Revised 5/11/06

Hydro-Optimization Team Meeting
Minutes
January 25, 2006 Portland, OR

Attendees:

Jack Allison - BPA
Scott Bennett – Corps, NWS
Su-Chen Chen – Corps, NWS
Mike Colesar – Corps, NWP
Rob Dies – BPA
Ken Earlywine – Corps, HDC
Don Faulkner - Corps, RCC
Gabrielle Foulkes – BPA
Larry Haas – Corps, HDC
Francis Halpin – BPA
Gail Hicks Corps, NWW
Tom Murphy – BPA *(co-chair)*
Richard Nelson – Corps, HDC
Stephen Perkins – Corps, NWP
Dan Ramirez – Corps, HDC
Gerald Sauve – Corps *(by phone)*
Lee Sheldon – Corps, HDC
David Smith, Corps, NWP
Glen Smith – Corps, NWP
Wayne Todd – Corps, HDC
Robert van der Borg – Corps, NWP *(co-chair)*

Introductions ***(Exhibit 1)***

Tom Murphy reviewed the agenda and led introductions. The minutes from 10/13/05 were accepted with minor modifications. The question of Corps representation is no longer an issue.

Type 1 Index Test Box (ITB) status ***(Exhibit 2)***

Note: these phases differ from the phases described in minutes from the 10/13/05 meeting.

Phase 1

Dan Ramirez explained that in phase 1, the research was looking at unattended and automatic data collection (situations where both gates and blades can move, compared to the standard index test where blades are fixed). The test showed potentially good results, and the system interfaced well with GDACS. A few corrections were identified, and now they need to verify that the bugs have been corrected. The test verifies that the ITB monitors unit operation to determine when user-defined steady state criteria is met and records data necessary to develop updated cam information. The test indicates that the proof-of-concept has been met, alhtough software bugs do not allow for unattended operation.

One of the findings is that there are too many, essentially identical, data points being logged. HDC requested revisions to the data logging routine so that only distinct data points are logged. HDC needs a way to analyze the data with some sort of data reduction technique that may differ between Francis and Kaplan units for cam curves and data profiles.

Phase 2
A non-GDACS index test box will help the Willamette Valley projects and the rest of the Corps nationwide. The staff proposes a demonstration project with additional ITBs that would verify that one ITB can run multiple units.

However, there are concerns with propagation of ITB in its current form: the ITB source code will not be made available (potential security issue) and ITB long-term maintenance Should code be developed and integrated into GDACS? A small team was established to develop a course of action for ITB.

Future work
Future efforts will focus on collecting and analyzing data. Before HDC can provide more detail on the schedule and activities, they need to resolve an internal issue with the contractor. The plan is to make a presentation at the next GMC meeting on 2/16. For that presentation, they will need to address the security issue; resolve the issue on whether to develop functionality within GDACS; and determine whether code development is something the government wants to do in-house or with contract. HDC will develop a proposal.

There is still work needed to get the Winter-Kennedy relative flow signal into GDACS: there is some design work necessary and they need to confirm resources. Lee Sheldon commented that transducers with automated flushing on each unit get out entrained air and control the temperature of water.

FY 06 – phase 1 - approved
- Test to verify bugs have been corrected
- Parallel to IHR index testing Feb. 2006
- Off-cam (fixed blade) testing of Kaplan unit should prove applicability of ITB to Francis unit
- Testing of IHR in lieu of previously proposed CHJ verification test
- Developmental process required to get the Winter-Kennedy relative flow signal into GDACS

FY 07-09 – phase 2 – budgeting administrative costs for developing budget and schedule
- Demonstration project, multiple Kaplan units (GDACS): LWG units 4-6 proposed site (FY 07)
- Demonstration project, multiple Francis units (non-GDACS): DWR or CHJ
- Install Winter-Kennedy at projects that don't have absolute flow measurements
- 3 unit installation/demonstration at LWG/DWR
- Develop new discharge tables

Follow-up actions:
- Index testing: Dan Ramirez will define the work that needs to be completed to finish index testing; re-establish clear dates and milestones for completing test reports for LWG and BON2; and include IH testing.
- Dan Ramirez will establish a small team to determine future T1 work (team is Rod Wittinger, Jerry Sauve, Lee Sheldon, Dave Smith, Ed Miska, Jack Allison, Richard Nelson). They will

define the work that needs to be completed and establish dates and milestones for completing the work.

Absolute flow

Should the Corps continue installing flow meters on all units at CHJ? Dan Ramirez proposes a test at DWR to determine whether it's possible to install only one meter, and then do index testing on the remaining units of a family to obtain a suitable degree of accuracy for future use of T2.

DWR offers advantages to using ITB and flow meters for comparison purposes.

