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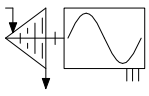

TURBINE DIAGNOSTIC SERVICES, INC
2521 SUCCESS DR UNIT 2
ODESSA, FL 33556

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ENG:	E J COLON	03-02-20

TITLE

SYSTEM DESCRIPTION, TURBONET DASH 1

SIZE	CAGE CODE	DRAWING NUMBER	REV
A	1XKV4	TDS003	A

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SHEET 1 OF 20

Table of Contents

1.0 Document Purpose

The purpose of this System Description document is to provide a general overview of the TurboNet *DASH 1®* control system offered by Turbine Diagnostic Services Inc.

This document is not intended to provide the details required to set up, program, operate or troubleshoot the system. This document will provide brief descriptions intended to familiarize engineers, managers, technicians and operators with the control system and its capabilities. This document will reference other documentation providing additional details.

This document is intended to describe to individuals interested in the system a broad knowledge of the system, capabilities, components, system architecture and where to locate additional detailed information.

Detailed documentation for the system is broken up into several major documents as listed in the Index of Publications.

2.0 System Documentation

The TurboNet *DASH 1* control system is documented in several publications that, in combination, make up the complete system description in the detail required to design, implement, program points and logic, operate and troubleshoot the entire control system.

As revisions are made to the system and section documentation and each is further developed the different publications will be revised and reissued independent of each other. This will allow for the further development of different parts of the system at future dates without revising the complete system documentation package.

These publications divide the system into logical sections of system development. The listing of the publications and description of their purpose and topics is documented in the first publication, P1000 - Index of Publication.

2.1 P1000 - Index of Publications

The Index of Publications is a listing of the publications issued by Turbine Diagnostic Services Inc. (TDS) to document the TurboNet *DASH 1®* control system. This document is a listing of the system documents with descriptions of the contents of the document. A detailed table of contents for each publication is contained in the respective publication. This listing is not intended to provide a detailed table of content for the listed publications.

Additional publications will be added as required to document system function additions. Changes to existing system components and functions will be updated in separate publication revisions and reissued. A listing of the current revision of the each publication will be documented on the Turbine Diagnostic Services web site at www.turbinedoctor.com. Downloadable copies of each publication are also available on the web site to obtain current revisions.

The following is the listing of TDS issued publications documenting the TurboNet *DASH 1®* control system:

AA96001	Description, Controller Block
AA96002	Instructions, Adding Signal
AA96003	Instructions, Downloading Firmware
AA96004	Users Guide, GraphCAD
AA96005	Users Guide, LoopCAD
AA96006	Users Guide, Historian
AA96007	Summary, Drop Alarms
AA96008	Users Guide, HMI
AA96301	Application Guide, 4-20 Milliamp Input Termination Board
AA96302	Application Guide, 4-20 Milliamp Output Termination Board
AA96303	Application Guide, Voltage I/O Termination Board
AA96304	Application Guide, 24VDC Contact Input Termination Board
AA96305	Application Guide, Overspeed Termination Board

AA96306	Application Guide, Relay Output Termination Board
AA96307	Application Guide, RTD Termination Board
AA96308	Application Guide, Thermocouple Termination Board
AA96309	Application Guide, Servo Termination Board
AA96310	Application Guide, Vibration Termination Board
AA96401	Module Description, 16 Channel Contact Input
AA96402	Module Description, 8 Channel Contact Output
AA96403	Module Description, 8 Channel Milliamp Input
AA96404	Module Description, 8 Channel Milliamp Output
AA96405	Module Description, 16 Channel RTD
AA96406	Module Description, 14 Channel Thermocouple
AA96407	Module Description, 8 Channel Voltage Input
AA96408	Module Description, 8 Channel Voltage Output

3.0 Experience and Design Philosophy

In this section a description of Turbine Diagnostic Services Inc. is included and the design and service experience of our personnel.

Also this section is intended to describe the design of the system and the philosophy and reasoning behind the design features.

3.1 Turbine Diagnostic Services

Turbine Diagnostic Services (TDS) started as a field service company. TDS was formed in 1998 and has grown exponentially to date. We have grown from a single man operation to a staff of start up engineers, mechanical turbine engineers, mechanical turbine representatives, controls and vibration technicians, design and manufacturing personnel and a crew of turbine millwrights. TDS has performed numerous governor and excitation retrofits culminating in the design and manufacture of the TurboNet *DASH 1®*. TDS provides qualified engineering, supervision and labor for quality turbine generator service.

