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Dear Mr. Jones,

It was good to speak to you last Monday. Thanks again for expediting my receipt of Mr. Sheldon's report. The information it contains opens avenues that had previously been barred. You suggested I prepare a series of questions for you to ask the District that would help cut to the truth of the matter and illuminate the problems.

Your suggestions that I'm pressing this in order to replace the existing equipment with my stuff are incorrect: I don't sell governors, 3-D cams or blade controllers. I sell equipment and services to test the performance of that equipment.

There is a market for my equipment in the FCRPS, but the extant problems with the turbine control systems must be corrected before the benefits of index testing can ever be realized and enjoyed.

You have asked me several times why I'm "making a career" out of this. Call it a moral obligation. If someone were clubbing baby seals in my front yard, I'd do what I could to stop it. Knowing the harmful effect the turbine blade misalignment has on fish passing through the turbines and the bureaucratic SNAFU that has created it is similarly compelling to a person of good conscience – it doesn't have to be this way.

People at HDC who know of this problem do not speak up for fear of reprisals; security protocols are used hide this problem from everyone else. Despite overt and covert actions to prevent it, my work there uncovered these serious problems – so the first questions I would ask is "If not me, then who? If not now, then when?" It's just the right thing to do.

My selfish interest will be satisfied when the reports from field tests of the ITB are received. These are necessary to further commercialize my instrument. Withholding these documents from me serves two purposes.

HDC has made false claims that the ITB is their development; not only does keeping the field test reports from me hamper my ability to claim credit for my work by publishing about it for commercialization, but also helps to cover up HDC's self-inflicted control system problems.

There is currently an ongoing lawsuit brought by the Indian nations and environmentalists against USACE, BPA and NOAA regarding fish mortality problems on the Snake and Columbia Rivers. The latest action in this matter is that the 9th Circuit Court of Appeals has upheld the lower court's rejection of the NOAA Biological Opinion (http://www.stoel.com/about.aspx?Show=960).

USACE, BPA and NOAA's new plan is due by July 31.

The BiOp that was prepared by Gary Fredericks of NOAA (503-231-6855) is a compromise that allows continued operation of the turbines during endangered fish migratory periods. When I spoke with Gary, he was alarmed to learn about the 1.0-degree blade deadband intentionally programmed into the turbines at McNary; the BiOp is dependant on optimal turbine efficiency.

One provision of the BiOp allows operation of the turbines during certain times when endangered fish are migrating by limiting generation to a window within 1.0 percent of the absolute efficiency peak of the turbine.

This portion of the Court's injunction ties the efficiency performance of the turbines into the subject matter of this lawsuit. By perpetuating this problem with their arbitrary, unilateral "close enough for Government work" position, HDC is acting in bad faith relative to that legal action.

BPA spends millions of dollars trucking fish downstream and is now considering building a new fish hatchery to alleviate the fish mortality problems. It has been said that BPA spends more on corrective actions to mitigate the fish mortality problem than the entire operating budget for all USACE and USBR hydroelectric projects.

HDC's position that by building their own control equipment instead of buying it from reputable suppliers saves USACE some money is terribly shortsighted - in the big picture, this is a false economy.

When the purported savings from building their own turbine control equipment is weighed against:

- Lost revenue from decreased turbine efficiency (caused by blade misalignment due to the excessive deadband),

- Lost revenue from periods when generation is limited (and even prohibited by the Court's injunction),
- Monies spent on trucking fish down river,
- Construction of new fish hatcheries,
- and, the costs of defending themselves against the lawsuit,

The true price of having HDC/ACSI provide the equipment themselves becomes much greater than just buying equipment from competent, reputable suppliers.

There are 5 hydroelectric plants on the Columbia River that are owned and operated by non-Federal enterprises. As such, the profit motive compels these entities to be much more aggressive in their index testing and turbine optimization programs. Every turbine in these powerplants is optimized individually on a scheduled basis and their 3-D cam surfaces updated accordingly. Perhaps this is part of the reason the ongoing litigation does not include these private powerplants.

