Revised 9/13/06

Hydro-Optimization Team Meeting
Minutes
May 23-24, 2006 Seattle, WA

Attendees:

Scott Bennett, NWS
Su Chen Chen, NWS
Ken Earlywine, NWP
Robert Ford, NWP
Brian Miller, NWW
Ed Miska, HDC
Tom Murphy, BPA *(co-chair)*
Richard Nelson, HDC
Jerry Sauve, NWW
Jeff Sedgwick, NWW
Lee Sheldon, HDC
Dave Smith, NWP
Robert van derBorg. NWP *(co-chair)*
Rod Wittinger, HDC

Introductions ***(Exhibits 1 and 2)***
Tom Murphy reviewed the agenda. He proposed that the team use the flow diagram to define, update the status, and plan for each item. This should help achieve group consensus on what has been done and what needs to be done to achieve T1 and T2 optimization. The group was comfortable with this approach.

T2 optimization
Ed Miska reported that the GDACS demonstration software project is currently under contract with ACSI, with beta test delivery at Bonneville and Chief Joseph before the end of FY 06. This software adds the following new GDACS functionality:

- Economic dispatch (determines where to load the units currently online)
- Instantaneous unit commitment (determines whether to start/stop based on economic criteria - constrained to all other operating criteria such as fish and flow - in accordance with feed forward trends, predetermined start stop schedules, etc.)

The overall HOT APPROVED T2 plan to date is to:

- Deploy this new GDACS Phase I T2 software to all GDACS projects (except ALF) in FY 07, pending satisfactory beta testing at BON and CHJ.

- Add future modifications to T2 (a T2 Phase II) that will add refinements based on more information exchange with BPA (requires ICCP modifications that are currently underway). Included in planned future T2 Phase II functionality is the ability to incorporate the future plant load point (time look ahead) in determining which units to stop/start and when to schedule the start/stops (this is broadly defined as the economic unit commitment).

Comparison of NRTO to T2 optimization benefits at Bonneville *(Exhibit 3)*
Lee Sheldon summarized his analysis, and concluded that the T2 algorithm provides a better answer than NRTO. Lee's report confirms the benefits of continuing the current HOT approved approach; i.e., NRTO at BPA to establish plant set points, and T2 at each plant (via GDACS) to fine tune unit commitment and dispatch.

Errors in performance testing of hydraulic turbines *(Exhibit 4)*
Lee's report addressed the question of how it is possible to measure performance improvements of ½% when the test error measurement accuracy is +/- 1%. He stated that precision error and random error are synonymous. Systematic error is now called bias error. There are two types of bias error:

- Constant error (does not change), e.g., a calibration error
- Variable error (changes with the magnitude of the measured parameter)

The bias errors are not critical to accuracy when talking about relative measurements.

Head sensing
The head sensing data has been input into individual units (except for 5 units at TDA). This information provides the right cam curve via the 3-D cam.

The next task is to use the individual unit head data now in GDACS to do something beneficial (i.e., substitute individual unit head data for the plant average head data currently used for all GDACS calculations). This work will be done as part of T2 Phase II.

Dynamic blade angle measurement *(Exhibits 5-8)*
Exhibit 5: "Economic benefit of accurate blade angle measurement instrumentation"
Exhibit 6: Schematic of turbines
Exhibit 7: "Need for direct blade angle measurement"
Exhibit 8: T1 optimization powerpoint

Rod Wittinger reviewed an economic study of accurate blade angle measurement instrumentation. He noted that model testing at WES earlier this fiscal year demonstrated the potential of dynamically measuring Kaplan blade angles. Before proceeding with a full scale prototype demonstration project, the HOT had asked for an analysis of the benefits of doing this on all the Kaplan units.

The conclusions of HDC's analysis show that:

- Efficiency is very sensitive to blade angle
  - A 1.0 degree blade angle error translates to approximately 0.7% efficiency loss.
- Existing blade angle measurements systems have a number of small inherent sources of measurement error.

- The proposed method of dynamic blade angle measurement with UT sensors has a positive B/C ratio under all circumstances studied (blade angle errors as low as 0.5 degrees)

Rod described the current proposal to install a prototype demonstration at Ice Harbor - perhaps on unit 2 which is currently planned for runner replacement. The objectives would be to better identify the exact existing error and confirm the economic benefit to be gained, and to confirm the design of the ultrasonic probes.

There was a long discussion on the benefit/cost calculation. What is the benefit of knowing individual blade angles if this error (a systematic error) is already accommodated in the planned T1 testing? In other words, will this benefit be gained if T1 is implemented? The issue was tabled and money taken out of the subagreement until more work could be done to clarify the benefits.

Follow-up action:

- A small team of Rod Wittinger, Ed Miska, Tom Murphy, Jerry Sauve, Lee Sheldon, Jeff Sedgwick, Bob Ford, and Ken Earlywine-facilitator will conduct an in-depth discussion on blade angle measurement and seek concurrence from BPA's program manager.

