Memorandum

April 21, 2005

To:
From: Lee Sheldon

Subject: Benefit of Using T2 Optimizer to Provide Unit Allocation at The Dalles

1. Unit allocation means the determination of how load is to be shared among the on-line generating units. At The Dalles, there are two groups of generating units. Units 1 to 14 are smaller size units while units 15 to 22 are larger. At present, load is shared by proportional allocation. That is, for a given powerhouse load set point, the larger units are loaded more heavily. The proportionality that is used in the present release of GDACS is the ratio of the spread of the one percent operating limits. Consequently, this proportionality is a variable that depends on head. At 75 feet of head, the minimum and maximum one percent limits for units 1 to 14 are 48.6 MW and 68.0 MW. This gives a spread of 19.4 MW. For units 15 to 22 the limits are 50.7 MW and 76.2 MW, which gives a spread of 25.5 MW. Therefore, the proportionality is, $(68.0 - 48.6)/(76.2 - 50.7) = 19.4/25.5 = 0.76078$. In other words, units 1 to 14 are loaded at 76.078% of the loading on units 15 to 22.
2. The T2 Optimizer program that is currently under development has two separate optimizing calculations. (The "T" in the name simply stands for the second of the three types of optimization). First, it calculates an optimum unit allocation for whatever units are selected to enter its optimization matrix. For this calculation the T2 program uses the synonymous name of "Economic Dispatch" and abbreviates it as "ED." In this calculation, no units are brought on-line or dropped off line. If the calculation results in a unit going to the full or to minimum power values in the data table, that unit's generation is simply fixed to remain at that value. This part of the T2 program is completed and is working correctly.
3. The second, separate, calculation that T2 is intended to do is called "Unit Commitment." This refers to the preselection of the specific units to be placed on-line to enter the load apportionment optimization matrix so that the final solution will be the one, true optimum. There are actually two types of unit commitment. One is based on unit efficiencies only and is referred to as instantaneous unit commitment. The second includes a number of other considerations and is referred to as economic unit commitment. This part of the T2 program still needs to be completed and thoroughly tested.
4. The purpose of T2 is to consider all the differences in unit performance profiles and to calculate an optimum loading for each unit so that the powerhouse combined efficiency is maximized. At The Dalles, the GDACS presently has only a single performance table for all units 1 to 14 and a separate, single, table for units 15 to 22. However, a hand calculation was done to determine if the economic dispatch feature of T2 could still provide a benefit over the present GDACS method of proportional allocation. It is emphasized that this is not all of the benefit available from T2, but only compares the economic dispatch versus

proportional allocation of two performance profiles. If the individuality of each unit could be considered and the unit commitment feature added, the benefit from T2 would be considerable larger.

5. First, a scenario was established in which all units were on-line, so that unit commitment was not involved. A tabular value of head at 75 feet was selected so that head interpolation was not involved. Then, this hand calculation was done in a reverse manner. Rather than starting with a powerhouse load set point, loadings on units 1 to 14 were assigned in even five MW increments. Next, the derivative of the rate of change of flow with respect to power (dQ/dMW) was calculated for each of these load points. Then the loading on units 15 to 22 for each of those same values of the derivative was calculated. Summing these gave the corresponding powerhouse load set points. Next, the proportional allocation for each of the powerhouse load set points was calculated. The flow rates were then determined for all of the preceding power values. Finally, the difference in the two powerhouse flow rates for each powerhouse load set point provided the flow saving benefit.
6. On Graph 1, this saving in flow by economic dispatch over proportional allocation for the two performance profiles is plotted versus the powerhouse load set point. The value of the benefit may be judged in that at this head, it takes about 185 cfs to generate one MW. On Graph 2, the difference in the proportional allocation minus the economic dispatch is plotted also versus the powerhouse load set point. It is noted that proportional allocation tends to overload units 15 to 22 and under load units 1 to 14.
7. In conclusion, even though individual performance profiles at The Dalles are not yet available and the work on T2 is not yet complete, the economic dispatch part of T2 is now available and its installation into GDACS at this time could provide a measurable benefit.