Then there's the simple fact that HDC's use of sub-standard equipment has a detrimental effect on the endangered fish species passing through the turbines - the crux of the lawsuit that is currently going badly for USACE.

It would be in the best interest of USACE to fix this problem post-haste, instead of continuing to cover-up this mess. Although not a panacea, wouldn't it make more sense to correct the turbine control problems to mitigate the fish mortality problem where it actually occurs?

This list of comments and questions will:

1. Ascertain that a 1.0-degree deadband and 35 second deadtime are intentionally programmed into the HDC/ACSC 3-D cams at McNary, and that all other HDC/ACSI 3-D cams have a similar added deadband error between 0.3 to 0.5 degrees and similar deadtime programmed into the 3-D cams.
2. Explain the detrimental effect on unit performance from this excessive deadband and deadtime.
3. Compare the GDACS 3-D cam performance to industry standards for deadband and deadtime that all other turbine control equipment suppliers comply with.
4. Explain the effect of deadband error on efficiency and fish mortality.
5. Present information describing the successful Federal lawsuit brought by environmentalists and the Indian nations against USACE, BPA and NOAA that takes exception to the high fish mortality rate.

6. Describe the operating envelope that is between maximum and minimum load (power output) contained in the BiOp. This envelope is delineated by the intersects of a line drawn 1.0 percent below the absolute peak efficiency of the machine and the curve of the efficiency profile.

The text in **bold type** are comments to help setup the questions. The questions are in regular type.

It is well known that tuning the blades to the optimum position relative to a given head and power output will result in increased operating efficiency and decreased turbulence in the flow stream. Increased efficiency will result in more electricity production, aka more money to the Federal Treasury, and reduced turbulence will result in lower fish mortality problems, a win-win situation.

Blade positioning accuracy affects efficiency and turbulence. The more accurately the blades are positioned, the better the efficiency and flow behavior will be. The operative question is: how good is good enough?

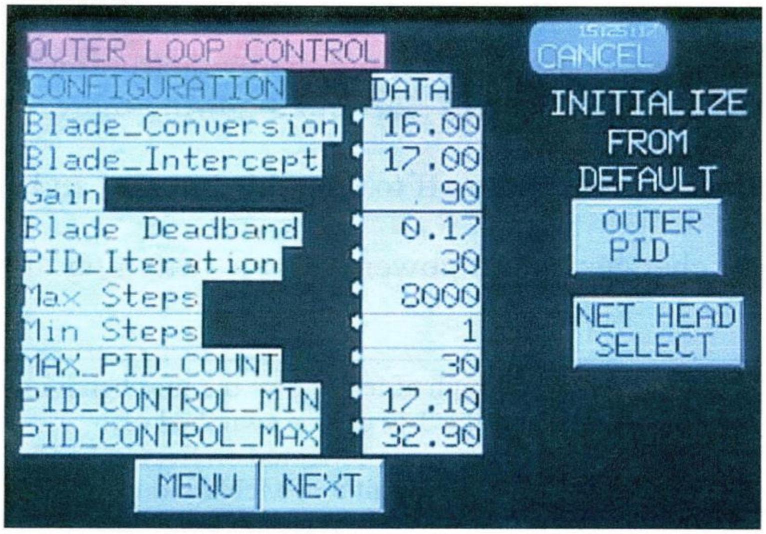
Industry standards have been developed to assure that operating efficiencies are maximized and fish hazards are minimized, but these standards have seemingly been disregarded by USACE HDC in their managing of the Kaplan turbines in FCRPS.

When USACE HDC purchased governors for the Bonneville extension powerhouse from Woodward Governor Company in the 1980s, Dave Bishoff, PE (now at L & S Electric – ph# 715-241-3434) was the project engineer. He recalls that the contract from HDC to Woodward at that time specified 1.0 percent blade deadband as a maximum allowance for slop and hysteresis. These records should still be available in the HDC contracting office for your inspection.

USACE's Kaplan turbine blades typically rotate over a 15.5-degree span. The industry standard of 1.0 percent is equivalent to 0.155-degree deadband on both sides of the optimal position. The GDACS 3-D cam 1.0-degree deadband is equivalent to 6.45 percent on both sides. ASME PTC-29 procedure sums the deadband from both sides, totaling a 12.9 percent deadband.

