SECTION G

Tab 1

CONDITION ASSESSMENT OF GOVERNOR CONTROLS FOR UPPER SALMON AND CAT ARM UNITS

Prepared by: Generation Engineering
(P & C Section)
Date: June, 2001

1) Purpose of Review

Hydro Generation requested Generation Engineering to prepare a condition assessment of the control portions of the governors for Upper Salmon (1 unit) and Cat Arm (2 units). The purpose of the assessment is to review the service history of the control components and to determine what technical support and spare parts are available from the original equipment manufacturers.

The end result of the review is to determine if and when the control sections of these governors should be replaced.

A section has been included on possible replacement controllers with a cost comparison.

2) Introduction

Upper Salmon is a single unit plant rated at 88.4 MVA (84MW). It has a Francis turbine and a Woodward Governor Mod II analog control system. This governor is the original equipment that has been in service since late 1982.

Cat Arm is a two-unit plant with each unit rated at 75.5 MVA (72MW). Each unit has a Pelton turbine with a governor made by Escher Wyss. These governors are an analog electronic type that has been manufactured by Escher Wyss since 1974. The governors at Cat Arm have been in service since 1984.

There have been notices from both Woodward (hydro turbine controls section now part of General Electric Global Controls Services) and Escher Wyss (now Vatech Hydro) that support for these systems will become difficult to provide in the next few years.

The report gives information on replacement systems and the estimated costs of these replacements.

3) Upper Salmon

a. Technical Support and Spare Parts

The need for a review of the Upper Salmon governor controls was highlighted by a memo dated 97-12-16 from Ron Bland of Woodward Governor to Louis Barnes concerning support for the Mod II governor. In this memo he states that "Through this process [product rationalization] we have determined that it is becoming increasingly difficult to provide support for the Woodward Mod I and Mod II Analog

control systems. This is mainly due to our inability to procure electrical components from our vendors. This means we can no longer manufacture new modules. We can, in many cases, still offer repair services on these modules as long as the components that are unavailable are still functional".

It was later confirmed with Woodward that new boards are not available and repairs can only be done as long as components are available. The Woodward representative stated in a note dated 99/07/06 that board repair for the Mod II governor was still available but limited. He stated that "Many of the necessary components are no longer available from our suppliers and we do not know which components have been discontinued until we try to purchase them. Unfortunately, this puts Mod II owners in a precarious situation. We will repair boards so long as we can get the parts, but at this point, there are no guarantees".

Hydro has a good supply of spare parts for the Mod II. However, if the spare is used, it may be difficult to replace it or have the removed card repaired. Technical Support (service representatives) is available for the Mod II.

b. Service History

The maintenance records between 1995 and 1999 were checked for the governor controls and brief descriptions are given below.

(i) 95-03-28 (W.O. #12906)
Problem: Unit will not load past 10% gate;
Action: Investigated speed control circuit; replaced 65MS motor and relay 33XYZ (coil burned out).

(ii) 95-11-01 (W.O. # 16013)
Problem: Check governor load setpoint fluctuations;
Action: 2 pots replaced.

(iii) 97-09-16 (W.O. # 25198)
Problem: Governor power setpoint control not responding to load control below 75MW;
Action: Adjusted tension on slip clutch; adjusted mechanical end stop.

(iv) 97-11-13 (W.O. # 25730)
Problem: Adjust SNL setting on speed/load control;
Action: Replaced speed sensor card.

(v) 97-11-14 (W.O. # 25731)
Problem: Replace relay 04T2;
Action: Installed a new relay.

(vi) 97-12-04 (W.O. # 26000)
Problem: Investigate discrepancies between load setpoint and the actual load;
Action: Replaced defective pot assembly.

(vii) 97-12-12 (W.O. # 26056)
Problem: Investigate difference between governor load setpoint and actual load;
Action: Replaced operational amplifier on speed sensor card.

(viii) 97-12-21 (W.O. # 24726)
Problem: Check controls to determine why unit shed load on 97-08-15;
Action: Hydro personnel did some checks after the problem first occurred. The problem reoccurred and a service representative was called in from Woodward. Amplifier IC14 was replaced and some bent pins on the speed sensor were straightened.

This is not a complete list of all service trips made by Bay d'Espoir but it does give an overview of the problems that have occurred.

4) Cat Arm

a. Technical Support and Spare Parts

A memo dated January 31, 1996 from Urs Gantenbein of Sulzer Hydro to Darren Moore highlighted the need for review of the Cat Arm Governor Controls. In this memo it was stated that replacement parts and the repair of cards would be available until the end of 2004. The last sales for new projects were July 31, 1996.

This was further confirmed in January 2000 by Sulzer Hydro that card repairs would be available only until 2004.

Hydro has a good supply of spare parts for the governor controls. With repair services available until 2004, Hydro is covered until then.

b. Service History

As per Bay d'Espoir maintenance records, there have been 4 cards and 3 power supplies replaced since 1990. Brief descriptions of the card problems are given below:

(i) 1990 (W.O. # 24159) *Problem: Unit # 1 governor needle # 6 would not open;*
Action: Replaced defective relay card SRA-11 used for needle # 6 switch on circuit.

(ii) 1990 (W.O. # 24793) *Problem: Unit # 1 governor needle # 6 picking up and dropping out suddenly;*
Action: Replaced card with spare (card not described).

(iii) 1990 (W.O. # 26825) *Problem: Unit # 1governor failure of 24V power supply;*
Action: Power supply replaced.

(iv) 1993 (W.O. # 28447) *Problem: Unit # 1limiter setpoint will not rise;*
Action: Limiter setpoint card replaced.

(v) 1994 (W.O. # 29992) *Problem: Unit # 1 power supply;*
Action: Temporary DC power supply installed. New power supply ordered from Escher Wyss (1994). Received and installed under W.O. # 23342.

(vi) 1995 (W.O. # 30658) *Problem:* Unit # 1 defective 24V power supply;
Action: Replaced power supply.

(vii) 2000 (W.O. # 118723) *Problem: Unit # 2 second needle does not cut in until the first is 100%;*
Action: Replaced and adjusted needle switch on card RUM-20 (damping switchover card).

5) Replacement Systems

Woodward Governor Company manufactured the governor controls at Upper Salmon and Escher Wyss manufactured those at Cat Arm. The hydro governor business of Woodward has been sold to General Electric and is now covered by GE Global Controls Services. Escher Wyss was later sold to Sulzer Hydro which became a part of Vatech Hydro.

Since Woodward and Escher Wyss were the original manufacturers, they were asked to provide information on replacements for Upper Salmon and Cat Arm respectively.

a. Upper Salmon

(i) GE Global Controls Services (Woodward) Proposal

Woodward submitted a proposal in 1999 (before sale to GE Global Controls Services) based on the Micronet Turbine Control System. Since then they have produced a new turbine control system called the Atlas PC. The Atlas PC has been accepted as the governor control at Granite Canal. GE Global Controls Services now use the Atlas PC as their standard product rather than the Micronet.

The upgrade from analog to digital controls also involves the replacement of the mechanical feedback systems with electronic feedback devices. The pilot stage of the hydraulic system will be replaced with an electrohydraulic interface. The analog cards will be replaced with the Micronet or Atlas PC system.

The Micronet was originally proposed by Woodward and it can be used to control gas turbines, steam turbines, gas engines or hydro turbines. It has a number of functions besides being a governor. The Micronet is available in both simplex, as originally proposed for Upper Salmon, and triple modular redundant (TMR) configurations.

The Atlas PC controller is based on an embedded PC technology using an industrial Pentium processor. There are two (2) models of the Atlas PC control system called the Atlas HMOD and the Atlas HC.

GE Global Controls Services have a CD titled "Hydro Solutions" where you can enter the type of turbine you wish to control and the best GE solutions will be presented. The Francis turbine such as at Upper Salmon can use either the Atlas HMOD or Atlas HC models with the Atlas HMOD being the recommended choice.

The differences between the Atlas HMOD, the Atlas HC, and the Micronet HC are shown in the comparison chart below. This chart is applicable to both Upper Salmon and Cat Arm if GE solutions are used at both sites. The chart shows the base model and which options are available for each model.