Type 2 optimization

Larry Haas reported that the Type 2 optimizer program is a power plant unit load sharing optimization program. It apportions megawatt set points for each available unit such that the plant may operate near optimum efficiency. Load sharing optimization among the units at a powerhouse consists of economic dispatch and unit commitment. The plan is to install at BON first and then CHJ before the end of the FY.

A task order is ready to be issued but they need some resolution on a property rights issue. The schedule is to develop an initial version of the program that is substantially functional in FY 06. Ongoing work in FY 07 should be planned. Unit commitment will be a suggestion (alarm-type prompt), but it will not automatically be implemented. The system will be better than the current proportional allocation.

What about a look-ahead to give operators some input and review on the optimizer program? There is an opportunity for Dave Smith to come into the lab for an early check-in before finalized.

Follow-up action:

- Larry Haas and Robert van der Borg will adjust the schedule for the subagreement for Type 2 optimization to account for delays in contracting and legal.

Loss of efficiency due to instrumentation errors ***(Exhibit 3)***

Lee Sheldon described research in the accuracy in measurements and how that affects efficiency. His data shows how an error in blade, gate, or head measurement relates to a loss in efficiency. Likewise, improving measurements could increase efficiency. He concluded that improving the accuracy of blade angle measurement could result in the most improvement. A cost benefit evaluation still needs to be performed. AND POSITIONING

Megawatt allocation proportioning between unit types at BON ***(Exhibit 4)***

Lee Sheldon led a discussion of the rate of flow relative to power among families of units. He was looking for efficiency among units by comparing a proportional allocation algorithm with

the true optimal solution. He determined that T2 economic dispatch can improve performance. The area on the charts between the two lines represents the benefit of T2.

Potential benefits can also be had from retuning the existing proportional allocation algorithms, but this may not need to be done since T2 will eventually be installed. However, HDC could make the retuning changes relatively simply. The proposal would be to change the coefficients on unit f families. This appears to result in short-term benefits before T2 is installed.

Follow-up action:

- Tom Murphy will look at changing the existing proportional allocation algorithms at other projects.

T2 compared to NRTO ***(Exhibit 5)***

Lee determined that T2 can provide some improvement to NRTO (up to .3%) due to economic dispatch (not addressing unit commitment). The analysis shows the loading per unit.

TDA powerhouse efficiency profile ***(Exhibit 6)***

Lee presented an analysis of powerhouse optimum efficiency.

PT/CT testing at MCN

Dan Ramirez noted that testing for accuracy will be installed on Unit 5 after all materials are purchased. The subagreement already supports testing (the decision was made at the last meeting). A job scope is being prepared for MCN. The funding is separate from HOT. Lee commented that Reclamation has also found errors.

Index testing ***(Exhibit 7)***

Dan summarized the status of the work to date, as well as a summary of the results from the earlier testing. At BON, the data is being confirmed by fish passage people for review, and then the full tables can be entered into GDACS. The funding for this work is in the subagreement.

At LWG, the data is being reviewed based on last year's testing, and there should be some updates.

IHR will be a new effort, with testing in the spring with and without fish screens.

This should complete all the families and all the projects for index testing.

Head sensing

Robert van der Borg indicated that NWP had 3 components that have all been completed, and all facilities are now up and running on a head sensing system. The system is working, although it

is not possible to compare the accuracy of individual head measurement with a single head measurement for the entire project.

The head sensing was calibrated to a clean trash rack. We do not have a way to measure head loss across a plugged trash rack in real time. What happens if both the traveling fish screens and trash racks are plugged? How does that affect head sensing? Should the sensor be installed at the lowest point? Can screens be monitored so that we can know when they are plugged? Would it make sense to install another sensor that could compare head above and below screens to provide a signal when racks need cleaning? It was noted that current maintenance practices include regular cleaning. Ed Miska noted that the health check he has been reviewing could include this type of problem detection without adding more sensors, but he doesn't know what level of sensitivity is possible.

Is it expensive to change the location of the current sensors? The index tests were done upstream of the screens, showing data with and without screens. Could model tests at WES help answer the questions? How much additional loss from screens occurs due to a change in head at each unit? Is that the only way to determine the impacts of being on the right cam curve?

Is there potential gain if monitored? There might be both maintenance and efficiency gains.

Follow-up action:

- Lee Sheldon will look at the loss in efficiency for an additional one foot head loss.

NRTO status

Rob Dies demonstrated new screens in NRTO that can provide reports on the benefits obtained by implementing optimization. The new benefits worksheet allows operators to change assumptions and see the impact of their actions.

The report can generate information showing losses during specific periods of time as well as trends. Columbia Vista might be able to assist with short term forecasts to help an operator determine whether to change unit commitments; i.e., give them information as to whether to add/subtract another unit for one hour or for a longer period of time. BPA duty schedulers now have plant loading information which can help them send better basepoints based on their knowledge of upcoming loads or water conditions.