This first line of questions is intended to shows that the industry standard was vacated in the 1980's, when HDC decided to make their

own blade control systems that have an added deadband and deadtime feature.



The image at left is the setup screen from a GDACS 3-D cam. These are input parameters set by the operators.
Note the 6th item down the list: "Blade Deadband."
At McNary, this value was set at 1.0 degrees.

Figure 1 GDACS 3-D cam setup screen with Deadband input feature

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1. What is the purpose of the adjustable pitch feature of Kaplan turbine blades?
2. Why is it important to position the turbine blades accurately?
3. What is the industry standard for positioning accuracy of these blades?
4. What was the specified accuracy from HDC to all suppliers for blade positioning equipment until approximately 20 years ago when HDC decided to make their own 3-D cams?
5. What is the specified accuracy in the contract to ACSI for the GDACS 3-D cams that are in place now? Is there an accuracy specification?
6. Is there a feature on the HDC/ASCI 3-D cam and blade control system that allows programming in an added deadband for blade position? (See figure 1 if their answer is no.)
7. Does this feature exist on any other manufacture's 3-D cam and/or blade control equipment?
8. What is the purpose of the added deadband in HDC/ACSI's 3-D cam?
9. How is the amount of deadband to add determined?
10. Who makes this determination?
11. Is the deadband setting on all of the blade controllers at McNary set at 1.0 degree?
12. Is there an added deadtime (approximately 35 seconds) before the GDACS 3-D cam responds to changes in head or gate position?
13. Why is this delay added to the GDACS 3-D cam?
14. Does any other manufacturer's equipment have an added time delay in blade positioning?

15. Do the units hunt and oscillate while running at a steady state power level?
16. Does this unwanted motion prematurely wear out the blade trunion bearings, causing additional hysteresis and slop and requiring more frequent repairs?
17. Do the operators ever shut the 3-D cams off to stop this hunting and oscillating?
18. What happens if the unit changes output power without switching the 3-D cams back on?

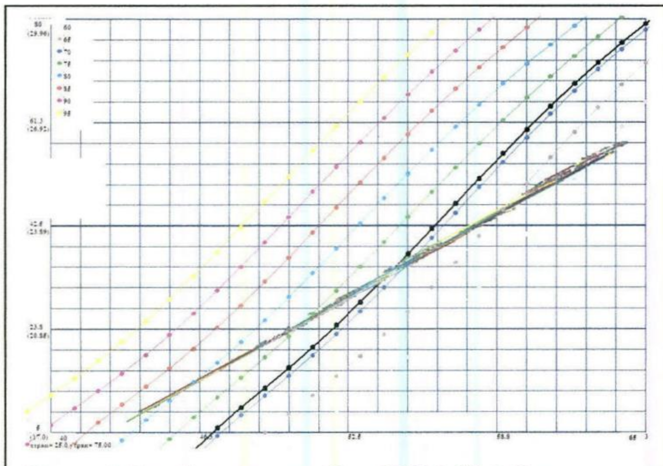


Figure 2 Baseline cam profile of GDACS 3-D cam

The graph at left shows the unit behavior when the 3-D cam is switched off.
This data was collected on September 8, 2005 from Unit 5 at McNary during an overnight data collection run.
The blades should be tracing one of, or a similar curve located between the colored head lines.
This data shows the baseline cam profile of the mechanical cam without the added input from the GDACS 3-D cam computer.

Industry standards set out in IEEE Std-125 call for blade positioning accuracies of 1.0 percent and response time of 0.2 seconds. The 1.0-degree deadband at McNary is 13 times this allowance. The 35 second deadtime is 175 times greater than the industry standard for time-response performance.

These voluntary standards were prepared in order to provide guidelines for contracting personnel to make sure that the equipment that gets deployed will perform satisfactorily, maximizing return on investment and minimizing detrimental effect on the environment.

