

Lower St. Anthony Falls HYDROMATRIX® – A Success Story for Low Impact Hydropower at existing US dams

Abstract

Lower St. Anthony Falls Locks and Dam on the upper Mississippi River is a new example of an existing navigation dam in the United States licensed for hydropower generation using the HYDROMATRIX® concept. The development and construction of this run-of-river hydropower facility is a collaboration between SAF Hydroelectric LLC, the US Army Corps of Engineers and VA TECH HYDRO. The construction project is anticipated to start in April of 2007 and is currently in its final development phase.

Introduction

For the past 5 years, VA TECH HYDRO has worked on the development of hydropower projects at existing navigation dams, retired lock structures, and other existing dam and gate structures around the World using the HYDROMATRIX® concept. The realization of four projects within this time period is a testament to the technical and economical viability of this innovative renewable resource technology.

The HYDROMATRIX® Concept

The HYDROMATRIX® concept is a patented technology utilizing an array of small propeller type turbine-generator units (“TG-Units”). These TG-Units are arranged in a matrix-type configuration to utilize the existing civil structure and to fit into an existing water passage. The TG-Units are mounted onto a steel structure, also called a Module. The Module design is integrated into the existing civil structure, requiring only minor modifications, if any, to the existing structure and allowing continued operation of the Locks and Dam. In one of the various possible configurations, the Module contains only the TG-Units (see Figures 1 and 2).



Fig. 1 – Modules at Jebel Aulia Dam housing 2 TG-Units in horizontal configuration. Modules shown in raised position from upstream side, yellow gantry crane to lift Modules, 40 Modules, total plant output 30 MW.



Fig.2 – Turbine Generator Unit at Jebel Aulia Dam

In another application, the module may also house the complete electrical and auxiliary equipment for the power plant itself (see Figures 3 and 4).

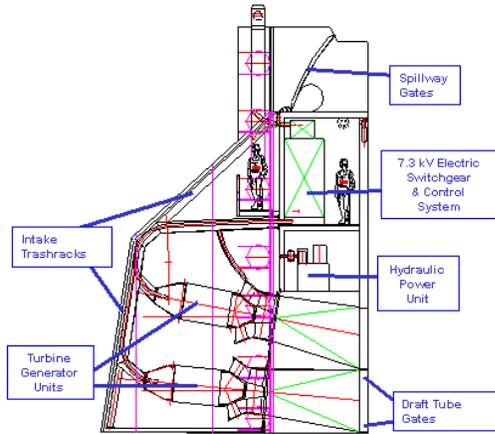


Fig 3
Cross Section of a Module housing 34 TG-Units and complete electric switchgear equipment

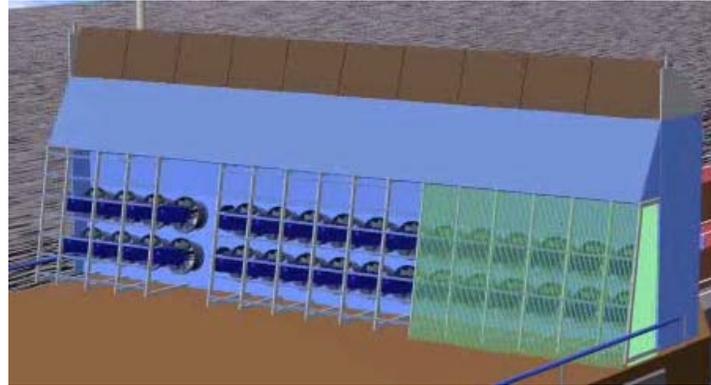


Fig. 4
Module (seen from upstream side)

Lower St. Anthony Falls Lock and Dam

Lower St. Anthony Falls (LSAF) Lock and Dam is located on the Mississippi River on the right bank of the river in Minneapolis, Minnesota. The project is bordered by Hennepin County on all sides and is virtually in the center of the metropolis (See Fig.4). LSAF forms part of the Inland Waterway Navigation System and was built by the US Army Corps of Engineers (Corps) between 1950 and 1956. It consists of a main lock, an uncompleted auxiliary lock, a dam section equipped with radial gates, a non-overflow concrete dam, and a non-overflow earthen dam (See Figures 5 and 6).