Additional information is available on our website at www.turbinedoctor.com .

3.1.1 TDS Controls Experience

The start up engineering background of the TDS engineers provides for competent and knowledgeable personnel specializing in turbine generator instrumentation and controls for troubleshooting and start up activities. While having an outstanding knowledge of the way the turbine controls function, our control system knowledge provides our engineers with the expertise on the intended operation of the equipment and can provide guidance and training to the plant operators and technicians.

TDS engineers are proficient in GE, Woodward, WDPF and Bailey Control Systems as well as GE & Bently Nevada TSI monitoring systems. TDS has balance of plant control system capability and in depth knowledge of the design, construction, implementation, operation and functionality of current turbine generator governors and control systems. TDS services Mechanical Hydraulic Control systems with flyball governors as well as analog and digital electronic turbine governors and control systems. TDS is knowledgeable in mechanical drive turbine applications as well as medium & large steam turbine and gas turbine control systems (Mark I through Mark V). Our gas turbine experience includes water injection, DLN1 and DLN2, up to DLN2.6 combustion controls.

Our engineers are proficient at troubleshooting turbine generator control system problems. TDS provides technical assistance with control problem diagnostics, start up support and calibration. TDS can direct customer supplied technicians or as an option

perform a turnkey job. We have equipment required to calibrate all the turbine field instrumentation and simulate control system functions.

TDS has start up engineers that are familiar with the installation, checkout, commissioning and start up of turbine generator controls and DCS systems. TDS can assist with all phases of installation and start up of the equipment. TDS has conducted MHC to digital electronic turbine governor upgrades and has implemented several commercially available turbine generator governor systems.

TDS experience has allowed for the design and release of a new digital turbine governor and balance of plant control system.

3.1.2 TDS Controls Design Philosophy

Using the vast experience and exposure to many types of control systems TDS has developed an insight of the outstanding features, deficiencies and limitations of the control system equipment currently available on the market.

Many offer distributed control systems but are not fast enough to conduct turbine controls. Others offer turbine control systems that are not distributed control systems. Still others package together disparate components and sell it as control systems. Much of the systems on the market are locked into the design and interface capability available. In most cases the customer is locked into the parts manufactured by the vendor and the vendor creates a new market by dropping support for parts of an older control system. Other systems on the market have few options and you get it their way.

With the TDS designed TurboNet *DASH 1®* control system TDS has created a revolutionary control system. This is truly a distributed control system with scan rates fast enough to conduct turbine speed control, load rejection and power-load unbalance. This system is provided with a hot backup standby processor and configured to accept inputs on a triple redundant basis with the addition of multiple I/O modules with signal averaging and voting conducted in the sequencing.

The TDS TurboNet *DASH 1®* control system is constructed with individual, readily available commercial off the shelf (COTS) components with few exceptions. This includes computers, monitors, processors, communications hardware, most I/O modules and HMI components. (Ref Section 3.2.1) The exception being three custom I/O modules made by one of our I/O module suppliers.

The custom I/O modules are the Speed/Overspeed module, the Servo Amplifier Feedback Loop driver module and the Vibration monitoring module. (Ref Section 3.2.2)

TDS has developed all the software for the control system on two different platforms: Linux and LynxOS. The Linux operating system is used on the HMI's while LynxOS is used on the control processors. The reliability of these operating systems is the backbone of the controller uninterrupted operation. (Ref Section 3.2.7)

The system design allows for applications where a large number of HMI's & EWS stations are required. The design also allows for the expansion of I/O connected to a given processor and additional turbine generators can be added as drops to the data highway. The system can also be accessed externally by the use of an additional router. These external locations can be provided with "view only" or "full" access. (Ref Section 3.2.20)

The HMI software is written and designed by TDS engineers so the user has a simple interface to the TurboNet *DASH 1®* system. The HMI has been designed for simplicity of configuration, programming, operation and troubleshooting utilizing TDS engineering experience with other manufacturer's equipment. (Ref Section 3.2.12) The EWS workstation is an HMI with the additional EWS software. This means that the EWS can also be used as an HMI on cost sensitive applications. (Ref Section 3.2.15)