NOAA Fisheries prepared the BiOp as a plan for how to operate the powerplants in FCRPS to comply with a Court order. Among these provisions is a prohibition from generating when certain endangered species are migrating. During other times when less endangered species are migrating, generation is restricted to operating the turbines only within the top 1.0 percent of the operating efficiency envelope.

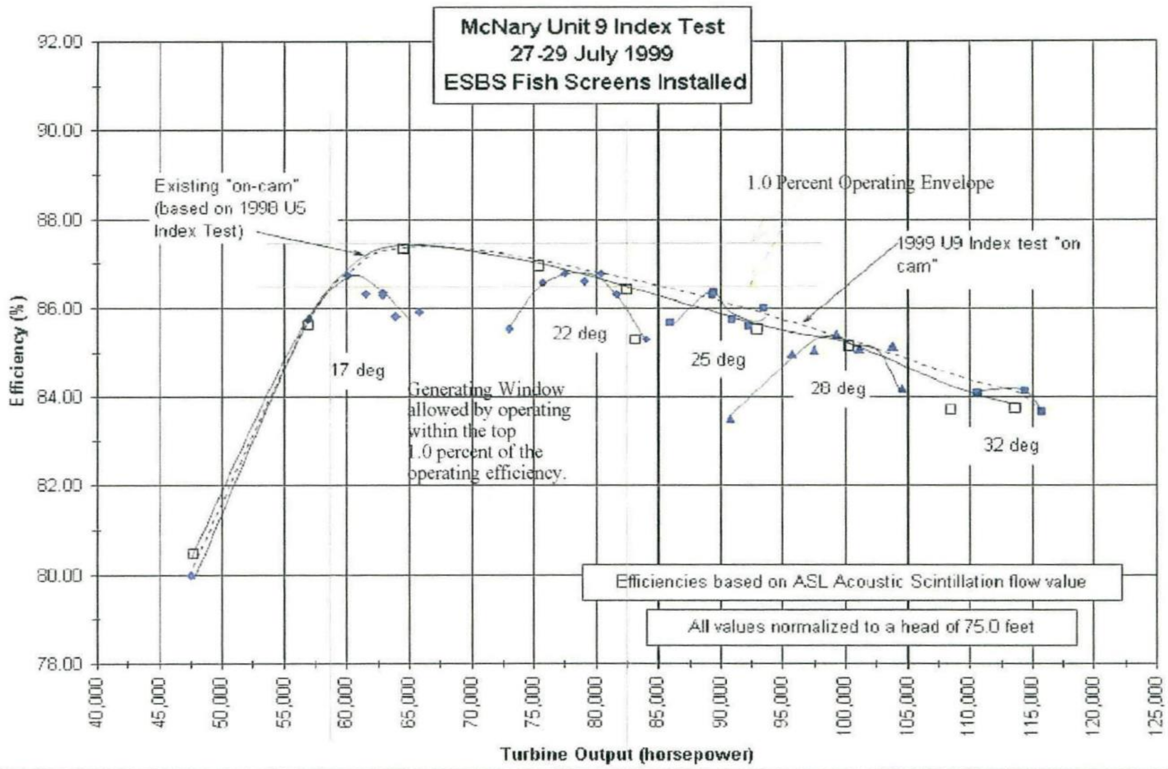


Figure 3 Operating Efficiency envelope of a Kaplan turbine

NOAA's BiOp is a compromise between the desire to generate electricity and the Environmental Protection Act (EPA) that is based on the operating efficiency envelope of the turbines.

The requirement imposed by the Court's injunction is for the units to be operated only within 1.0 percent of their absolute efficiency peak. The theory is that by maximizing turbine efficiency, more energy from the water is imparted to the turbine runner to provide torque to spin the generator. Wasted energy from operating off-peak efficiency becomes turbulence in the water flow, thus creating a more hazardous environment for fish passing through the turbine.

Figure 3 illustrates the operating efficiency envelope of a Kaplan turbine resulting from an index test, with the top 1.0 percent delineated by two horizontal lines.

The top line is tangent with the absolute peak efficiency, and the bottom line is 1.0 percent below it.

During certain periods of the year when moderately endangered fish are migrating, the Federal Court restricts operation to within this top 1.0 percent of this efficiency envelope.

