1500 KW.

During this period, we have built up expertise in the country in the design, engineering and construction of microhydel schemes. A couple of manufacturers have also come up and specialised in the manufacture of microhydel generating units of various types and covering a large range of heads. We have also constructed about a dozen microhydel projects in Bhutan and Afghanistan. These have proved successful and more such schemes are being taken up in these countries with Indian assistance.

A couple of years ago, a team of Indian Engineers was invited by the Govt. of FIJI for looking into their hydro-electric potential and investigating some microhydel schemes. The team has completed detailed investigations for 4 Nos. of microhydel schemes in 4 different islands. These will be taken up for construction shortly.

2. <u>Plans for this activity in the next 5 to 10 years:</u> -

(i) For local supply to the remote villages, installation of small units ranging from 100 KW to 500 KW is under active consideration in the States of J&K, Himachal Pradesh, U.P., Sikkim, Arunachal Pradesh, Nagaland, Manipur and Meghalaya. These projects are listed in the enclosed ANNEXURE II.

(ii) For utilisation of small drops in the irrigation canals, installation of tubular and other types of units of capacities ranging from 1 MW to 5 MW is being considered by States like Jammu & Kashmir, Madhya Pradesh, Gujarat, etc. in the country. These projects are also listed in the ANNEXURE II.

3. Research and Development work in this area:-

(i) While topographically the Himalayan Region is very attractive for development of microhydel schemes, the geology etc. of the terrain presents several problems. The streams also carry considerable quantum of silt, boulders etc., particularly during the monsoon period, presenting problem of their exclusion.

The steep hill slopes along which the water conductor systems have to be constructed also present difficulties from the point of view of stability. Protection against these tend to push up the cost of civil engineering features.

The design of diversion weirs, intakes and water conductor systems are being reviewed constantly to bring about economy and improvement so that rising costs can be neutralised and requirements of frequent repairs are kept to the minimum. Among the new designs adopted can be included the "trench type weir", which has been successfully tested in streams carrying silt and boulders.

(ii) Manufacturers have developed standard generating sets with in-built flexibility for different heads, speeds and outputs. Since greater part load efficiences are of not much consequence in case of small units, complicated and costly "Kaplan" turbines are not attractive in application in microhydel installations. Impulse turbines are used for higher heads, and propeller & Francis type reaction turbines are in use for low heads. The axial admission (turgo) impulse units with higher specific speeds for an impulse turbines, effectively bridge the gap between the reaction turbine and the high head peltons wheel. A list of generating units manufactured in the country so far is enclosed in ANNEXURE XIX.

(iii) Static self exciting and self regulating systems providing D.C. excitation in controlled form to the generator field, provide robust and simple generators for most of the microhydel installations.

(iv) In certain instances, where the units have to operate continuously in parallel with adequately strong local supply networks, a simpler arrangement employing induction generators is also being considered favourably.

(v) With more and more potential sites of low head irrigation canal power stations being identified, manufacturers are actively considering development of "tubular" and other appropriate types of turbines suitable for low heads and higher discharges.

4. Lessons drawn in implementation of these schemes:-

(i) Minimum Civil Works:-

The cost of civil works, electrical equipment and establishment charges cannot be reduced proportionately in case of microhydel projects [illegible] making the cost per KW generated substantially higher, as compared with bigger [illegible]. [illegible] present economic conditions, a representative microhydel scheme of say 1000 kw installed capacity with 4 units of 250 KW capacity each, under favourable conditions will cost anything between Rs. [illegible]/-per KW to Rs.14,000/-per KW, depending upon the civil engineering features involved. Out of this, the cost of electrical equipment would be of the order of Rs.22,[illegible] lakh or Rs. [illegible]/-per KW.

Apart from the initial capital cost, the cost of operation and maintenance, particularly repairs of civil structures such as water conductor systems and penstocks, is substantial. These repairs, when required to be carried out occasionally, result in prolonged shutdown of the power station.

Thus the success of a microhydel station depends upon keeping the civil works to the minimum. The microhydel schemes are, therefore, generally designed as run-of-the-river developments for meeting limited power requirements and also to minimise the capital [illegible] construction of storage reservoirs. The storage required for meeting the diurnal variation of load is usually provided in the forebay, instead of at the diversion structures. Streams with sufficient dry weather flows and steep gradients offering ideal possibilities for microhydel development are usually selected for these schemes. A typical layout of a microhydel scheme is shown in the enclosed drawing No. [illegible].

