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Client: Kennebunk Electric Power and Light District
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Contact: Todd Shea, General Manager
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Task: Review of Hydro Generation Electrical Condition

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GENERAL COMMENTS

POND LEVEL CONTROL:

To be able to maximize the output of the stations a pond level control system should be considered at each site. Typically pond level control improves power production by approximately 10+ % for a station. I can provide examples of sites where pond controls were installed and which have now realized the large amount of generation lost over the years. Site visits can be arranged. This would be money well spent by KPLD and the return should pay for itself after just a very few years. See site specific notes relative to pond level control for each site further on in this report

TURBINE GUIDE BLOCK MAINTENANCE:

Proper maintenance of the turbine guide blocks is critical to good operation of a vertical water turbine. Failure to properly maintain these blocks will result in turbine wear and very significant loss of power producing ability. Most sites I deal with adjust block monthly.

Existing mechanical wear to the rotating components must be repaired before any production improvement is to be realized. When repairs are completed a monthly program will be necessary to maintain the guide block adjustment. While repairs are being accomplished a complete examination of the turbine runners and wicket gates, wicket gate adjustment, and wear in the linkage and bull rings should be accomplished. Any wear and cavitation or holes in the blades or runners should be fixed. A simple example would be wear in the gate linkages not allowing the actual gate to go fully open

even when the bull ring is in the full open position thus not allowing full possible power available from the flow and head pressure.

All these issues are critical to maximizing output and efficiency of the machine, these issues add up and pay for themselves in short order when corrected.

RENEWABLE ENERGY CREDITS:

KPLD may be eligible to receive payment for Renewable Energy Credits (REC's) based on the generation of power by hydro. Hydro being a non-carbon, green energy footprint source of energy and renewable allows the producer to go to the market place and sell his REC's to any business who is a producer of high carbon footprints. I have several contacts in the hydro business who sell REC's (not energy) to business in RI, Ma and Ct.

The contacts I deal with who are in this program tell me they receive approximately 2 cents per KWH of energy produced. This added to the value of the energy produced now averaging 3 cents per KWH brings the value of the energy production to 5 cents / KWH, this can change the financial viability of a site. The REC payment has nothing to do with where the actual energy is sold or consumed or value received for the energy. This feature can enhance the image of the hydro power production for KPLD. This is almost free money available for the asking.

OIL LEAKAGE

Any efforts up front to control or eliminate oil leakage from various hydraulic systems or oil lubricated bearings could play a significant bonus in any relicensing efforts. Presently each station does show various oil leaks that have the potential to enter and contaminate the river water. The various watchdog groups would make a very significant issue of any oil found in the water. Impact on relicensing efforts could be significant. This effort should not be limited to applying absorbent materials but should go the root cause of the leaks, replacing gaskets, O rings, torque up fittings, clean joints, replacing hydraulic hoses and whatever else that is identified as an issue.

HISTORICAL SITE MAINTENANCE

I have had an association with KPLD for approximately 25 years, primarily dealing with the electrical side of the hydro generation. I have always been told that we cannot spend any money as we may not keep the sites operational. KPLD is now at the point that some money will be absolutely necessary if these sites are to continue operating. Proper application of funds can increase the output of the sites and should make them an asset to KPLD and the rate payers.

TAKE ADVANTAGE OF ALL THE WATER AVAILABLE

While I was at the sites; water was going over each dam and no site was running. Each site was reported as able to run. This is obvious lost production and revenue. Pond level controls can help with this issue.

SITE SPECIFIC OBSERVATIONS

DANE PERKINS

Dane Perkins site is a machine of approximately 125 KW ability as installed. I believe I recall having been told in the past that the machine as originally built for the Crane Paper site in Dalton, Massachusetts and it was for a slightly higher head than is available at this site.

WINDINGS

The last time I examined the generator windings they were not new but in acceptable condition for several more years use.

GUIDE BLOCKS

During my visit Tuesday I asked about adjustment of the turbine guide bearing blocks. The response was in 5 years this has never been done. Normal maintenance practices are to adjust these blocks monthly. The purpose of the blocks is to keep the runner centered in the casing. Based on the response I can safely predict that the runner blades have been well worn and that a lot of water is leaking by the runner. A safe estimation is that approximately 10% of the possible power producing capability has been lost. When repaired and restored the result could be that the energy effectively would be worth 10% more.

The guide bearings are normally manufactured from Lignum Vita wood, a very dense hard wood that is worked using metal cutting tooling. The sand / grit in the river water wears these bearings, hence the monthly adjustments required.

SWITCHBOARD

The switchboard at this site is now and has been for some time beyond any safe and reliable service. No drawings and/or wiring diagrams exist for this switchboard and control. The generator breaker is in extremely poor condition; a few years ago it was possible to close the breaker such that it could not trip on a fault detection situation. This breaker is very difficult to get to properly latch closed. The site has open /exposed 2400 volt controls and power wiring and devices that could easily be contacted by someone working at the site. Electrically this site is dangerous. If any continued operation of this site is to be expected a complete new switchboard and breaker should be installed, one that complies with the National Electrical Safety Code and is more compliant with OSHA requirements. Being an electrical utility KPLD is exempt from the National Electrical Code for electrical power generation installations.

(See NFPA 70 Article.90.2 B 5.)