From the data in Figure 3, the operating window is restricted to between 58,670 and 82,500 Horsepower.

The BiOp ties operating efficiency of the turbines to compliance with the Court's directives.
It is incumbent upon HDC to take all possible steps to comply with the Court's orders.

Figure 4 shows the effect of blade error on turbine efficiency. This data was gleaned from HDC's own turbine index test data, and is representative of typical large Kaplan turbine performance.

Note that with a 1.0 degree blade error, the efficiency decreases about 0.5 percent.
This is not the only source of lost efficiency; it is just one factor that is added into the error budget that must be within the 1.0 percent operating envelope.
HDC's arbitrary deviation from industry standards to save a few bucks in deference to the Court's order is disingenuous, and contrary to USACE's compliance with the Court's order.

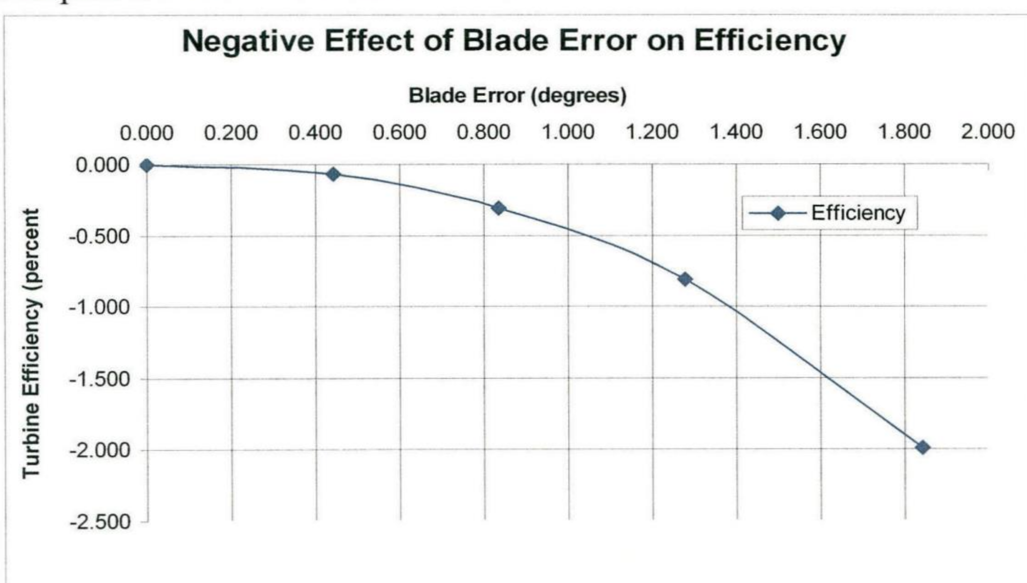


Figure 4 Effect of Blade Error on Turbine Efficiency

Judge Redden has used data collected and reduced by the Fish Passage Center (FPC) (http://www.fpc.org/), an agency that counts fish and analyzes fish mortality rates as they migrate through the hydroelectric plants on the Snake and Columbia Rivers.

FPC's analysis suggests that spilling water will reduce fish mortality rates. As a result of FPC's recommendation, Judge Redden directed USACE to spill water while certain fish species are migrating.

FPC is funded at $1.3M/year by BPA. On 30 November 2005, the Washington Post reported (http://www.washingtonpost.com/wp-dyn/content/article/2005/11/29/AR2005112901288.html) that Senator Larry Craig (R-Idaho) had inserted wording in a Federal energy and water appropriations bill that banned all future funding for FPC.

After the bill defunding FPC was passed, Judge Redden ordered that funding be re-established (http://www.lclark.edu/org/nedc/fishpassage.html) so FPC's work could continue. FPC's data is still being used by Judge Redden to evaluate the success of the BiOp compromise. The Court's rejection of the BiOp was based on real data from FPC indicating that the problem was not solved.

From the December 2005 field test of the ITB we learned that in the midst of this struggle, that HDC has been hiding the fact that turbine efficiency has been compromised by deploying sub-standard control systems on all of the 113 turbines on the Snake and Columbia Rivers, thus defeating the fundamental purpose of the BiOp.