Functionality	Atlas HMOD		Atlas HC		Micronet HC	
Servo Control	Base	Option	Base	Option	Base	Option
- Off line Speed Control (Dedicated Gains)	X		X		X	
- Integrated Manual Position Cntl	X		X		X	
- Blade Position Control (3-D CAM)		X		X		X
- Needle Control				X		X
- Load Control (Frequency/Load – Dedicated Gains)	X			X		X
- Gate Position Control (Frequency/ Load – Dedicated Gains)	X		X		X	
- Level Control				X		X
- Flow Control				X		X
- Pumping Control (pump turbine)				X		X
- Synch. Condense				X		X
- Isochronous Control		X		X		X
- Loadsharing (DSLC)				X		X
- Gate Limit	X		X		X	
- Integrated Electronic Overspeed Protection	X		X		X	
Sequencing						
- Start Permissive	X		X		X	
- Start Ramp	X		X		X	
- Breaker Control	X			X		X
- Synchronization (DSLC)		X		X		X
- Integrated Synchronization		X		X		X
- Rough Zone Avoidance				X		X
- Stop Ramp (soft unloading)	X		X		X	
- Emergency Shutdown	X		X		X	
- Black Start				X		X
- Creep/Dead Stop Detection		X		X		X
- Blade Lock/Tilting		X		X		X
- Needle Sequencing				X		X
- Gate Lock		X		X		X
Auxiliary Control						
- Speed and Gate Position Switches	X		X		X	
- Var/PF (DSLC)				X		X
- HPU (echelon control)						X
- Lift Oil Pumps				X		X
- Brake Control	X			X		X
- Lube Oil/Water Cooling Pumps				X		X
- Pressure Tank Air Charging				X		X
- Black Start Diesel (start/stop)				X		X
- Spill Gate				X		X
- Standalone Manual Positioning (723MP)						X
- Additional Auxiliary Control				X		X

Functionality	Atlas HMOD		Atlas HC		Micronet HC	
Monitoring	Base	Option	Base	Option	Base	Option
- Trips/Alarms	X		X		X	
- Control I/O (status)	X		X		X	
- Generator variable (real/reactive Power, etc)		X		X		X
- Temperature/Pressure		X		X		X
- Levels (head, tail and/or net head)		X		X		X
- Vibration				X		X
- Expanded Capability				X		X
Operator Inferfaces						
- Operator Control Panel (OCP) (hardwired)		X		X		X
- Operator Interface Terminal (mini touchscreen HMI)	X			X		X
- HMI (local and/or remote)		X		X		X
- SCADA		X		X		X
- Interface Expansion				X		X
Service Tools						
- Two-line Display/Handheld Programmer						
Maintenance Mode	X		X		X	
Calibration Mode	X		X		X	
Dynamic Tuning	X		X		X	
- Servo Timing	X		X		X	
- Maximum Speed Capture	X		X		X	
- Integrated Index Testing				X		X
- PC Diagnostic and Configuration Software						
Watch Window (configuring/ viewing control variables)		X		X		X
Trender		X		X		X
Control Assistant (datalog viewing, tunable maintenance)		X		X		X
Port Monitor SOE (sequence of events)		X		X		X
Port Monitor DEC (data event capture)		X		X		X
- GAP License		X		X		X
- Remote Service & Support (dialup)		X		X		
Communication (Modbus)						
- 1 Serial Port (RS-232, RS-422, RS-485)	X		X		X	
- Ethernet	X		X			X
- Expanded Communications (Profibus)				X		

NOTE:

1) Atlas HC refers to Hydro Custom. The custom work is in the hydraulic interface to non-Woodward units.

2) DSLC - Digital Synchronizer and Load Control (separate device)

3) OCP - Operator Control Panel – hardwired that provides minimum control inputs (switches) and outputs (meters) for local unit operation. The OCP is generally provided on the door of the electrical enclosure.

4) HMI - As per the description, Standard HMI operator interface consists of an industrial flat panel display or a commercial desktop computer running Intellution Software. It provides integrated sequencing, unit mode control, auxiliary control and monitoring of the individual unit from a graphic display. The HMI can also provide first out alarm/trip annunciation, data acquisition and trending.

5) GAP - Graphical Application Programmer is the software used to write the control application.

The recommended choice by GE Global Control Services for Upper Salmon is the Atlas HMOD. As can be seen from the comparison chart, the Atlas HMOD has fewer features than the Atlas HC or the Micronet HC. Some of these features are not necessary for a Francis turbine such as Needle Control, Level and Flow Control or Pumping Control.

Plant personnel would have to review the functionality to see if features not included in the Atlas HMOD are needed, such as some of the items under Sequencing (Rough Zone Avoidance, Black Start) or Auxiliary Control (Lift Oil Pumps, Lube Oil/Water Cooling Pumps, etc.)

For use as a governor only, the Atlas HMOD appears adequate.

The cost estimate for the Atlas HMOD and Micronet is given in Appendix A.

Pros:

1) GE Global Controls Services, purchaser of Woodward hydro controls section was the original equipment supplier.

2) GE Global Controls Services through their purchase of Woodward has a great deal of experience in hydro turbine control.

3) The Atlas PC will be in service at Granite Canal in 2003. There would be benefits in spare parts and training to use the same system at other sites.

Cons:

1) The Micronet and Atlas PC are proprietary systems and GE Global Controls Services would have to supply all spare parts.

2) Higher cost then for PLC system. (See cost estimate page 12).

(ii) PLC Based System

When the Digitek Plant Controller with the governing function was replaced at Paradise River in 1998, a programmable logic controller was supplied by Russelectric using a GE Fanuc Series 30. Therefore, PLC based systems should be considered for governor controls replacement at Upper Salmon.

Both Russelectric (Boston, Mass.) and L & S Electric (Schofield, Wisconsin) were asked to provide an estimate for replacement of the existing Woodward governor controls with a PLC based system.

a) Russelectric

Russelectric is a company based in Hingham, Massachusetts (outside Boston) that does "power protection and control systems for critical facilities" (as per their website). They are represented by C-Tech of North America Inc. based in Florida and the estimates in this report were provided by C-Tech.

Hydro has experience with Russelectric with the replacement of the Digitek controller at Paradise River. Russelectric did a good job and the replacement was successful. The PLC based governor and control system has worked well during the two and one half years it has been in service.

A copy of the estimate and scope of work from Russelectric is given in Appendix B. The estimate is for a governor controls replacement only and it does not include other control functions.

b) L & S Electric

L & S Electric are based in Schofield, Wisconsin. They have been providing automation systems, governors, excitation systems and SCADA systems for 18 years. They have about 165 governor and/or gate positioner units in service. L & S Electric have done governor projects in Canada for West Kootenay Power, B.C. and Ontario Hydro (Red Rock, Ear Falls)

L & S Electric bid on the Paradise River Digitek replacement using an Allen Bradley PLC, but their quotation was higher than the one from Russelectric.

A copy of the estimate and scope of work from L & S Electric is given in Appendix C. The estimate is for a governor controls replacement only and it does not include other control functions.

Pros:

1) Russelectric has supplied a system at Paradise River (GE Fanuc 30) that is working well.

2) The hardware and software for the PLC (GE Fanuc, Modicon, Allen Bradley) is readily available.

3) Russelectric has given good service on the Paradise River control system.

4) Both Russelectric and L & S Electric provided quick responses to the request for automation.

5) Lower cost than GE Global Controls Services. (See cost estimate page 12).

6) L & S have a number of former Woodward employees on staff.

Cons:

1) Neither company has the experience that GE Global Control Services (Woodward) has.

2) Both companies' experience is mainly with smaller machines.

(iii) Cost Estimate (Upper Salmon)

Based on purchase and installation in 2002. All estimates were given in U.S. dollars. The conversion rate used is 1.50. All costs below are shown in Canadian dollars.