3/4/05

T2 OPTIMIZATION
COST ESTIMATE

FY05 Cost Estimate

1. AE Contractor Cost: $105K
   a. TO1 - Engineer, design, develop and lab test an upgraded version of the T2 Optimizer Program containing Unit Dispatch, and include Unit Allocation on a efficiency basis only: $45K
   b. TO2A – Program, develop, integrate and lab test the upgraded T2 Optimizer, which will now include unit commitment on a constrained and time basis, into GDACS: $60K (Assumes TO2 split in FY05 and 06, and only 2 to 3 months is available for work in FY05.)
2. HDC GMT Plus Wittinger/Sheldon/Miska Cost: $35K
   a. TO1 – $20K {GMT - $10K: Others – $10K}
   b. TO2A - $15K (Assumes TO2 split in FY05 and 06, and only 2 to 3 months is available for work in FY05.) {GMT - $10K: Others - $5K}

FY06 Cost Estimate

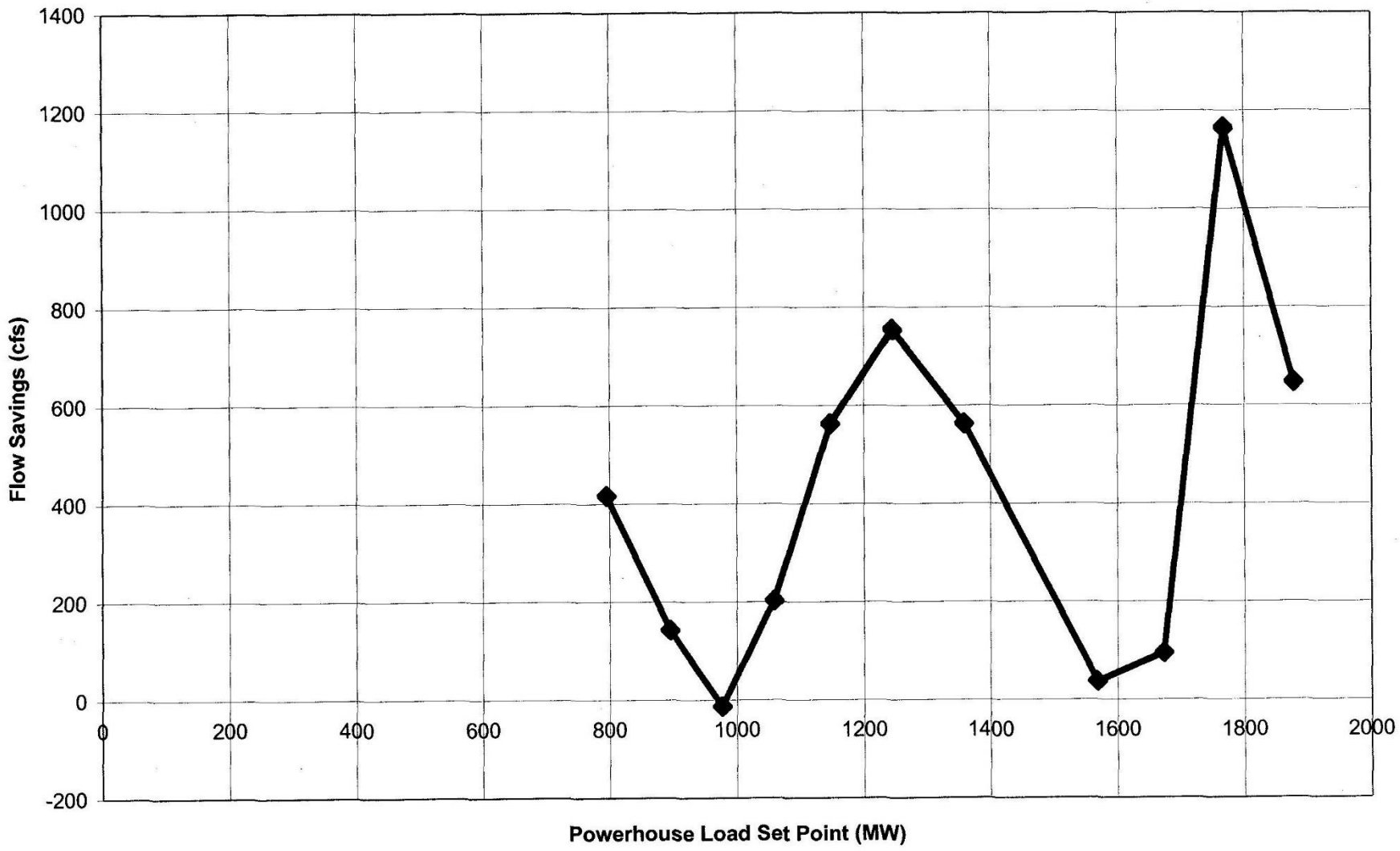
1. AE Contractor Cost: $395K
   c. TO2B – Continuation of TO2A above: $165K
   d. TO3 – Implementation, and testing of T2 Optimizer at one site: $160K
   e. TO4 - T2 Optimizer program refinement as a result of site testing - $70K
2. HDC GMT Plus Wittinger/Sheldon/Miska Cost: $145K
   a. TO2B - $60K {GMT - $50K: Others - $10K}
   b. TO3 - $60K {GMT - $50K: Others - $10K}
   c. TO4 - $25K {GMT - $20K: Others – $5K}