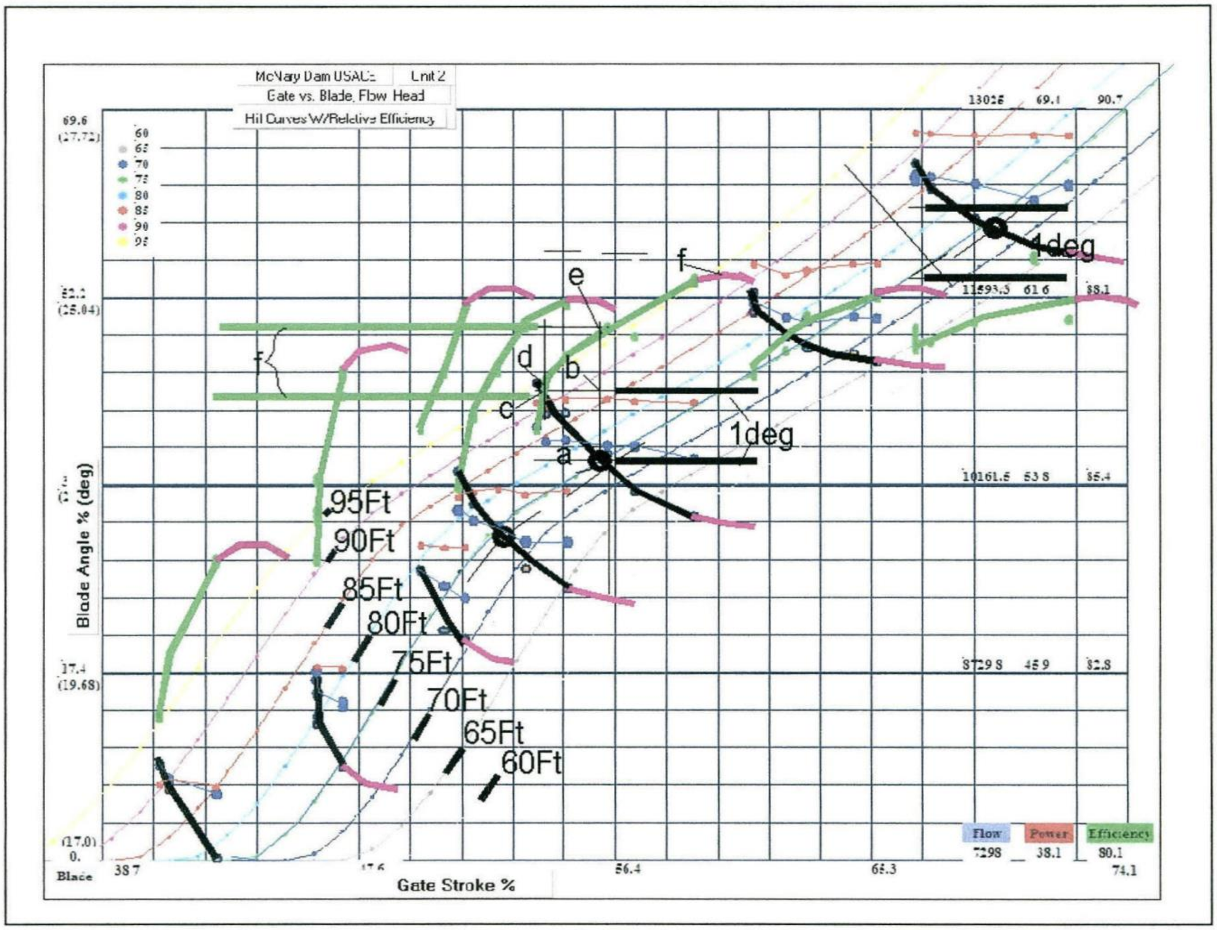
Doug

Appendices:

1. Graphic Analysis of turbine efficiency using December 2005 McNary unit 9 test data.

2. Discussion of GDACS 3-D cam turbine's gate to blade behavior

Appendix 1. Analysis of McNary Unit 9 data



Effect of a 1.0 degree deadband on operating efficiency.