(ii) Necessity of Adequate Investigations:-

Before a microhydel scheme is conceived, minimum necessary investigations have to be conducted. Reconnaissance with reference to anticipated power requirements of the localities have to be assessed over a period of about 10 to 15 years. The discharge observations of the stream near the proposed off-take point, particularly during the lean months, form an important part of investigations. Though it is preferable to have long term observed discharge data for these streams, in the absence of such data, at least 2 to 3 years discharge measurements are necessary to arrive at a reasonable estimation of flow for design basis. Right angled, rectangular or trapezoidal notches constructed across the streams form reliable means for obtaining correct discharges in the hill streams. Besides hydrological observations, necessary topographical and minimum geological investigations are also required to be conducted to establish suitability and stability of ground for power channel penstock etc. Safety under flood conditions is also to be considered.

The tendency to save on the minimum investigations, in order to keep the initial gestation period and cost per KW generated on the lower side, because only a small quantum of power is involved, proves costly in the end; and is not recommended.

(iii) Careful consideration of economics involved:-

Before deciding to construct a microhydel station, a careful study is required to be made of the economics of constructing a microhydel station.

Small villages in remote hilly areas, where water for running the microhydel units can be tapped, are rarely situated within 15 Kms. from any grid. If they are within 15 Kms. from the grid, it is definitely economical to construct 11 kV line. Taking into account the difficult terrain, the cost of 3-phase 11 KV line in these parts is likely to be of the order of Rs.20,000/- per Km. That is, the cost of 15 Km. long 11 kV line will cost only about Rs. 3 lakhs, as compared to Rs.60 lakhs, the cost of construction of a microhydel project of 1000 KW installed capacity.

If the distance from the grid is more than 15 kms. which is likely to be the case, a 33 kV line is required to be constructed. This will serve to transmit 1 MW of power upto a distance of 50 kms. In the difficult terrain, considering the cost of 3-phase 33 kv line to be Rs. 50,000/- per km, the 50-km long line will cost Rs.25 lakhs. Thus the construction of 3 phase 33 kv line to the extent of 50 km is also economical as compared with the cost of construction of a microhydel station within 1 MW installed capacity.

However, in such cases, the increase in the total energy generated in the grid from the microhydel generating units must also be noted; and installation of the microhydel station may be taken up from this point of view. The total per unit cost of power from the grid including the power generated from the microhydel station may go up only marginally, as the quantum of power generated from the microhydal station would be small in relation to the power available from other sources in the grid.

Beyond a distance of 50 km from theg grid, it is hardly worth considering construction of 66 kv line for transmission of power of the order of 1 MW or so. In such cases, a microhydel station can be installed as a means developing the loads in the first instance. Ultimately as the load develops, construction of transmission lines can be resorted to, the microhydel station being used for augmentation of total energy available in the grid.

Sl. No.	Transmission voltage	Maximum distance for 5% to 6% voltage regulation	Power that can be transmitted economically
1.	11 kV	11 km ([illegible] to 20 km)	500 KW
2.	33 kV	33 km (40-50 km)	1 MW to 1.5 MW
3.	66 kV	66 km (50-90 km)	10 MW to 15 MW
4.	132 kV	132 km (120 km)	40 MW to 50 MW

(iv) Installed capacity of microhydel schemes:

Earlier, microhydel projects were defined as hydel stations having a total installed capacity of about 1000 kw or less, with generating units installed being either a single unit of 1000 kw capacity, or a number of smaller units with a total capacity of 1,000 kw.

Now because of shortage of fossil fuels, and pollution problems, interest in utilising small canal drops for installation of hydel units of upto 2-3 MW capacity is building up. These sets are being used for supplying power to irrigation pumping sets for utilising sub-soil water, and for augmentation of power generation in the grid.

It will, therefore, be necessary to classify hydel stations having a total installed capacity of upto 5 MW, as micro/mini hydel stations.

(v) Operation and Maintenance:

Because of the remoteness of most of these microhydel stations, it is usually difficult to get trained personnel to run and maintain these power stations. The trend is, therefore, to design and manufacture units which are simple to run and maintain, so that the microhydel installations can be manned even with untrained personnel, who will be able to take charge of the power stations, after only a few days' lessons/training in power station itself. Subsequently, when the area grid gets extended to cover these remote areas, it will be advantageous to run the micro units in parallel with the main grid. This would require some simplification of turbine governors etc., so that fluctuations of outputs and voltages of the micro units is minimised and attention need be given to this aspect.