FY07 Cost Estimate

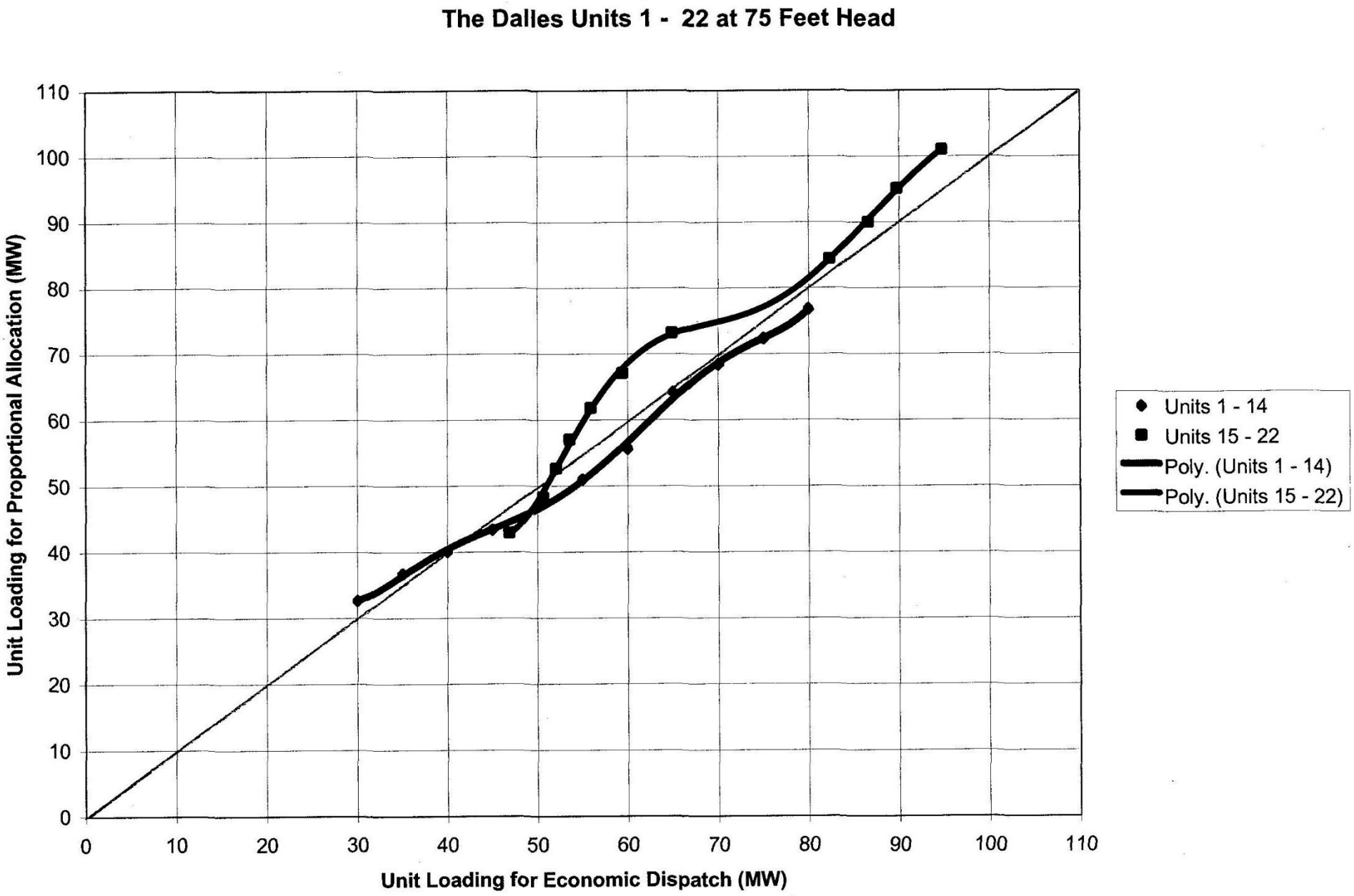
1. AE Contractor Cost:
   a. TO5 – Engineer and configure T2 Optimizer for
2. HDC GMT Cost:
   a. TO5 -