This analysis uses real data collected from Unit 9 at McNary Dam.

To show the impact of a 1.0-degree deadband, graphic measurements are used to demonstrate the efficiency loss, and resulting cost of this intentional misalignment of the blades.

Point "a" is the Ideal Cam position from the GDACS 3-D cam running at

53 MW at 75-foot head. Assuming this is the actual efficiency peak of the machine (due to other calibration problems with the unit, it's not), project a line up a distance of 1.0 degree to point "b," – this is the deadband error programmed into all of the GDACS 3-D cams at McNary.

The unit is still operating at the same power level as point "a." The constant generation curve shows where 53MW will occur at "c," the gate-blade operating point for 53 MW with a 1.0-degree blade error.

Now project two vertical lines up to meet the efficiency contour at "d" & "e." The distance between "d" & "e" is the lost efficiency from operating at the same power level with a 1-degree blade angle error - if the Ideal Blade position at "a" were truly the optimum point.

But it isn't; the actual efficiency peak indicated by the index test data we collected is somewhere around "f," the extrapolated point that was projected beyond our test range. The actual lost efficiency is the vertical distance from "d" to "f."

Using the same graphical method, the distance from "d" to "f" is measured to be a loss of about 1.5percent efficiency. By the 1.0 percent Injunctive Relief edict, when operation is restricted to protect endangered species migrating downriver, this unit should not be operated at all.

To compute the financial losses, this analysis is projected along the 53MW Constant Power line of the unit, so the 1.5 percent loss is calculated at 53MW.

The math is simple:

Assume 5 cents/kWh at the meter on the side of a typical house buying this power. (Here in Illinois, we're paying 8 to 14 cents/kWh.)

(I'm ignoring distribution costs and other overheads because they are already paid for out of the diminished power level that is already being obtained from the machine. By just moving the blades to the proper angle, all of the power to be regained will be pure profit.)

Assume that the unit is achieving 85 percent efficiency at 53 MW when we start, and the 1.5 percent is added to increase efficiency to 86.5 percent.

The power output increase is computed as:

If 85%=53 MW, then 86.5% = 53.935 MW, an increase of .935 MW.

The retail value of this is:

.935 MW * 1000 kW/MW * .05 cents/kWh = $46.75/hour.

Assume 50% running time annually, the annual loss is $204,765/year.

To put it bluntly, a conservative estimate of the cost to the Treasury of using HDC/ACSI's GDACS 3-D cams is $204,756 annually, just for Unit 9 at McNary – now extrapolate this estimate over all power production on the Snake and Columbia Rivers to get the full scope of this ongoing waste.

Appendix 2 Discussion of Gate/Blade Motion

While I was at HDC in August 2004, I received an explanation of the effect of the GDACS 3-D cam 1.0-degree deadband & 35 second deadtime and the deadband and deadtime in the GDACS control system's outer power controlling closed loop.

1.) When a large upward SetPoint change is made in power; starting at (a.) on figure 6, the governor's speed motor is activated to raise the SetPoint by the GDACS control system. The gates open rapidly to get the power output up to the new SetPoint level. For this example it's the 53MW Constant Power line at (b).