5. Socio-Economic Aspects:-

The per capita electric power consumption, now-a-days, is considered to be an index of advancement and well-being of any society. Since Independence in 1947, India has also taken long strides in the generation and utilisation of electric power. As against the total installed capacity of about 1700 MW in 1947, Generating Units thermal, hydro, and nuclear, totalling to about 22000 MW, have been installed through sustained and planned efforts during the last 30 years.

However, because of the peculiar geographical features, a large number of remote villages in the hilly regions have yet to see an electric light in their vicinity. In order to make these villages aware of the advantages of use of electricity, and to bring them in the mainstream of development being achieved in the rest of the country by raising their standard of living, it is necessary to make electric power available to them by constructing microhydel projects, and extending transmission lines. Even in certain areas of plains, where small falls in canals or rivulets are available, installation of microhydel projects at these locations can also prove useful for supply of electric energy to surrounding areas independently or in conjunction with the grid supply, if and when available.

Microhydel schemes can play a major and very important role in such electrification of remote villages, thus contributing in the Rural Electrification Programme presently being implemented, which makes considerable social impact on the local population. The higher initial capital costs and higher operation and maintenance costs in case of many of these projects, as compared with the major hydel projects should be viewed, in the context of the social aspects, the alternatives for energy supply in a time perspective, as also a long range view of energy sources. With the social aspects being foremost in considerations, long term loans at concessional interest rates as well as special consideration given to lower returns in such cases, could be viewed in relation to financial viability of the schemes.

6. Technology Transfer and suggestion for programme suited for countries of ESCAP Region.

The quantum of power available from microhydel stations being small, these schemes do not get into the limelight in the power development of any country. The practices adopted in the construction of modern and bigger power stations do not necessarily suit the construction of such small stations. The requirement of equipment for microhydel stations is also limited; and many manufacturers of hydel generating units are not attracted to develop small units. Even in a big country like India, where sites and conditions for microhydel development are favourable, therex are hardly a couple of firms manufacturing small units.

It is, therefore, necessary that whatever technology transfer is to take place on this subject, has to be on International basis, to be of some significance. The private manufacturing companies cannot be expected to take lead in this matter, on purely commercial considerations; and steps in this regard should therefore better be initiated by the Stage Governments themselves.

Most of the countries in the Asian and Pacific region being developing countries, are way behind in electric power generation, and are facing similar problems in this field, such as advancement and simplification of technology and financing problems. Exchange of technology could, therefore, be beneficial. India has developed expertise in the planning, design and construction of microhydel schemes as well as in the manufacture of small generating units and associated switchgears, which it could make available. India can advise countries in the ESCAP region on:-

1. Conducting of preliminary surveys for the collection of hydrological, topographical, geological and electric power demand data for that country.

2. Identifying potential sites for mini/micro/hydro-electric development.

3. Investigations of such projects and preparation of project reports.

4. Supply of microhydel generating units and associated switchgear and control panels.

5. Construction of civil structures, installation, commissioning and testing of the generating units and other equipment at the microhydel power stations.

6. Operation and maintenance of the microhydel schemes.

ANNEXURE - I

MICROHYDEL PROJECTS UNDER OPERATION

Sl. No.	Name of the Project	Gross Head (M)	Installed Capacity
I. Uttar Pradesh:-			
1.	Garur	21	1 x 25 kw
2.	Bageshwar	50	1x50 + 1x18.4 kw
3.	Champawat	76	2 x 100 kw
4.	Uttarkashi	93	3 x 200 kw
5.	Bhatwar	107	2 x 25 kw
6.	Dharasu	12.2	1 x 25 kw
7.	Barkat	13.7	1 x 5 kw
8.	Rudraprayag(Interim)	55	1 x 30 kw
9.	Genti Chera	300	2 x 100 kw
10.	Deoprayag	89	2 x 50 kw
11.	Rudraprayag (Tilwara)	65.5	2 x 100 kw
12.	Chamoli	110	3 x 200 kw
13.	Guptakashi	230	2 x 100 kw
14.	Badrinath (Interim)	30.5	1 x 30 kw
15.	Simli	12.2	1 x 5 kw
16.	Pipalkoti (Interim)	12.2	1 x 5 kw
17.	Joshimath (Interim)	-	1 x 25 kw.
II. Himachal Pradesh:			
1.	Nogli	72	2x250 + 4x500 kw
III. Jammu & Kashmir:-			
1.	Jammu	-	2 x 800 kw
2.	Udhampur	-	2 x 320 kw
3.	Rajouri	-	1 x 560 kw
4.	Ponch	-	3x98 + 2x30 kw
5.	Bhandurwah	-	1 x 560 kw
IV. Arunachal Pradesh:			
1.	Pussighat	55	2 x 100 kw
2.	Rahung	126	3 x 250 kw
3.	Basar	125	3 x 50 kw
4.	Dirrang	-	1 x 40 kw
5.	Kalaktang	12.2	1 x 10 kw