Item	GE Global Controls Services		Russelectric	L & S Electric
	Micronet	Atlas HMOD		
a) Equipment - controller - interface cards - display	$270,000	$187,500 See Note 1	$164,000 Note 2	$127,000 Note 2
b) Installation supervision	$40,000 Note 3	$40,000	10 days (Included in Item a)	(10 days) $30,000
c) On-site training	$25,000 Note 4	$25,000	$25,000	$25,000
Subtotal	$335,000	$252,500	$189,000	$182,000
d) Misc. Material	$25,000 Note 5	$25,000	$25,000	$25,000
e) Installation (Internal)	$100,000	$100,000	$100,000	$100,000
f) P & C Engineering	$50,000	$50,000	$50,000	$50,000
Total Direct Costs	$510,000	$427,500	$364,000	$357,000
g) Corporate Overheads	$33,600	$28,200	$23,900	$23,500
h) IDC	$6,100	$5,400	$5,300	$520
i) Contingency	$51,000	$43,000	$36,000	$36,000
j) Escalation	$11,700	$9,900	$8,300	$8,000
TOTAL	**$612,400**	**$514,500**	**$437,500**	**$429,800**

NOTES:

1. The cost is based on a new EHI pilot valve version that retains the existing distributing valve.
2. The PLC based systems do not include a separate operator interface. The existing switches and meters are used. The Atlas PC has a mini touchscreen HMI included.
3. GE Global Control Services - based on 3 weeks for a commissioning engineer.
4. Training – based on 5 days for technicians and 5 days for operators; includes presentation materials and all instructor costs/expenses.

5. Miscellaneous material – all Hydro supplied material such as laptop computer, terminal blocks, cable & mounting hardware.

6. All estimates are based on using the turbine controllers as governors only. Additional control and monitoring could be added.

CONCLUSION:

Based on the cost comparison, a PLC based system would be the least cost.

b. Cat Arm

(i) Sulzer Hydro Proposal:

Sulzer Hydro (now Vatech Hydro) submitted a price based on their model DTL 595 digital turbine control system. This controller has been used by Newfoundland Power at their Rose Blanche plant.

Vatech Hydro did not provide detailed information on the capabilities of the DTL 595. There is a two page description on their website and this is included in Appendix D. The references show that the DTL595 has been used on large machines.

(ii) PLC Based System:

As with the Upper Salmon governor controls, Russelectric and L & S Electric can provide a PLC based system.

The Pros and Cons of using a PLC based system are the same as for Upper Salmon. Neither Russelectric nor L & S Electric has the experience of Vatech Hydro on machines of this type and size.

(iii) The Atlas HC by GE Global Controls Services could be used as a replacement for the governor controls at Cat Arm. They have done a replacement for a six-needle impulse Escher Wyss system at NCPA Collierville (2001).

Cost Estimate (Cat Arm)

Based on purchase and installation of first unit in 2004. The estimates from Russelectric and L & S Electric were given in U.S. dollars. The conversion rate is 1.50. All costs below are shown in Canadian dollars.

Item	Vatech Hydro	Russelectric	L & S Electric	GE Atlas HC
(a) Equipment -controller -interfaces -mux	$80,000	$220,000	$355,000	$277,500
(b) Installation supervision	10 days included	10 days included	$30,000 (10 days)	$30,000
(c) On-site training	$25,000	$25,000	$25,000	$25,000
Subtotal	$105,000	$245,000	$410,000	$332,500
(d) Misc. material	$15,000	$15,000	$15,000	$15,000
(e) Installation (Internal)	$100,000	$100,000	$100,000	$100,000
(f) P & C Engineering	$50,000	$50,000	$50,000	$50,000
Total Direct Costs	$270,000	$410,000	$575,000	$497,500
(a) Corporate Overheads	$17,800	$27,000	$37,900	$32,600
(b) IDC	$4,200	$5,500	$6,500	$6,000
(c) Contingency	$27,000	$41,000	$58,000	$50,000
(d) Escalation	$19,200	$29,100	$40,900	$35,100
TOTAL	**$338,200**	**$512,600**	**$718,300**	**$618,700**

Based on the cost comparison, the controller from Vatech Hydro is the least cost.

The cost estimates are given in Appendices A, B, C & D.

Recommendations:

1. The governor controls at Upper Salmon should be replaced due to the unavailability of components for the cards.

2. The governor controls for one unit at Cat Arm should be replaced by 2004 when card repairs are no longer available. The second unit should be replaced within a year or two of the first one with the same model and type.

3. The specifications for both sites should be written to include the use of proprietary equipment or PLC based systems.

4. The Plant should review their long term governor replacement plans for the mechanical units at Bay d'Espoir. If it is decided to use GE Global Controls Services (Woodward) only, there may be some value in using that product at Upper Salmon and Cat Arm.

APPENDIX A

ATLAS PC and MICRONET TURBINE CONTROLLERS AND COST ESTIMATE

doug.nolan@ps.ge.com on 02/28/2001 03:47:47 PM

To: Rick Leggo/NLHydro@NLHydro
cc:
Subject: FW: Newfoundland Hydro - Upper Salmon, Cat Arm

Rich,
Please see our basic rough order of magnitude pricing and descriptions below.

Upper Salmon

Our standard upper-end product is now Atlas, so a MicroNet quote is not needed. A budgetary estimate at this unit takes two forms - 1) Atlas control with a new EHI pilot valve version that retains the existing distributing valve, or 2) Atlas control with a new FC-5000 distributing valve. Option 1 is estimated at $125,000. Option 2 is estimated at $145,000. These prices include a site visit, manuals and engineering for the above solutions. Note that the MicroNet/EHI quote given by Scott two years ago was for $160,000. This shows the improvement that the Atlas has given us in pricing.

Cat Arm

This is based somewhat on the NCPA Collierville job that we're doing, which is also a six-needle impulse Escher-Wyss system. Again, the Atlas is the control of choice and EHI's are the way to go with multiple-needle units. Assuming the six-needles and one deflector (so, 7 EHI's), the price for Unit #1 is estimated at $185,000. If Unit #2 is identical and we don't have to re-engineer any differences, then it is estimated at $112,000. Again, these prices include the typical level of site visit, manuals and engineering.

Values are in USD. Our standard terms and conditions apply to any resulting order. Our prices are subject to review and acceptance of complete project specifications.

If a Micronet system is still desired for Upper Salmon the current pricing would be estimated as $181,000. Is there some compelling reason to use Micronet rather than Atlas here ? Are there additonal requirements which we need to consider ? What are your needed on site dates for this equipment ? Rick, of course we are interested in working with you on this project. Please advise if we can be of any further assistance.
Regards,

Douglas

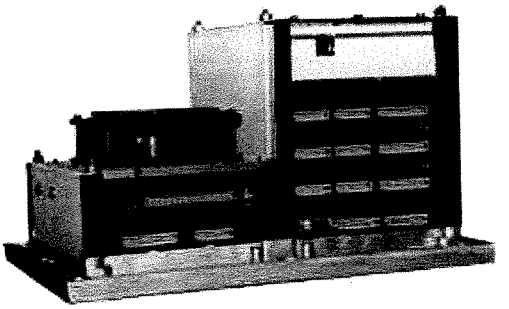
-----Original Message-----
From: Rick_Leggo/NLHydro@nlh.nf.ca [mailto:Rick_Leggo/NLHdro@nlh.nf.ca]

WOODWARD

Product Specification
03213

AtlasPC

TURBINE AND ENGINE CONTROL SYSTEM



APPLICATIONS

The AtlasPC Control System is a new generation of turbine and engine control that provides the power of PC technology in a rugged and deterministic system. The flexible and powerful software tools and exceptional computational power make AtlasPC an ideal solution for controlling a variety of Prime Movers:

- Industrial Gas Turbines (large and small)
- Aero-derivative Gas Turbines
- Gas and Diesel Engines
- Steam Turbines
- Hydro Turbines

The AtlasPC control is well suited to many specific applications:

- Generator Applications – Main, Peak, Stand-by, Marine
- Mechanical Drive – Compressors, Marine
- Any Application Requiring a Low Cost, Powerful and Rugged Control

The AtlasPC Control System scales up and down extremely well. Through field bus expansion, the system fits almost every application. Whether used as a core fuel control or an entire package control, AtlasPC is the solution.

DESCRIPTION

AtlasPC is a powerful and rugged industrial control with embedded PC technology and dedicated I/O for real time control of turbines and engines. At the heart of the small and powerful AtlasPC Platform is an industrial Pentium Processor with Real Time Operating System (RTOS). The AtlasPC platform utilizes the industry standard PC/104 bus structure to leverage "PC Economics," resulting in lower costs and greater feature flexibility.