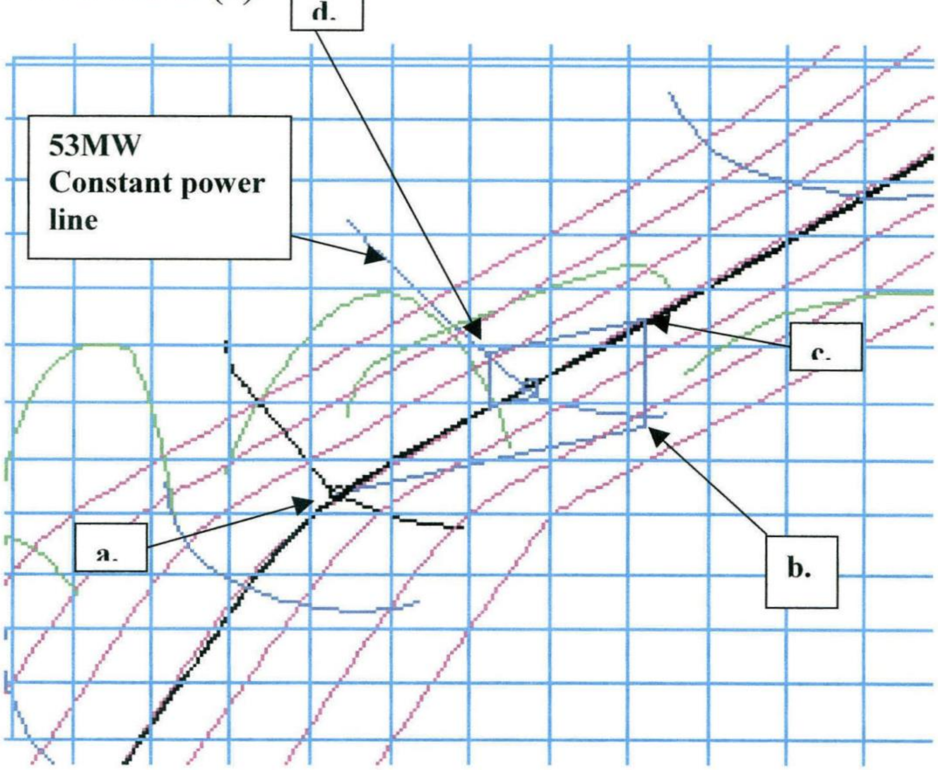


Figure 6 Rectangular Spiral motion of GDACS 3-D cam.

The increase in power output is sensed by the GDACS control system, which will continue to open the gates until the generation SetPoint demand is satisfied at (b).

Due to the 35-second deadtime in the blade control system, the blades move only in response to the profile of the linear rise mechanical cam mounted on the gate restoring shaft, indicated by the line from (a) to (b). During this time, the stepper motor in the GDACS 3-D cam that provides the rest of the required motion to get to the "Ideal Blade" angle does not move. This causes the gates to overshoot, moving farther than they would have had the blade controller been robust and accurate and the blade angle tracked the cam curve properly.

About 35 seconds later, the blade controller wakes up, takes note of the change in gate position, computes the new Ideal Blade angle, and then moves the stepping motor to complete the blade motion to the new Ideal Blade position for 75 ft head relative to gate position at (c.), as dictated by the 3-D cam algorithm and cam surface lookup table.

When the blades move to this new, steeper position, power output increases significantly, exceeding the deadband set for the power level controller in the GDACS, and then the closed loop on power in the GDACS pulls the gates closed to get power back to the SetPoint.

After another deadtime in the GDACS load feedback, the speed motor is moved again to lower power back down to the load SetPoint at (d.). Again, the blades do not move in unison with the gates to track the cam line because the 35-second deadtime is in effect.

This motion continues until the blades are within the 1-degree deadband programmed into the Panel Mate touch screen control panel.

To avoid this "rectangular spiral," (or to better characterize the impact this misalignment would have on any fish passing through the turbine during this sequence, we could call it a "rectangular death spiral") the operators change the generation SetPoint very slowly so the blade control system can keep up.

The programmed-in 1.0-degree deadband that prohibits blade motion if the blades are within 1.0 degree of the Ideal Blade position, which results in a permanent and continuous 6.5 percent blade position error away from the Ideal Blade position.

As defined by the ASME PTC-29 measurement technique, which sums the deadband on both sides of the optimum cam line, this is actually a 13 percent deadband. Add this to the anticipated 2 percent deadband of the mechanical hysteresis in the blade positioning system of these 50-year-old machines (downstream of the oil head blade angle feedback transducer), and they are now operating with a 15 percent blade positioning deadband.

IEEE Std-125 characterizes an acceptable deadband at 1.0 percent, which all other suppliers conform to. This is not a mandate, however, these are just guidelines indicating what is reasonable and customary throughout the industry for contracting agents to refer to in preparing purchasing documents. If other suppliers can achieve this level of accuracy, why is USACE HDC accepting such an inaccurate system from ACSI?