6.	Takeing	-	1 x 10 kw
7.	Bomdila	122	3 x 30 kw
8.	Tezu	44	4 x 100 kw

V. Manipur:

1.	Leimakhong (Stage I)	-	600 kw.

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ANNEXURE II

MICROHYDEL SCHEMES UNDER EXECUTION

Srl.No.	Name of Project	Gross Head (M)	Installed Capacity
I. Uttar Pradesh:			
1.	Koti	46M	2x100 kw
2.	Charchula	278 M	2x100 Kw
3.	Harsil	177.7 M	2x100 kw +1x300 kw
4.	Pandu Keshtwar	117 M	3x250
II. Himachal Pradesh			
1.	Rungtong	44 M	2x80kw + 2x250 kw
2.	Holi	173 M	3x1500 kw
3.	Killar	37 M	2x50 kw
4.	Rukti	79 M	4x375 M
5.	Sissu	27.7 M	2 x 50 kw
6.	Thirot	256 M	2 x 1500 kw
7.	Baner	173 M	4 x 1500 kw
8.	Neogal	156 M	4 x 1500 kw
9.	Binwa	230 M	3 x 2500 kw
III. Jammu & Kashmir:			
1.	Tangdar	-	2 x 300 kw
IV. Arunachal Pradesh:			
1.	Along	36 M	4 x 100 kw
2.	Towang	221 M	4 x 500 kw
3.	Zero	213 M	4 x 500 kw
4.	Dirrang	136 M	3 x 500 kw
5.	Tuting	36.5 M	3 x 50 kw
6.	Kalaktang	12.8 M	3 x 10 kw
7.	Taksing	-	3 x 10 kw
8.	Anini	-	2 x 50 kw

V. Manipur:

1.	Leimakhong (Stage II)	79 M	3 x 100 kw
2.	Nangarugkhong	-	300 kw
3.	Kharamlak	-	1500 kw
4.	Likrurilok	-	50 kw
5.	Lokchao	-	500 kw

VI. Bhutan:

1.	Mongar	182.5 M	3 x 130 kw.

VII. Afghanistan:

1.	Bamiyan	27 M	3 x 250 kw.
2.	Samangan	42 M	2x100 kw + 3x100 kw
3.	Faizabad	54 M	3 x 85 kw.

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LIST OF MICRO HYDEL GENERATING UNITS (SUPPLIED BY M/S JYOTI LIMITED) INSTALLED

Sl No.	Year of supply	Site	State	Type	Quantity	Capacity	Head M	Discharge LPS
1	2	3	4	5	6	7	8	9
1.	1965	Moticher on Kakrapar weir	Gujarat	900 HPT	1 No.	250 Kw	15.8	2900
2.	1965	Lahaul & Spilti Valley	Himachal-Pradesh	450 VF	5 Nos.	50 Kw	25.0	355
3.	1964	Barapani	Assam	9-B-25	2 Nos.	25 kw	61.0	68
4.	1965	Genthi Chhera	U.P.	27AP-100	2 Nos.	100 Kw	266.0	545
5.	1965	Champawat, Almora	U.P.	30P-100	2 Nos.	100 kw	155.0	111
6.	1966	Lahaul & Spilti Valley	Himachal Pradesh	500 VFIA	3 Nos.	100 kw	25.0	730
7.	1966	Bijanbari Darjeeling	West Bengal	[illegible]-1000B	2 Nos.	1000 kw	250.0	590
8.	1966	Rudraprayag, Garhwal	U.P.	16.5B-100	2 Nos.	100 kw	61.0	590
9.	1966	Guptakashi, Garhwal	U.P.	27 AP-100	2 Nos.	100 kw	221.0	645
10.	1966	Dharasu Garhwal	U.P.	200 VFIO	1 No.	5 kw	12.2	71
11.	1966	Simli, Distt. Garhwal	U.P.	[illegible]00 VFIV	1 No.	5 kw	12.2	71
12.	1966	Simli, Distt. Garhwal	U.P.	200 VFIO	1 No.	5 kw	12.2	71
13.	1966	Pipalkoti	U.P.	200 VFIO	1 No.	5 kw	12.2	71
14.	1966	Bukti Khad	Himachal Pradesh	250 VF5A	2 Nos.	50 kw	36.5	207
15.	1966	Mehbar Khad	-do-	250 VF5A	2 Nos.	100 kw	58.0	304
16.	1967	Garur, Distt. Chamoli	U.P.	250 VF5A	1 No.	25 kw	20.0	191.5