AtlasPC environmental specifications allow it to move out of the control room and closer to the prime mover, even on the turbine skid in many cases. It is generally bulkhead mounted in an enclosure. Engineering and service interface is through serial or Ethernet ports. An optional display and keypad may be added to provide a limited local interface (future - check for availability).

AtlasPC contains on-board I/O optimized for prime mover control. The performance of these channels gives precise turbine and engine control not always possible with general-purpose I/O products. Configurability on many channels maximizes flexibility and channel usage, usually offering the least expensive I/O choice available.

Where additional I/O expansion is required, AtlasPC makes use of a field bus networking strategy. Field bus networks like Profibus DP or Ethernet (TCP/IP ModBus) are used to distribute I/O and smart devices from a variety of different vendors. Entire package control, including auxiliary sub-system control, system monitoring, and overall sequencing, becomes very economical.

AtlasPC CONFIGURATIONS

AtlasPC supports two bus technologies and two "stacks" of modules, the PC/104 stack and the Power Bus stack. The modules utilize connectors that build the bus structure as they are stacked together. See the graphic next page.

Each bus structure supports different types of modules. The PC/104 stack uses the PC industry PC/104 standard and supports most I/O modules, the Pentium processor, and the communications modules. The Power Bus stack supports the power supply and limited I/O modules.

- Powerful Real Time PC Control for Turbines and Engines
- Low Cost – Sensible Alternative to a General Purpose PLC
- Produced and Backed By Woodward - Turbine and Engine Control Experts
- Pentium Processor Provides Exceptional Processing Power
- Real time Multi-tasking Operating System with Deterministic Update Rates
- Fast, Accurate On-Board I/O Modules
- Profibus and Other Field Bus Options for Additional I/O Expansion
- Excellent Networking Capabilities
- Scalable From Core Fuel Control to Total Package Control
- Generator Synchronizing and Power Management Functions Optional

Modular construction allows considerable flexibility in meeting market requirements. Module options are listed at the end of this document.

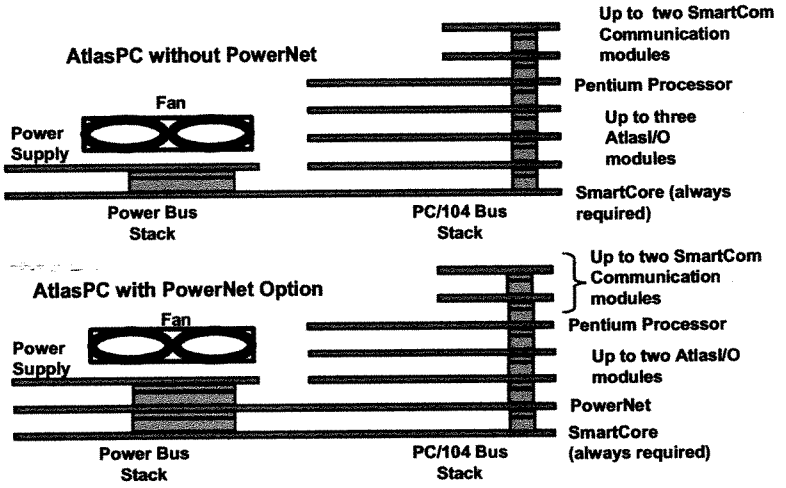
Every system contains the "SmartCore" module that bridges the power bus and the PC/104 bus. It contains I/O required by many prime mover control applications.

The PowerNet board (future - check for availability) is a specialized I/O module for Generator Control including Synchronizing, Load Management, and Load Control. PowerNet extends across both bus stacks.

"AtlasI/O" personality modules are placed on the PC/104 bus stack to tailor AtlasPC to the particular needs of certain market segments. Up to three AtlasI/O modules may be used (two if PowerNet is present).

The Pentium CPU Module always sits on top of the AtlasI/O modules on the PC/104 stack. One or two small "SmartCom" Communications Modules (E.G. Profibus DP Master) can stack on top of the Pentium.

The "Power Bus" distributes power to the control. The power supply provides regulated power for AtlasPC and also contains the relay driver outputs. The power bus stack will also support certain actuator options (future - check for availability).



High Performance On-Board I/O

AtlasPC on-board I/O is optimized for prime mover control

- High Speed and Deterministic update times
- High CMRR and control specific filtering result in high degree of noise immunity
- 15 bit resolution differential inputs, allowing very precise control
- I/O is accurate across temperature range
- I/O is isolated in groups to prevent ground loops and other induced noise issues

PROGRAMMING AND SIMULATION

AtlasPC makes use of the same powerful and proven tools used by all of Woodward's PC control systems. Engineers create powerful and flexible programs through the IEC 1131-3 programming environment:

- Function Block Diagrams - through Graphical Application Programmer (GAP)
- Sequential Function Charts - through Graphical Application Programmer (GAP)
- Structured Text
- Ladder Logic (On-line Programmable)

GAP (Graphical Application Program) software is Woodward's pictures-to-code programming tool. GAP accesses libraries of control objects to quickly and efficiently implement complex (or simple) control strategies. The GAP environment lets application engineers concentrate on system level control rather than software coding details.

NetSim is the virtual simulation environment for testing Atlas code without hardware in the loop. NetSim links prime mover and package models (created in standard modeling packages - MatLab/Simulink, MatrixX, ACSL) to the GAP environment. With NetSim, the control code can be completely tested in the office before field commissioning begins. The performance of NetSim is optimized to provide simulation results that correlate very tightly to actual field results.

AtlasPC's programming and simulation tools are optimized for controlling turbines and engines, and their driven loads. Rather than providing a generic environment that is adaptable to any industrial automation requirement, GAP and NetSim are specific. The libraries of supported functions have been proven over many years and countless applications.

Woodward's worldwide organization has unequaled turbine and engine control expertise. To support its OEM and Packager customers, Woodward can supply software tools, or entire solutions, or a variety of options in-between.

REAL TIME OPERATING SYSTEM (RTOS)

AtlasPC utilizes the same field-proven real time operating system (RTOS), as the MicroNet™ NT control. The RTOS utilizes the power of Windows NT together with Venturcom's RTX real time extension.

The Rate Group structure of the GAP development environment, integrated with the NT RTOS, enforces fast, deterministic, and completely repeatable dynamic behavior. Thorough and extensive FFT testing has proven the control system response is exactly as expected at all times, regardless of what is happening elsewhere in the system. The response is also identical to previous proprietary Woodward RTOS architectures. PLC's often make use of a less rigid looping structure that can introduce dynamic instability as code is added or removed.

The GAP/NT RTOS has leveraged the power of Windows NT while ensuring the highest reliability. Unnecessary components of Windows NT are removed to reduce the footprint size and complexity. All required drivers have been extensively tested for robustness and inability to affect system reliability or real-time control. To ensure integrity, no unapproved drivers can be added.

CONTROL AND PLANT LEVEL COMMUNICATIONS

The AtlasPC supports multiple protocols and physical mediums for communications to DCS systems, PLC's, HMI's and SCADA systems.

Protocols Supported:

- ModBus (RTU and ASCII) over serial or Ethernet
- Ethernet TCP/IP
- Ethernet UDP
- OPC (Ethernet) – OLE for Process Control
- DDE - Dynamic Data Exchange (serial)
- EGD (Ethernet)
- Additional Communications Options may be available – check with Woodward.

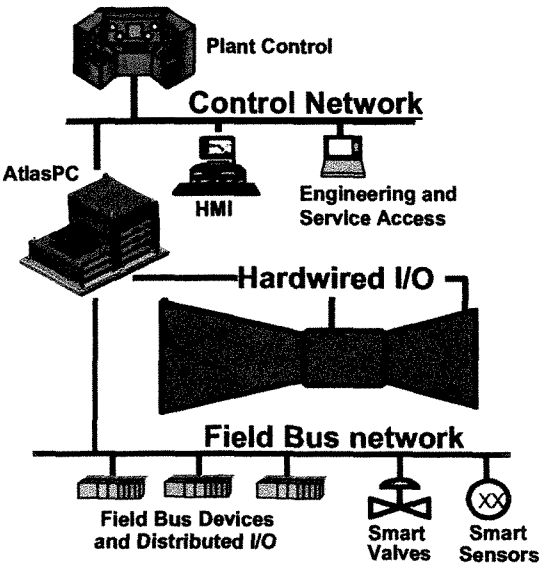
FIELD BUS INTERFACE

Field bus technologies provide the ultimate flexibility in control I/O and distributed intelligence. AtlasPC embraces this trend while still providing on-board I/O for those signals that are not commercially or technically ready for field bus distribution.

