THESIS

MAXIMIZATION OF HYDROPOWER PRODUCTION AT POWER HOUSE No. 3 FOR KURRAM TUNGI DAM PROJECT

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ABSTRACT

Constant availability of flow plays an important role for power production. Power house-III for Kurram Tangi Dam Project was planned in Cascade with no storage reservoir. High variations in flow through the year (maximum available flow was 1970 cusecs and minimum flow was 380 cusecs), resulted high variations in turbine efficiency. Two Francis turbine units each with rated discharge of 1000 cusecs are being planned by Kurram Tungi Dam Consultant but are not giving the maximum hydropower production for low discharge value such as 380 cusecs (minimum flow available throughout the year).

Rated/design discharge values were adjusted as near possible to cater for the minimum flow available to keep the turbine efficiency as high as the peak value. This was done by increasing the number of turbine units from two to three, four and five with the rated discharge of 657 cusecs, 492.5 cusecs and 395 cusecs respectively.

Their behaviour to increase the annual power production and annual energy is computed using the turbnpro software. This software gives the hill efficiency curve which in turn gives the peak efficiency of turbine for the particular rated discharge and maximum head. Hill curves are developed and comparison of efficiencies against different discharge values was observed.

Power tunnel diameter was also enlarged to observe the effect of reducing the head losses on annual power production. Power tunnel with different diameters of 16 ft (originally designed), 18 ft, 20 ft and 22 ft resulted in considerable increase in power production.

Economic analysis reveals that increasing the number of Francis Turbine units from two to three numbers increases the net incremental benefits whereas the further increase to four and five number of Francis Turbine units decreases the net incremental benefits (though the benefits remain greater than the cost for all set of Francis Turbine numbers). Whereas net incremental benefits decreases at the lesser rate when the power tunnel diameter is increased from 16 ft. to 18 ft, the rate of decrease becomes rapid when the power tunnel diameter is further increased to 20 ft. and 22 ft.

Net incremental benefits with installation of two Francis Turbine units were 1140.72, 1121.51, 1081.06 and 1028.43 (Million Rupees) for power tunnel diameter 16 ft., 18 ft., 20 ft., and 22 ft. respectively. Net increment benefit with installation of three turbine units were 1153.31, 1135.49, 1096.44 and 1043.46 (Million Rupees) for power tunnel diameter 16 ft., 18 ft., 20 ft., and 22 ft. respectively. Net incremental benefit with installation of four Francis Turbine units were 1017.38, 999.57, 960.51 and 907.89 (Million Rupees) for power tunnel diameter 16 ft., 18 ft., 20 ft., and 22 ft. respectively. Net incremental benefit with installation of four Francis Turbine units were 884.26, 867.14, 828.09 and 775.60 (Million Rupees) for power tunnel diameter 16 ft., 18 ft., 20 ft., and 22 ft. respectively.

Economic analysis (where investment is made by the public sector) allows to opt the installation of three Francis Turbine unit with 18 ft. power tunnel diameter with reduced benefit cost ratio as compared with the installation of two Francis Turbine units with 16 ft. tunnel diameter. Financial analysis (where investment is made by the private sector) restricts to the installation of two Francis Turbine units thus to maximize the profit.

Three Francis turbine units with the rated discharge of 657 cusecs with 18 ft. power tunnel diameter is strongly recommended which maximizes the annual energy from 81.48 GWH to 84.36 GWH (with the net increase of 2.88 GWH of annual energy). Benefit/ cost ratio being 1.63.