POND LEVEL CONTROL

To be able to maximize the output of this station a pond level control system should be considered. Typically they improve the power production by 10+ % for a generating station. I can provide examples of sites with pond controls recently installed that have now proven the large amount of generation lost over the year. Site visits can be arranged. Auto start of the site from pond control at this site will be expensive. Control regulating

the machine output to keep the water level at a desired height will improve the yearly KWH production at this site

OIL LEAKS

Gate Control hydraulic power unit does show evidence of oil leakage. If this oil reaches the river water and be traced back to the site the potential environmental clean-up costs will be expensive. Also the publicity will be very detrimental to KPLD. Mitigation efforts before the fact would be money well spent. The fish and river watchdog groups would make a big issue out of any oil leakage; the impact on any relicensing effort could be significant.

TWINE MILL

The Twine Mill site is an induction generator site built as an incline turbine site with a gear box. The turbine shaft speed is increased to the generator synchronous speed by a gear box. Several years ago work was done on this gear box to lengthen its life. Eventually this gear box will need to be replaced or replacement high speed pinion and bull gear will be required.

I do not have a good handle on the water side of this turbine. I will make no comments on the anticipated condition of this aspect of the site.

SWITCHBOARD

The electrical switchboard provides reasonably adequate protection for the generator. The site does not have any bus voltage protection. This is a requirement of IEEE 1547 and/or if the site was to be connected to an electric utility such as CMP. The value of this to KPLD is that it provides protection to the systems customers from wild voltage excursions from the generation site to the grid.

The switchboard is a closed bottom sheet metal enclosure that was placed directly on the concrete floor. This site is historically damp inside the building. The floor of the enclosure is in an advanced state of rust and rot. Eventually the enclosure will start to tip over. I suggest a channel or angle iron frame work be installed to prevent the enclosure from falling over. Pulling the enclosure up off the floor is a possibility but will be a fairly large task due to revision of the various large diameter conduit runs with large power cable rework necessary.

This site should be suitable for several years of continued operation with proper care.

POND LEVEL CONTROL

Inclusion of pond level control at this site has the possibility of starting and stopping the site as water level rises and falls. This advantage would greatly improve the overall yearly KWH generation output for this site. This site being of the induction generation

type lends itself to auto start / stop on pond level control much easier and far less costly than the other two sites.

KPLD should see the greatest production improvement at this site due to the ease of accomplishing auto start / stop via pond control. Production increase could be as much as 15% at this site.

KESSLIN

GENERATOR WINDINGS

The Kesslin site has several has serious issues that will require attention if any meaningful life is to be realized.

A few years ago (2012) I was asked to look at the Kesslin facility and investigate the generator windings as they had been condemned by AC Electric of Auburn Maine. AC Electric is a very reliable and competent facility.

The windings of this generator are nearing failure. Four years ago when I visited the site I was very surprised we were able to get the machine to generate again. My parting comment to KPLD was “take what you get for life extension. It is a gift”. The windings are very dirty and do contain a lot of oil and carbon dust as well as being class B organic insulation. The windings may be original windings, and judging from the stator frame arrangement, I suspect this machine is an early 1920’s era machine. This machine will fail in the foreseeable future and a complete rewind will be required. Ideally removal of the generator to a repair facility would be best. Getting this generator out of the building appears likely to be very difficult and costly. Rewinding in place can be done but it will be more expensive than a repair facility rewind. It is a possible consideration, however.

FIRE RISK:

The condition of the windings and the location of the machine present a significant fire exposure / risk to KPLD. If this machine were to fail and if the oil saturated winding were to start to burn; they may continue burning and spread to the building. Due to the location and other tenants / residents of the building I suggest to KPLD they consider a fire suppression system be installed for this site and that the existing fire alarm and sprinkler system be coordinated with the generator switchboard and controls. Any operation of the sprinkler system, the existing fire alarm system or any newly installed suppression system should be arranged to shut down the generator.

I did note that the existing smoke detector for this space has been removed.

Any fire that could be traced back to the generator would be very costly for KPLD and its insurance coverage / carrier.

SWITCHBOARD:

The Switchboard and electrical controls at Kesslin are in the best condition of any site on the KPLD system. Good generator and bus protection exist.

TURBINE GUIDE BLOCKS:

During my visit Tuesday I asked about adjustment of the turbine guide bearing blocks. The response was in 5 years this has never been done. Normal maintenance practices are to adjust these blocks monthly. The purpose of the blocks is to keep the runner centered in the casing. Based on the response I can predict that the runner has been well worn and that a lot of water is leaking by the runner. A safe estimation is that approximately 10% of the possible power producing capability is being lost. When repaired and restored the result is the energy effectively is now worth 10% more.

POND LEVEL CONTROL

To be able to maximize the output of this station a pond level control system should be considered. Typically, this will improve the power production by 10+ % for a generating station. I can provide examples of sites with pond controls that have now proven the large amount of generation lost over the years. Site visits can be arranged. Auto start of the site from pond control at this site will be expensive. Auto stop from pond level control of this site can easily be obtained. Control of the machine output to keep the water level at a desired height will improve the yearly production at this site. This site being very visible to the public, pond level control has the potential to take advantage of one additional aspect of pond control, keeping a prescribed water level within the pond and or a prescribed level of water over the dam for public image enhancement while maximizing production within the parameters set. Public image is a very powerful force.