Field bus standards supported:

- Profibus DP (12MBaud) - optional SmartCom communications module
- Ethernet TCP/IP ModBus - standard on Pentium CPU
- Check with Woodward for additional options - other common field bus protocols can be added through optional SmartCom communications modules.

Many field bus standards currently compete for market share in engine and turbine control. AtlasPC is a platform that can adapt to changing requirements.



Typical AtlasPC Configuration – Networked Control Strategy

ENGINEERING AND SERVICE ACCESS

Woodward offers a complete suite of software products for service interface. From simple monitoring of any system variable to high resolution plotting of control variables, service tools are available to simplify troubleshooting.

- Watch Window - Ethernet or Serial connection to Windows-based control variable viewing (see product spec 03202)
- Control Assistant - Ethernet connection to Windows-based viewing of high-speed data log captures and other useful utilities (see product spec 03201)
- Other Engineering Interface Tools - Ethernet access to AtlasPC for program loading, network configuration and support, and system diagnostics (refer to manual)
- Remote Access - Powerful and seamless remote connectivity is inherent in the Windows NT operating system of AtlasPC. Remote viewing, access and diagnostics are as close as a network or a modem.
- Human Machine Interface (HMI) - Standard commercial HMI programs interface through Ethernet or serial to provide operator access.

WOODWARD

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United States (Alabama, California, Illinois, Pennsylvania, Texas, Washington)

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Woodward has an international network of distributors and service facilities. For your nearest representative call (1)(800) 835-5182 or see the Worldwide Directory on our web site.

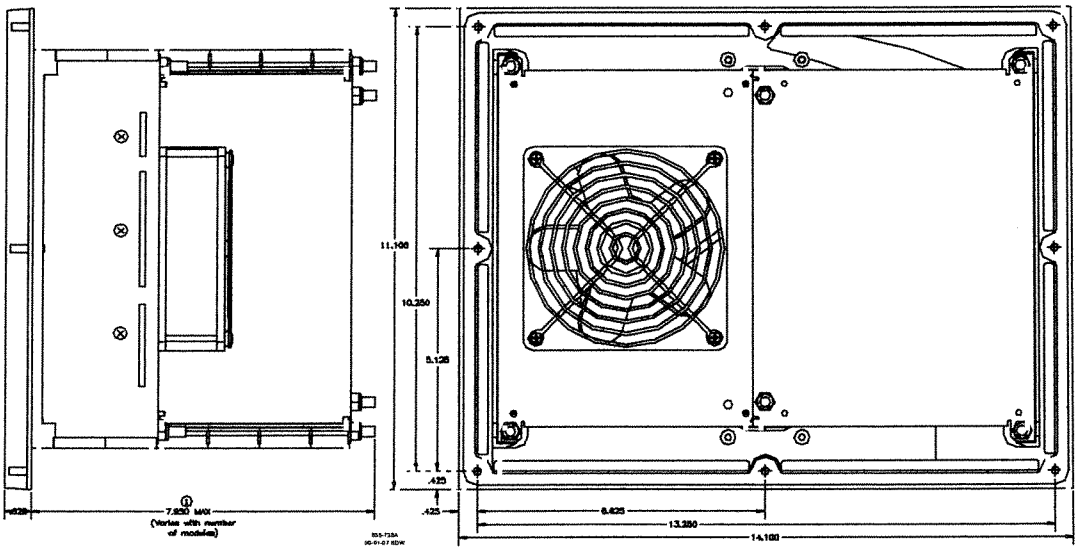
CORPORATE HEADQUARTERS
Rockford IL, USA
Ph: (1)(815) 877-7441

AtlasPC Modules

- **Pentium CPU Board**
  - 266MHz Pentium, 64MB RAM
  - On-board solid state hard drive
  - Hard Real Time NT operating system
  - Ethernet (communications, distributed I/O)
    - *10/100 Base T auto sensing and auto switching*
  - 2 Serial Ports (Service Interface and Remote Access Services)
- **SmartCom Profibus Communications Board**
  - 12 MBaud Profibus DP Master
- **AtlasI/O Analog Input/Output Board**
  - (2) MPU speed pickups
  - (4) RTD (100 or 200 ohm, 3 wire) /4-20 mA inputs (software selectable)
  - (11) Thermocouple (E, J, K, N, R, S, T) /4-20 mA inputs (software selectable)
  - (2) 4-20 mA analog outputs
  - On-board cold junction sensor
- **SmartCore Board**
  - 3 serial ports
    - *1 RS232*
    - *2 configurable RS232, RS422, or RS485*
  - 2 MPU/Proximity
  - 16 Discrete Inputs
  - 4 Analog Inputs (4-20mA, 0-5V)
  - 4 Analog Outputs (4-20mA)
- **Primary Power Supply**
  - 18-32 VDC
  - 12 Relay Drivers
- **PowerNet Board**
  (Check with factory for availability)
  - 120/240/277 VAC PT sensing
  - 0-5 Amps CT sensing
  - Speed Bias (PWM, 0-5V, V, +/-1V +/-3V)
  - Voltage Bias (PWM, 4-20mA, +/-3V, +/-9V)
  - Redundant LON Channel – communicate to other Woodward Power Management Controls

Environmental Specifications

- **Skid Mount Packaging**
  - Class I, Div 2 and Zone 2 HAZLOC Environment
  - CE compliant - Low Voltage Directive, Machinery Directive, Heavy Industrial EMC Directive
  - Operating temperature: -20 to 70° C (55° C with Profibus)
  - Storage Temp: -20 to 85° C
  - Vibration: Lloyds RS Env 2 (0.7g, 15-150 Hz)
  - Shock: Mil-Std-810C, M16.2 (30g, 11msec, 1/2 sine)
  - IP56 Front Panel with optional *Display and Keypad (future)*



AtlasPC Control Outline Drawing

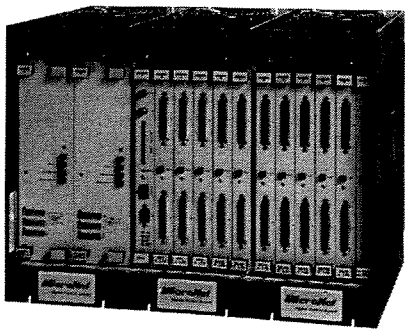
For more information contact:

00/3/F

WOODWARD

Product Specification
85583B

MicroNet•
CONTROL SYSTEM



APPLICATIONS

The MicroNet™ Control System is a state-of-the-art digital controller that is programmable for many types of applications in the control of:

- Gas Turbines
- Steam Turbines
- Hydro Turbines
- Diesel Engines
- Gas Engines

The MicroNet Control System provides a flexible platform to control any prime mover and its associated processes such as high speed control functions, system sequencing, auxiliary system control, surge control, monitoring and alarming, and station control. The MicroNet digital control is available in both simplex and triple modular redundant (TMR) configurations. Each version is expandable into multiple chassis as required by the system size and will support any mix of I/O, including networked, distributed I/O.

PROGRAMMING

The MicroNet Control System provides an IEC1131-3 environment for programming.

- Function Block Diagrams - through Graphical Application Programmer (GAP)
- Sequential Function Charts - through Graphical Application Programmer (GAP)
- Structured Text
- Ladder Logic (On-line Programmable)

GAP software is the graphical programming tool specifically designed for quick and easy implementation of complex control strategies. Gap provides an environment where application engineers can concentrate on control and application issues, not on software coding details.

SYSTEM DESCRIPTION - MicroNet™ DIGITAL CONTROL

The MicroNet control is available in two chassis sizes with either 6 or 12 VME slots. Both have a dedicated power supply section and control section located in a single chassis. The power supply section supports simplex or redundant power supplies.