Index testing

IHR units were not tested with fish screens as planned in February due to funding and district/project coordination problems (including the failure of Unit 7 at McNary which affected the expense budget). They hope to reschedule this planned test at IHR to June 2006, with the approval of the fish folks. Rod believes that there should be a regular planned test schedule of two per year until T1 is fully deployed. He noted that if further testing is required to verify T1 operation, the testing would be covered by capital, not expense. Tom proposed and the team approved that the team only forecast (and budget via the new PPEI amendment) testing that is required for T1, which can be capitalized.

T1 – Individual Test Box (ITB) ***(Exhibit 9)***

Status:

1. HDC is working on a report to summarize what was learned to date.
2. One lesson learned from the R&D effort to date is that the original plan to hold constant power on the unit during the T1 testing has been too difficult to achieve. This leads to an unplanned need to develop a new algorithm to do this (item 3 below).
3. A methodology (algorithm) to reduce the data is required. HDC has prepared a draft solicitation to purchase this (there is a good chance that currently available OTS software can be configured to do this).
4. DWR and LWG have been selected as test sites for the next round of T1 testing.
5. DWR needs to have wicket gate position and absolute flow (Acusonics) inputs added into GDACS to facilitate T1 testing.

6. A Winter Kennedy sensor flushing device needs to be designed and installed on the LWG and DWR test units.
7. Acquire two new index test boxes to do the LWG and DWR testing (HDC proposes to use the existing R&D contract to do this).
8. HDC will provide a new draft solicitation *(Exhibit 9)* for a generic ITB that will incorporate all lessons learned. The current plan is to have this ready to use to procure the final ITB that will be deployed throughout the region. Generic means that it is stand alone, but the short term plan is 1) to interface this device with GDACS during the development stage, and 2) to insure that the software is developed such that it can be integrated into GDACS at a later date.
9. HDC will investigate assembling an appropriate in-house/hired contractor team to develop the generic ITB via a method analogous to GDACS. Deliverable will be a proposal for a future HOT meeting which could be an alternative to advertising the generic ITB solicitation being developed in 8 above

In conclusion, the current ITB plans are to do two things in parallel:

- continue current R&D testing (items 1, 3, 5, 6, 7) and
- pursue a final generic ITB (items 8 and 9).

This proposed approach was approved.

Follow-up action:

- HDC will investigate assembling an appropriate in-house/hired contractor team to develop the generic ITB via a method analogous to GDACS. The deliverable will be a proposal for a future HOT meeting which could be an alternative to advertising the generic ITB solicitation being developed in 8 above

3D Cams

Currently the electronic 3-D cam systems installed on the Lower Columbia (BON, TDA, JDA) differ from those installed at MCN and the LSN. The Lower Columbia cams are the older original stand alone NWD cam. The NWW cams are a newer generation design. New cams use superior gate and blade position transducers, a number of design improvements that allow cam tables to be easily changed, and are installed in the GDACS RTU. Now that the proposed plan is to interface the T1 test box with GDACS, the Lower Columbia cams will need to be changed to accommodate the planned design of the ITB.

The conclusion at this meeting is that additional information is needed before a HOT decision can be made. Possible information could include:

1. Benefits that could be achieved at BON, TDA, and JDA by replacing the Lower Columbia cams with the new NWW design.
2. Costs and schedule to implement, along with some suggestions for an acquisition strategy.
3. Confirmation that the current NWW design now installed has achieved the design goals. (What are the lessons learned?)

4. How replacing the Lower Columbia cams would affect the benefits forecast for T1; i.e., a comparison of T1 benefits that could be achieve with the current NWW and NWD cams.
5. Where should the 3-D cam function reside? Should the regional plan be to install the cams in governors, or should they remain stand alone, or should they be part of GDACS?

HOT requested the information in items 1 to 4 above, but felt that the issue in item 5 (how to implement, stand alone vs. digital governor vs. GDACS) should be done elsewhere. HDC believes they could get this study done in FY 07.

Health check

This is a proposed new project to automatically monitor the proper operation of the 3-D cam function. The monitoring function uses the Winter Kennedy tap and gate and blade data. The monitoring function collects the data, stores it, compares current data to the historical data, and sounds an alarm if the current data is out of tolerance with historical relationships which could indicate an operation problem.

The proposal was approved by the HOT. Funding will start in FY 07.

Budgets

The meeting ended with no significant FY 07 and FY 08 costs being identified. Assessment of the lower river 3D cam work will have to be done prior to finalizing estimates.

Action items ***(Exhibit 10)***

The action items were not reviewed. Tom Murphy will review the action items based on the meeting.

Next meeting

The next meeting of the Corps Hydro Optimization Team will beheld with Reclamation **September 12-13, 2006** at Grand Coulee project.

LIST OF FOLLOW-UP ACTIONS

- Contracting: Richard Nelson will look into augmenting FTE to work on T1.
- A small team of Rod Wittinger, Ed Miska, Jerry Sauve, Lee Sheldon, Jeff Sedgwick, Bob Ford, and Ken Earlywine-facilitator will conduct further study on blade angle measurement and seek concurrence from BPA's program manager.
- HDC will investigate assembling an appropriate in-house/hired contractor team to develop the generic ITB via a method analogous to GDACS. The deliverable will be a proposal for a future HOT meeting which could be an alternative to advertising the generic ITB solicitation.