1	2	3	4	5	6	7	8	9
17.	1967	Bageshwar, Distt: Chamoli	U.P.	250VF3A	1 No.	50 kw	44.2	166
18.	1967-68	Uttarkashi Distt:Garhwal	U.P.	16.5T-250	2 Nos.	250 kw	90.0	425
19.	1967-68	Chamoli	U.P.	16.5T-250	2 Nos.	250 kw	108.0	354
20.	1968	Nogli	Himachal Pradesh	400HFO	2 Nos.	500 kw	72.0	1000
21.	1969	Kdarnath (Harsil)	U.P.	30P-100	2 Nos.	100 kw	114.0	130
22.	1969	Gharola Scheme	Himachal Pradesh	9B-50	1 No.	50 kw	94.5	84
23.	1969	Badrinath(Pandukeshwar)	U.P.	16.5T-250	2 Nos.	250 kw	99.0	335
24.	1969	Bhatwari	U.P.	15AP-25	2 Nos.	25 kw	107.0	35
25.	1969	Deoprayag	U.P.	9B-50	2 Nos.	50 kw	87.5	85.5
26.	1969	Pangi	Himachal Pradesh	250VFeA	2 Nos.	50 kw	40.8	135
27.	1969	Jorthang	Sikkim	15.5T-100	2 Nos.	100 kw	78.0	190
28.	1969	Rongli	Sikkim	300 VFIB	2 Nos.	50 kw	30.0	250
29.	1969	Manule	Sikkim	400 VFIO	1 No.	100 kw	30.5	500
30.	1969	Phoobsering T.E.	West Bengal	15P-50B	1 No.	50 kw	257.0	33.1
31.	1969	Namring T.E.Distt: Darjeeling.	West Bengal	30P-100	1 No.	100 kw	131.0	133.5
32.	1969	Nagri Farm T.E.	West Bengal	15P-50B	1 No.	50 kw	189.0	4[illegible]
33.	1969	Wangdi	Bhutan	16.5T-100	3 Nos.	100 kw	712.0	193
34.	1970	Koti	U.P.	300VFIO	2 Nos.	100 kw	40.0	332
35.	1970	Rimbi	Sikkim	300VFIC	2 Nos.	100 kw	36.6	410
36.	1970	Thubro, T.E.	West Bengal	30P-100B	1 No.	100 kw	165.0	93.5

1	2	3	4	5	6	7	8	9
37.	1970	Imphal	Manipur	13.5B-100	3 Nos.	100 kw	76.5	190
38.	1970	Kalaktang	Arunachal Pradesh	250VFIB	2 Nos.	10 kw	12.2	133
39.	1970	Tewang	-do-	200VFIC	1 No.	5 kw	12.2	71
40.	1970	Goroka	Papua & New Guinea	350HFIB	1 No.	200 kw	63.1	478
41.	1971	Rehung	Arunachal Pradesh	16.5T-250	3 Nos.	250 kw	133.0	267
42.	1971	Besar	-do-	9T-50E	2 Nos.	50 kw	97.6	75.5
43.	1971	Passighat	-do-	250VF3B	2 Nos.	100 kw	53.3	283
44.	1971-72	Dharchula	U.P.	21P-100	2 Nos.	100 kw	275.0	52
45.	1972-73	Tashigaon	Bhutan	16.5-250	3 Nos.	250 kw	171.0	213
46.	1972-73	Gidakom	-do-	16.5T-250	5 Nos.	250 kw	171.0	213
47.	1972-73	Chardeh Ghorband	Afghanistan	13.5T-100	3 Nos.	100 kw	76.5	190
48.	1973	Along	Arunachal Pradesh.	400VFIC	4 Nos.	100 kw	30.5	594
49.	1973	Tuting	-do-	250VF3A	3 Nos.	50 kw	36.5	207
50.	1973	Mongar	Bhutan	30P-130	3 Nos.	130 kw	180 kw	142
51.	1973-74	Kohima	Nagaland	16.5T500E	3 Nos.	500 kw	180	400
52.	1974	Lakhimpur	Assam	350HFIB	3 Nos.	220 kw	61	600