PROGRAM EXECUTION

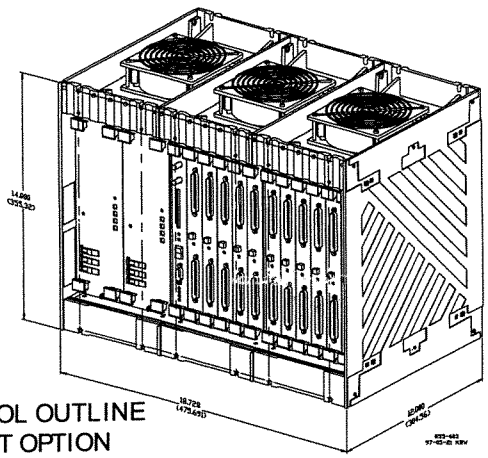
The MicroNet Operating System, together with GAP, produces a very powerful control environment. Woodward's unique rate group structure ensures that control functions will execute deterministically at rate groups defined by the application engineer. Critical control loops can be processed within 5 milliseconds. Less critical code is typically assigned to slower rate groups. The rate group structure prevents the possibility of changing system dynamics by adding additional code. Control is always deterministic and predictable.

CPU OPTIONS

Two families of Central Processing Unit (CPU) modules are available which provide different levels of performance and features. Both use the same programming methods and rate group structure.

- Pentium/NT CPU - the newest offering for the MicroNet gives very high performance for the most complex (size, speed of execution, math intensive, etc.) applications imaginable.

- Provides Total System Control
- Expandable to Meet System Needs
- Communication via Serial Ports and EtherNet LAN's
- Available in Either Simplex or TMR Configurations
- Hot Replacement of Modules
- Simplex or Dual Redundant Power Supplies
- Real time Multitasking Operating System with Deterministic Update Rates
- Based Upon Proven NetCon® Control Hardware and Software
- High-Density I/O Modules With Time Stamping



CONTROL OUTLINE
(12 SLOT OPTION

The Windows NT• operating system is enhanced with areal-time extension that, together with the rate group structure of GAP, provides determinism. This CPU is only available in the Simplex architecture.

- Ethernet Port (10/100 BaseT)
- Two RS232 Serial Ports
  - Video, Keyboard, Monitor output for local display support
  - Program loading over Ethernet TCP/IP network using standard Windows Explorer

- Motorola 68040 CPU - the traditional workhorse of the MicroNet and its predecessor (NetCon) that gives excellent performance for most applications. The proprietary operating system supports both Simplex and Triple Modular Redundant (TMR) architectures. Features include:
  - RS232 Serial Port
  - Fiber optic port for local display support
  - PCMCIA port for program and data file loading

COMMUNICATIONS

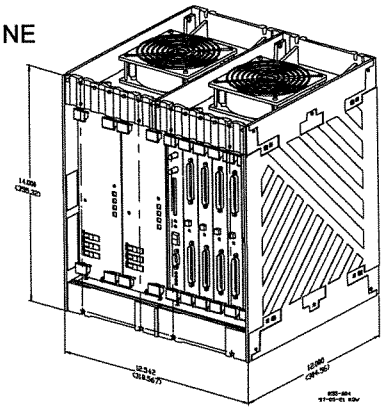
The MicroNet supports multiple protocols and physical mediums for communications to DCS systems, PLC's, other controllers, distributed I/O, and actual field devices. In addition to the physical ports available on the selected CPU, other ports are available.

- Ethernet UDP module available for Motorola CPU family
- Serial I/O (SIO) communication card with 4 ports (2 RS232, 2 configurable for RS232, RS422, RS485)
- LON network for LinkNet• Distributed I/O Modules
- Specialized serial communications modules for a variety of specific communications applications such as mechanical device drivers and sensor interfaces

Protocols Supported:

- Modbus (RTU and ASCII) over serial or Ethernet
- Ethernet TCP/IP (Pentium/NT CPU only)
- Ethernet UDP
- Dynamic Data Exchange (DDE)
- Printer Drivers, Modems, Data Loggers
- Custom Proprietary Drivers for communicating to specific devices

CONTROL OUTLINE
(6 SLOT OPTION



HUMAN MACHINE INTERFACE (HMI)

PC-based Human Machine Interface software provides a powerful interface to operators and technicians. Communications to the HMI are through Serial or Ethernet connections. The HMI provides operational and analytical information such as graphical display of operating data, historical trending, event logging, X-Y plotting, system overviews, calibration pages, and other functions.

SERVICE INTERFACE

Woodward offers several software products for service interface. From simple monitoring of any system variable to high resolution plotting of control variables, service tools are available to simplify troubleshooting.

EXPANSION

The MicroNet Control is expandable for systems requiring more I/O than that accommodated in the base chassis. Depending on the type of I/O and control functions required, the expansion can be accomplished by adding an additional MicroNet chassis, LinkNet or other distributed I/O modules, or any combination.

I/O MODULES AND FIELD TERMINATION

The MicroNet digital control can accommodate any combination of Woodward I/O modules to provide maximum application flexibility. Standard I/O modules available are:

- Thermocouple inputs
- Resistance Temperature Devices (RTD)
- Analog inputs (mA, V)
- Discrete inputs
- Discrete outputs
- Magnetic pickup (MPUs)
- LVDT and RVDT position inputs
- Proportional and Integrating Actuator Drivers
- Serial Communication cards (SIO)
- Local Area Network, EtherNet
- Special hardware cards
- Chassis expansion modules
- Relay interface modules
- High-Density Discrete I/O
- High-Density Analog I/O
- High-Density Combo Card

MicroNet I/O modules are designed and tested for the specific needs of Prime Mover control and monitoring. Exceptional accuracy, fast updates, high channel to channel isolation and other features differentiate them from common industrial I/O modules.

Hot-replacement of most modules allows modules to be exchanged while power is applied. Many modules are "Smart Modules" with an on-board micro-controller to manage the module's internal operations and to provide continuous self-diagnostics. Smart modules are self-calibrating and provide periodic on-line calibration monitoring to ensure the integrity of I/O measurement and control. The high-density modules allow for very cost effective I/O and can time stamp discrete signals with 1 ms resolution and analog signals with 5 ms resolution.

Termination of field wiring is accomplished using Woodward Field Termination Modules (FTM's). The FTM's mount to a standard DIN rail and provide easy access to field wiring. Standard cables connect the FTMs to the control I/O modules.

DISTRIBUTED I/O MODULES

Distributed I/O gives a cost effective solution for sequencing and monitoring functions that do not require the performance available with the standard control modules. Distributed I/O is a concept where I/O modules are distributed on a Local Area Network. Modules can be located in the field to minimize the wiring runs of many sensors and devices. Only the network connection comes back to the control system. Distributed I/O can also be located in the control room (in the control cabinet or simply nearby) as an alternate means of gathering I/O.

The MicroNet supports several distributed I/O options. Woodward's LinkNet distributed I/O modules connect to a dedicated LON driver card located in the MicroNet. The Pentium/NT CPU provides a Modbus over TCP/IP Ethernet alternative that allows the use of commercially available Distributed I/O products. Contact Woodward to determine which products are supported.

SYSTEM DESCRIPTION - MicroNet TMR

The MicroNet TMR control system incorporates the features of the MicroNet described above in a Triple Modular Redundant (TMR) control architecture. The MicroNet TMR uses the Motorola CPU architecture (the Pentium/NT CPU does not presently support TMR) with double exchange voting and the same software synchronization routines as the NetCon F/T. The MicroNet TMR consists of three isolated kernel sections. Each section includes its own CPU, CPU power supply and up to 4 I/O modules. The I/O modules can be used for simplex I/O, redundant I/O, triple redundant I/O or any redundancy combination. Each kernel I/O section is expandable into one or more of the MicroNet chassis discussed above. Interface modules provide inter-rack communications.

The kernel sections individually monitor all input data, perform all application calculations and generate all output values and responses. Outputs are assessed with the 2-out-of-3 voting logic. With this configuration any fault or number of faults associated with a kernel can be tolerated without affecting system operation. The advantages of triplex architecture as compared to duplex architecture are as follows:

- 2-out-of-3 voting provides superior fault detection of all I/O, hardware and control algorithms.
- Eliminates single point failures
- Reliability is vastly improved by extending fault coverage to nearly 100%
- Greater flexibility for implementing a variety of fault-tolerant configurations.
- Superior latent fault detection
- On-line serviceability

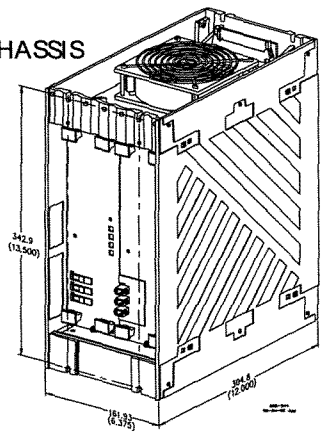
The high-density MicroNet cards provide first-out indication for monitored system events to reduce troubleshooting time. These cards will time stamp the event within 1 ms for discrete inputs and 5 ms for analog inputs.