The benefits worksheet is a self diagnostic tool that focuses on losses. The worksheet is being sent to the OMs weekly.

The next version of NRTO will be simplified to require only a single password for each project.

Follow-up action:

- Everyone should let Tom know if they want to receive the weekly NRTO benefits report.

Feed forward AGC/Bias

Fran Halpin is analyzing data to see how the bias is calculated for CHJ/GCL hourly coordination and bias swings. The Transmission Business Line had asked that bias be scheduled flat for reliability purposes and for AGC for several months. The data from those flat operations show how large the power losses are due to dynamic bias v scheduled bias. The Mid-Columbia plants are also studying the results. Fran commented that it doesn't really hurt them to schedule flat over the hour rather than dynamically every 4 seconds. They like to stay as full as possible to keep the head high.

The effect on the FCRPS projects has been to keep units on to accommodate the requested flows. CHJ and GCL have both experienced losses due to the Mid-C desire to maintain flexibility during the hour.

Now that TBL's operations are over, the plants will go back on a scheduled bias (every 20 minutes) during CHJ spillway deflector construction.

BPA is working with the Mid-C owners to help them pre-schedule. The Mid-Cs need to figure out a way to know what their purchasers are doing with their own resources so that Mid-Cs are not affected by huge swings.

Absolute flow solicitation

After previous rounds of testing, the Corps concluded that scintillation and acoustic flow cannot provide full accuracy to use with T2. Lee Sheldon pursued magnetic measurement, but that technique is no longer supported, so now he hopes that industry has other approaches.

Lee sent out a Request For Information (RFI) to solicit ideas on how to measure run-of-river flow more accurately (testing in lab), hoping to borrow techniques from another industry. The assumption is that the Corps or a contractor will build a prototype or large size device of the concept, and then a lab will test it. WES doesn't have high flow testing ability, but other labs do. The Corps is interested in new methods or improvements in existing methods.

Robert van der Borg stated that expense money (for R&D) has been set aside. FY 06 expenditures will be relatively small, with award assumed to occur in FY 07. Funds are included in the current subagreement for the first phase to prepare the contract solicitation.

Lee will bring the responses to the RFI back to the HOT with best and final proposals. Three companies have responded with conceptual interest. Accusonics may respond – if they don't, the Corps contracting group may ask why they didn't.

It is difficult to determine whether results of acoustic testing from LWG were accurate because there is no known method to determine flow in a Kaplan unit. Acoustic testing appears to have more repeatability than scintillation.

Richard Nelson requested more information about what was learned at the test at LWG. How did Accusonics perform? Should there be lab testing of Accusonics? Is there precision or random bias? Is the error constant or variable?

Next steps –
The Corps needs to review the results of the original scintillation and Accusonics tests at LWG to look at bias and field test. Then they need to decide whether they still need the solicitation. They will bring a plan to HOT for review to get something that works.

Follow-up action:
- Lee Sheldon will prepare a brief report on the conclusions from the original scintillation and Accusonics absolute flow testing at LWG, and prepare a proposal on what contracts would look like.

Absolute flow Accusonics at LWG and DWR ***(Exhibit 8)***
Jack Allison and Dan Ramirez reported that data from CHJ Units 11 & 15 and DWR are ready to enter into GDACS – it is a code-approved method for Francis units. DWR offers advantage of using ITB and flow meters for comparison purposes, and provides opportunity to verify indexing units based on gate/power comparisons for T2.

Machine adjustment proposal
This is a proposal for a quality assurance check on the machines to make sure they're not off-cam. HDC will prepare a proposal for a survey to check tables for Kaplan units on the mainstem. Any corrective action would be taken by the project. .

Follow-up action:
- HDC will prepare a proposal for a survey to check cam tables for Kaplan units on the mainstem.

Blade angle measurement
Lee has done some initial assessment of the role of blade angle and the significance relative to efficiency. He still plans to quantify potential benefits, and make rough estimates of milestones and costs.

Speed index testing
Lee read a paper on speed index testing. Apparently the method works: it is somewhat faster although it has a higher degree of scatter (i.e., more uncertainty and is possibly less accurate than the conventional method). Most of the time for testing is travel and set-up time, so it's not clear that it is an economic alternative. This method would test the sliding gate in one day compared to three days of testing 6 or 7 fixed blade angles. Dan Ramirez intends to use speed index testing at IHR to compare methods.

Subagreement
Should it be divided by district or kept in one? Robert can divide it, but it has to be at least $250k to be a capital subagreement, and the Seattle district work may be somewhat smaller than that.

Next meeting
The next meeting of the Hydro Optimization Team will be **May 23-24, 2006** in Seattle.

LIST OF FOLLOW-UP ACTIONS

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