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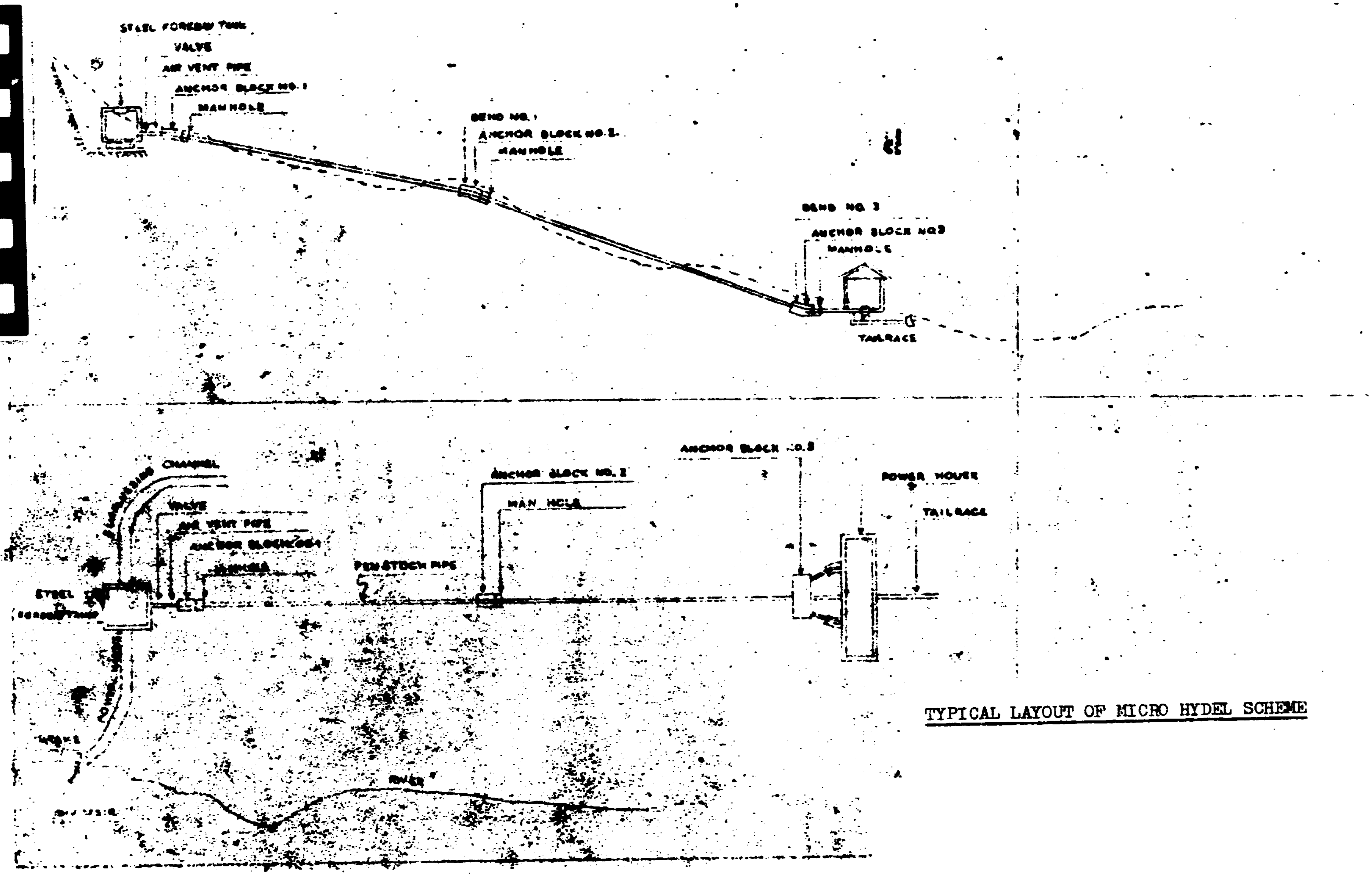

TYPICAL LAYOUT OF MICRO HYDEL SCHEME

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.

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