The MicroNet TMR uses two power supplies, each of which powers the control from a separate power source. Inside each power supply are three independent power converters, one for each CPU and I/O section. The triplicated power architecture provides maximum protection against hardware failures.

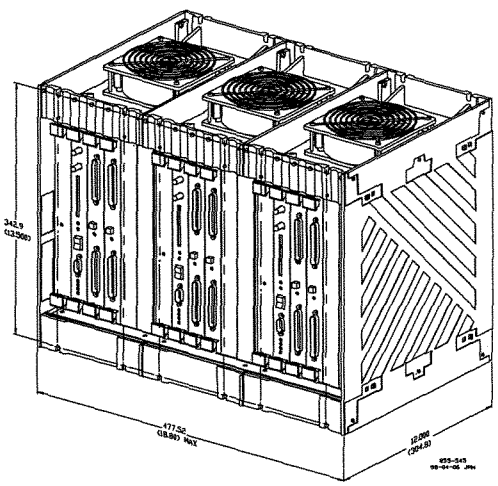
Woodward also provides full TMR relay modules for critical discrete outputs. To accomplish this, a six relay configuration is used. If any one relay fails in a normally open configuration, or if any two relays fail in a normally closed configuration, the contact path is not interrupted, and the fault does not interrupt normal operation. Latent fault detection is used to monitor and detect any relay faults.

The MicroNet TMR control will drive multiple actuator coils and current drivers to support dual redundant and triple redundant field devices.

MicroNet TMR
POWER SUPPLY CHASSIS



MicroNet TMR CONTROL
CHASSIS OUTLINE



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CORPORATE HEADQUARTERS
Rockford IL, USA
Ph: (1)(815) 877-7441

SPECIFICATIONS

OPERATING CONDITIONS

Temperature
0°C to +55°C (32°F to 131°F) ambient air temperature range
0°C to +50°C (32°F to 122°F) for Pentium/NT CPU

Shock
MIL-STD-810C, method 516.2-1, procedure 1B

Vibration
Lloyd's ENV2 test #1

Emissions*
EN55011, Class A, Gr 1

Immunity*
EN50082-2 (1995)

Certifications*
CE, UL/cUL (Class I, Div 2), LR for Cat ENV1 & ENV2, ABS

MicroNet CHASSIS
All versions are bulkhead mounted or adaptable to 19" rack mount back panel.

MicroNet WITH POWER SUPPLY SECTION AND 6 I/O SLOTS
Dimensions
12.6" wide x 14.3" high x 12.1" deep (320.04 mm wide x 363.22 mm high x 307.34 mm deep)

Approximate weight
35 lbs (15.9kg)

MicroNet WITH POWER SUPPLY SECTION AND 12 I/O SLOTS
Dimensions
18.8" wide x 14.3" high x 12.1" deep (477.52 mm wide x 363.22 mm high x 307.34 mm deep)

Approximate weight
53 lbs (24 kg)

MicroNet TMR—18 SLOT CHASSIS
Control chassis dimensions
18.8" wide x 14.3" high X 12.1" deep (477.52 mm wide x 363.22 mm high x 307.34 mm deep)

Control chassis weight
55 lbs (25 kg)

Power chassis dimensions
6.4" wide x 14.3" high x 12.1" deep (162.56 mm wide x 363.22 mm high x 307.34 mm deep)

Power chassis weight
16 lbs (7.3 kg)

POWER SUPPLY INPUT OPTIONS
18-36 Vdc, 100-150 Vdc, 88-132 Vac (47-63 Hz), 180-264 Vac (47-63 Hz)

*Specifications apply to most components and modules. Some certifications may be pending. Contact Woodward for further information.

For more information contact:

99/8/F

APPENDIX B

COST ESTIMATE FOR RUSSELECTRIC PLC SYSTEM

C-TECH of North America, Inc.
4201 Sawgrass Point Drive #204
Bonita Springs, FL 34134

Phone: 941-947-9185
Fax: 941-947-0842
E-Mail: ctech.crider.tom@worldnet.att.net

VIA e-mail
(Rick_Leggo/NLHydro@nlh.nf.ca)

February 8, 2000

Mr. Rick Leggo
Newfoundland and Labrador Hydro
P.O. Box 12400
Materials Management Department
4th Level, Hydro Place
St. John's, Newfoundland A1B 4K7

Re: Budget Prices for Governor Replacements

Dear Rick:

I have looked at your general description of the workscope for each of the following projects and offer the following budgetary prices:

Upper Salmon

Based on reusing the existing switches and meters as the operator interface, the hardware scope would generally consist of providing a GE-Fanuc PLC mounted either on a sub-panel or in its own cubicle with required I/O modules and a hydraulic interface manifold. Based on similar Woodward cabinet actuator governor only retrofits, I estimated the I/O at:

Digital In = 64
Digital out = 32
Analog In = 16
Analog Out = 16

The panel would require redundant main power supplies, terminations, fusing, and two speed signal transducers that will interface directly to the existing Woodward speed sensors. These transducers convert to a 4-20 ma output and maintain an update rate of less than 50 ms.

We would also supply you with a hydraulic interface manifold that mounts in the governor cabinet. The manifold contains the control servovalve and separate shutdown circuit logic. It replaces virtually everything inside the cabinet actuator except the main distributing valve, which is retained. We provide a porting block that mounts directly to the work ports on the distributing valve's servomotor (top of the dist. valve). We also furnish a LVDT and mounting bracket that connects to end of the distributing valve spool and provides position feedback to the PLC for the distributor valve position. A Temposonics linear position transducer is provided for mounting on one of the gate servomotors and replaces the existing cable feedback.

I assume that N&LH would do the installation with Russelectric providing a startup technician. I have included 10 days of on site support.

Based on the above, a budgetary price, including hardware, engineering, programming, documentation and field support would be $140,000 Canadian ($97,000 USD).

Cat Arm

I assume that the six deflectors are controlled via one common control valve, and likewise for the six nozzles. Assuming this is correct, the governor retrofit scope is very similar to that listed above. The primary difference is that the hydraulic manifold now requires a second control circuit for the needles. Also, a second Temposonics linear position transducer is required for needle position (the first being used for deflector position).

Assuming two (2) systems bought together and including 10 days of field support for each system, a budgetary price would be $168,000 Canadian EACH ($115,000 USD).

These prices are based on 2000 delivery and a current exchange rate of $1 US = $1.45 Canadian. Delivery is typically 20 weeks.

Thank you for this opportunity. Please call if I can be of further assistance.

Best regards,

Thomas F. Crider

APPENDIX C

COST ESTIMATE FOR
L & S ELECTRIC PLC SYSTEM

L&S ELECTRIC INC.

CORPORATE

Post Office Box 740
5101 Mesker Street
Schofield, WI 54476.0740 USA
Phone: 715.359.3155
Fax: 715.355.5931
Web: www.lselectric.com

BUDGETARY ESTIMATE

To: Newfoundland & Labrador Hydro
PO Box 12400
St. John's, NF A1B 4K7
CANADA

Estimate No:	E00197-JCG-060200
Terms:	Progress Payments
Delivery:	22-24 weeks
D.D.P:	Destination
V.A.T:	Unpaid
Freight:	Prepaid and Charged
Prices:	Budgetary
Date:	June 02, 2000

Attn: Mr. Rick Leggo

Subj: Cat Arm and Upper Salmon – Digital Governor Upgrades

L&S Electric, Inc. is pleased to estimate the following:

Item	Qty	Description
A	1	Supply of low-pressure governor retrofit for the Cat Arm Pelton Units. The existing hydraulics and main distributing valves will be retained.