****

The Dalles Units 1 - 22 at 75 Feet Head



GRAPH 1


The Dalles Units 1 - 22 at 75 Feet Head
Unit Loading for Proportional Allocation (MW)
Unit Loading for Economic Dispatch (MW)
0
10
20
30
40
50
60
70
80
90
100
110
Units 1 - 14
Units 15 - 22
Poly. (Units 1 - 14)
Poly. (Units 15 - 22)

GRAPH 2

Difference in Unit Loading by Economic Dispatch and Proportional Allocation
Unit Loading by Proportional Allocation Minus Economic Dispatch (MW)
10
8
6
4
2
0
-2
-4
-6
0
200
400
600
800
1000
1200
1400
1600
1800
2000
PEAK POWERHOUSE EFFICENCY
Powerhouse Load Set Point (MW)
Units 1 - 14
Units 15 - 22

Willis
4/19/05

T2 FY05 & 06
Work to be Contracted Out

Step 1: (TO issued April 05) Develop functionality to provide unit commitment on an efficiency basis – Instantaneous UC. (FFP)

1. Create system at ACSI for nightly build, zip creation and run of test cases
2. Create new smooth curves using strictly GDACS unit flow data from TDA and smooth unit multipliers
3. Create new ED test cases
4. Create new UC test cases
5. Use up to 5 test case scenarios submitted by COE and develop expected best UC by hand
6. Modularize existing code to enhance maintainability
7. UI change to add a new checkbox to allow the user to select between ED and UC operation. This will allow the checking of UC results by using the ED functionality.
8. Create UC wrapper with ability to do just ED
9. Create unit priority list based on unit operating efficiency at the UI provided high MW limit (highest efficiency is highest priority)
10. Create unit priority list based on unit operating efficiency at the UI provided low MW limit (highest efficiency is highest priority)
11. Create unit priority list based on the UI provided low MW limit (smallest MW is highest priority)
12. Create unit priority list based on the UI provided high MW limit (largest MW is highest priority)
13. Traverse priority list in order of decreasing priority putting units "on line" until total efficiency starts to decrease
14. UC wrapper to traverse all the priority lists and keep/report the best result
15 Enhance the debug output to include UC actions
16. Enhance the debug to allow selection between only ED, only UC and with both
17. Document new and modified code to the level of existing T2O
18. Document UI to the level of existing T2O
19. Document the success/failure of all test cases
20. Deliver documentation and source code on CD when done – two copies
21. Deliver bound copies of the documentation when done – two copies
22. Deliver final result on COE provided laptop running Windows 2000
23. Provide up to 4 hours of training in program use at the time of final delivery