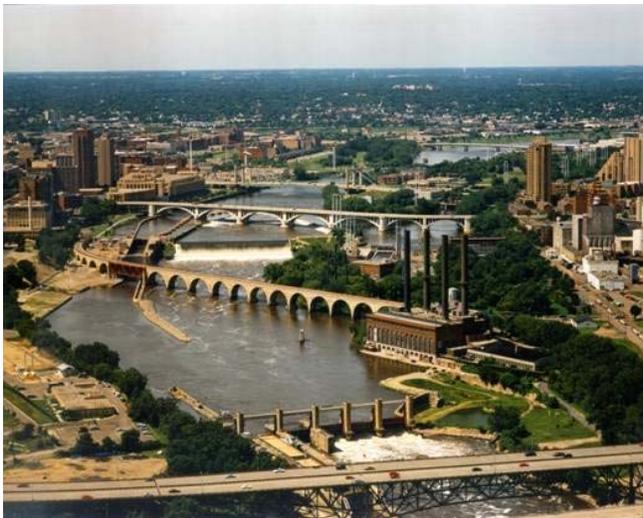


Fig.5: Aerial view of Upper and Lower St. Anthony Falls, Minneapolis

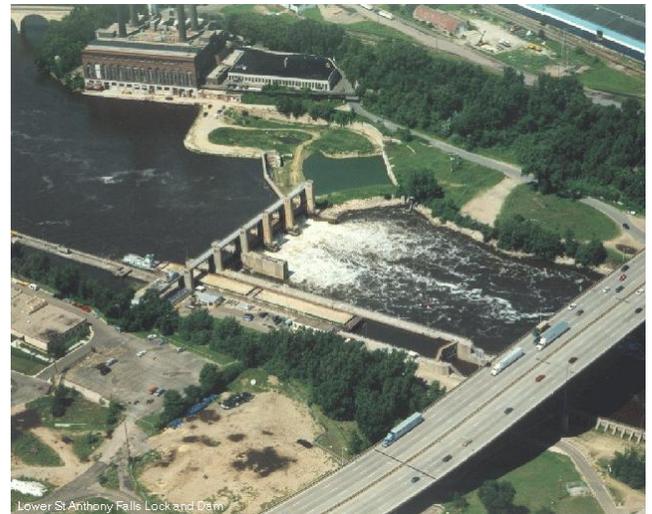


Fig. 6:
Aerial view of Lower St. Anthony Falls Locks and Dam

While the main lock is fully functional for navigation, the auxiliary lock consists of only an upstream gate bay. The upper gates in both locks are submersible radial gates, which can be

used to discharge high flows in case of flooding. The pool level upstream of LSAF is maintained at 750 feet A.S.L. and the tailrace level ranges between 722 and 735 ft. A.S.L. depending on the river flow.

The dam section equipped with radial gates extends from the auxiliary lock to the non-overflow closure dam located on the left bank of the main river channel (Fig. 5) and consists of three 56 foot wide radial gates. The gates are submersible up to 6 feet below nominal upper pool level to help in passing ice or debris.

The concrete non-overflow dam is approximately 230 feet in length with a top elevation of 755.0 feet. Xcel Energy operated a hydropower plant adjacent to the non-overflow concrete portion of the dam from 1897 until the powerhouse collapsed in November 1987 and was replaced with a non-overflow earthen dam with an elevation of 757.0 feet. (Fig 5). Xcel Energy determined that replacement was not feasible and removed the project from their FERC license for the Upper St. Anthony Falls project.

Development and Licensing process of Lower St, Anthony Falls

The development of the new Lower St. Anthony Falls Project began in 2001 when SAF Hydroelectric LLC filed a preliminary permit at the project site. Subsequently SAF filed a license application in January 2004 and received a license from the Federal Energy Regulatory Commission (FERC) in February 2006. The project also applied for and was selected for a Renewable Energy Grant from Xcel Energy. This \$2,000,000 grant was awarded from the Renewable Energy Development Fund which was mandated by the Minnesota State Legislature. Project development has required extensive coordination with the Corps of Engineers regarding the use of the auxiliary lock structure and operational and construction activities at the Corps facility.

The Lower St. Anthony Falls Hydroelectric Project

The latest example of VA TECH Hydro's HYDROMATRIX[®] technology can soon be found at the Lower St. Anthony Falls Lock and Dam. The 10 MW plant has been developed by a private development group and will be installed in the existing auxiliary lock owned by the US Army Corps of Engineers. Start of site construction is scheduled to begin in late spring of 2007 with completion of the project in summer of 2008.

The LSAF Hydroelectric Project will consist of the following main facilities:

- Eight removable steel modules, each module containing two (2) horizontal 4.16 kilovolt (kV) turbine-generator units (TG-Units) positioned in the module, one above the other in a vertical arrangement
- An "Obermeyer" spillway gate located at the top of the retaining wall
- An overhead traveling gantry crane to raise and lower the TG-Units spanning across the two locks.
- An outdoor switchyard housing the main transformer and switchgear
- A 13.8 kV underground primary transmission line
- A control building to house the control system and part of the station service system



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