Estimated Price for first unit ..... U.S. $210,000.00
Estimated Price for second unit ..... U.S. $195,000.00

B	1	Supply of low-pressure governor retrofit for the Upper Salmon Francis Unit. The existing hydraulics and main distributing valves will be retained.

Estimated Price ..... U.S. $75,000.00

C All on-site time including preliminary site visits, installation supervision, commissioning and training shall be made available at the following rate:

Rate (per individual) ..... U.S. $1,000.00/Day + (Expenses x 1.1)

1. Hourly rates are based on 8 hours/day Monday-Friday 7 A.M. to 6 P.M.
2. Overtime (standard) rate weekday hours prior to 7 A.M. or beyond 6 P.M.; all Saturday time. Total time not to exceed 16 hours/day.
3. Overtime (premium) rates are Sundays and Holidays; all time in excess of 16 hours/day.
4. Minimum billing is 4 hours.
5. Stand-by and holdover will be charged, up to 8 hours, at the listed rate.
6. Travel time is to be considered service time and will be charged at the listed rate. However, the maximum charge per person for any one calendar day will be 8 hours.
7. Expenses will be charged at cost plus 10%.
8. Mileage will be charged at $0.60 per mile

Payment Terms

Prices shall be based upon a milestone progress payment schedule. L&S Electric will propose a schedule at the time of a firm quotation.

Prices

All prices included with this estimate are provided in *U.S.* Dollars. All invoices and payments shall be made in U.S. Dollars. Prices include all applicable customs duties.

Canadian provincial and federal sales and service taxes

As stated on the first page of this estimate, shipping terms are "D.D.P., V.A.T. unpaid" (Deliver Duty Paid, Value Added Taxes unpaid). Canadian provincial and federal sales and service taxes (PST and GST) are not included as part of this quotation and shall be payable by the customer. Customer shall be the "Importer of Record" and shall pay all applicable taxes directly to the government of Canada.

Warranty

The warranty provides for the supply of replacement hardware due to failure of components during intended operation, along with warranty of system performance as defined in the project technical proposal. Labor required to replace hardware due to warranty claims shall be the responsibility of the customer. Labor responsibilities necessary to correct items on L&S Electric's supply in reference to system performance based on project specifications shall be borne by L&S Electric, Inc. Costs associated with materials being damaged due to improper field installation shall not be the responsibility of L&S Electric, Inc. This warranty shall be effective for a period of one (1) year. The one (1) year period shall begin after successful completion of the project or 120 days after delivery of the system equipment, whichever is first.

Our estimate is based on the preliminary information supplied by Newfoundland & Labrador Hydro. A firm quotation will be provided after the receipt of additional system information. Please advise us of any additions or deletions that you would like to make to the scope of supply.

Thank you for the opportunity to estimate your requirements. If you have any questions or require additional information, please feel free to contact us.

Sincerely,

L&S ELECTRIC, INC.

J. Christian Grul
Applications Engineer

Ronald J. Hahn
Manager, Application Engineering
Engineering Division

AM-SM-MF

APPENDIX D

VATECH HYDRO
DTL595 TURBINE CONTROLLER
AND COST ESTIMATE

"Pomeroy, Keith" <pomeroy.keith@vatech.ew.fpt.ca> on 07/26/2000 12:16:38 PM

To: Rick Leggo/NLHydro@NLHydro
cc: "Hunkeler, Dieter" <hunkeler.dieter@vatech.ew.fpt.ca>
Subject: RE: Cat Arm Governors

Dear Rick

We have prepared a budget offer which we will send by courier with some literature about the DTL governor system and a reference list. The basics of the budget (in Canadian dollars) are:

Design, program and supply 2 X DTL 595 digital governors:
including installation and commissioning, and documentation: $150,000 lot

This includes about $25,000 for the field work portion.
We have assumed that the old ETRs would be removed from the panel by yourselves.
Installation and commissioning is roughly 10 days/unit.
Delivery is approximately 10 weeks after clarification of all technical details.

During the commissioning some hands on training is possible including a review of the documentation provided. Additional time at site for training or fore delays not caused by us would be charged at $120/hr plus expenses.

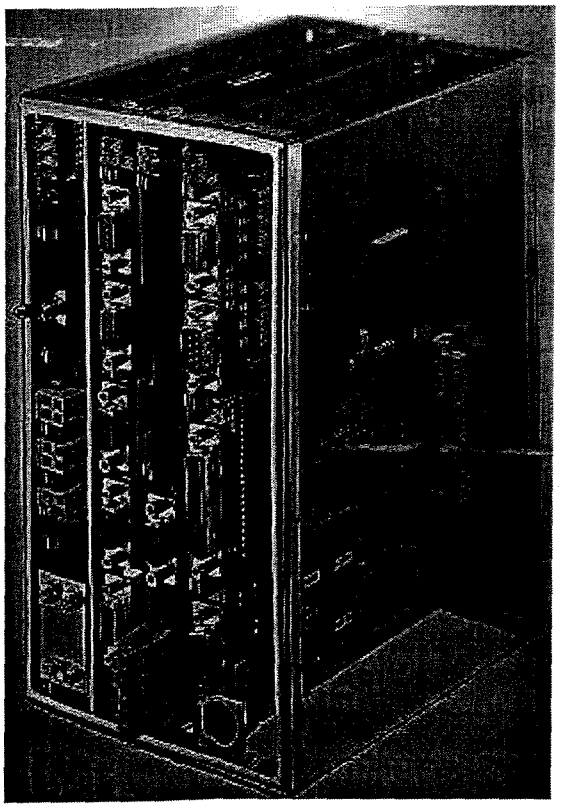
I trust that this is sufficient for your planning purposes but do not hesitate to ask any questions you my have.

Kind Regards
Keith Pomeroy

> -----Original Message-----
> From: Rick_Leggo/NLHydro@nlh.nf.ca [SMTP:Rick_Leggo/NLHydro@nlh.nf.ca]
> Sent: Tuesday, July 25, 2000 7:33 AM
> To: pomeroy.keith@vatech.ew.fpt.ca
> Subject: Cat Arm Governors
>
> I am preparing a report on the need and cost to replace the governor
> controls.
> Based on an earlier letter from Sulzer Hydro saying that parts for the
> controls
> would not be available after 2004 we have put an estimate in the 5 year
> budget
> to replace one unit in 2004 with the specification being prepared in 2003.
> My
> report is to look at what is available for governor controls replacement
> and the
> cost.
>
> Therefore, a budgetary price with the cost of on site assistance and
> training

> would be adequate. I would also like some information on the new system.
> The
> scope of the project is just to replace the governor controls. However, if
> there
> are features on the new controls that are worthwhile it could be decided
> to
> include some of those also. However, I would need the information first.
>
> Thank-you
> Rick Leggo
> Generation Engineering
>

DTL595
Digital Turbine Control System



Water turbine applications
- speed / power / level control
- joint control
- unit start / stop
- distributed control
- field signal conditioning and data acquisition

Powerful turbine control system with control and monitoring functions
- realtime - multitasking operating system
- local and remote I/O
- galvanic isolation of process signals
- operator interface (MMI)

High-performance computer
- 32-bit computer, MC68341
- Flash-PROM operation
- floating point math
- realtime and calendar clock
- watchdog

Functional block programming
- visual / graphical programming
- self documenting
- sophisticated software module library
- interfaces: C / Fuzzy

Communication
- serial interfaces
- SCADA / RTU
- CAN-Bus, Profibus SINEC-L2 FMS
- Modbus
- Modbus Plus

General Performance Data - DTL595	
Speed dead band	<= 0.02 %
Range of speed measurement	0 - 300 %
Resolution of speed measurement	<= 5 × 10-5
Nonlinearity of linear position transducer	< 0.05 % F.S.
Blade control dead band	<= 1.0 %
Governor dead time	<= 0.2 s
Speed stability index	<= 0.3 %
Power stability index	<= 0.4 %

Highlights from the Reference List:	
Tarbela	Four Francis turbines 440 MW each
Macagua	Twelve Francis turbines 198 MW each
Iron Gates	Two Kaplan turbines 200 MW each
Brisay	Two Kaplan turbines 234 MW each
San Agaton	Two Pelton turbines 349 MW each
Soutelo	One Pelton turbine 127 MW

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