The control sequencing is programmed from a graphical block application program developed by TDS (LoopCad). Predefined blocks are utilized to process signals, develop logic, and provide control schemes. This sequencing is compiled and downloaded to the controlling processors. The EWS has on line sequencing display capability to monitor real time control parameter values as established by the block program sequencing. The EWS can also make changes on line without shutdown of the process. (Ref Section 3.2.17)

Backup processors can be put into control, while putting other processors into standby or out of service without interruption of the process control. The backup processor is constantly writing data to its memory as transmitted from the primary processor so a bumpless transfer occurs when processors are swapped or in the event of a failure of the primary processor. (Ref Section 3.2.8)

The system software development has made the specialized application of the TurboNet *DASH 1®* system unique in its design, application and interface. While TDS has developed several specialized boards for speed/overspeed, servo control and vibration the programming of the TurboNet *DASH 1®* system application software is what makes the use of these components unique. (Ref Section 3.2.7)

The system has been designed with the intent of not just turbine generator control, but rather an expandable plant control DCS that specializes in turbine control. (Ref Section 3.2.13) The system has been designed for the maximum amount of user interface capability with a minimum amount of training, experience and controls capability. The engineering and programming functions have been simplified to easily allow modification and troubleshooting on and off line.

3.2 TurboNet *DASH 1®* Control System

The TurboNet *DASH 1®* is a universal DCS control system capable of applying to control of steam and gas turbines generators and control for the balance of plant equipment.

The TurboNet *DASH 1®* control system is easily separated into logical sections. The control processing is conducted at the processor level which have drops off the main data highway (EDH). These processors are arranged with primary and hot back up processors for each unit or block of control equipment in balance of plant applications. Each of the processors are connected to the main data highway (EDH) regardless of its status as primary or hot backup or whether on units 1 or 10.

The processors interface with the field inputs and outputs and provides the control functions as described in the downloaded control sequence programming. The processors read and write data on the main data highway (EDH) for monitoring and control functions. The HMI stations are also drops on the main data highway (EDH) for collection and display of the data for operator interface. The operator provides control commands through the HMI operator interface display which are received by the processors across the main data highway (EDH). Additional HMI interface displays with capabilities beyond that of the operator interface HMI station is used for Engineering Work Station (EWS) for the purpose of making programming changes and additions for the operator HMI graphic interface or the processor control functions. The EWS connects to the engineering data highway (EEH) to provide a high speed download communications connection to the HMI's and HIST.

A historian computer (HIST) is connected to the EDH and EEH for the purpose of collecting data for long term data trending. The historian collects data from the main data highway for recall from the HMI operator interface stations for long term trending displays.

3.2.1 Conventional Components

Much of the TurboNet *DASH 1®* control system uses COTS components with conventional communications to conduct the controlling functions required for turbine generator and balance of plant control.

The processors used for control are manufactured by Advantech. They feature 64 Mb Flash Card Memory and 128 Mb Ram. This can be changed for increased capability or speed, per customer requirements, and limited only by cost. The processors receive general purpose inputs and outputs from modules for digital I/O and analog signals. The modules communicate data to the processors across the EIO. This Ethernet I/O interface allows for a max case scan rate capability of 50 hertz which is sufficient for the control applications proposed currently. The processors also communicate to the main data highway (EDH). This hub is expandable as required to support the needs of the system to

be installed. The EDH also supports ethernet communications to the HMI's, EWS's and HIST.

The HMI, EWS and HIST (desktop or rack mounted) minimum requirements are Pentium 100MHz processors with any monitors as specified by the customer. The stations can be located anywhere. Fiber optic communications to remote locations is available.

The HIST is a standalone computer with either a CD burner or any other data storage unit desired by the customer and supported by Linux. This computer has no monitor and only collects data from the EDH. The capability of this data storage computer is only limited by cost. (Ref Section 3.2.18)

The cost of the system provided is based on the level of redundancy desired, processor or computer upgrade requirements and amounts of drops desired for the customer's needs. The system is expandable based on cost limitations rather than system limitations. This system HMI and EWS can be constructed based on customer standardized computer components if desired.

The standard ethernet communications will allow for the connection of a router (of customer IT department choice) to connect to the company network for monitoring of operating parameters by network users with the required privileges.

Additional units, processes and system control can be added to the overall system by additional processor drops for each unit or block of controlling equipment. For systems in excess of the max case I/O limitations expansion is as simple as adding another processor and more I/O on another drop off the main data highway (EDH).

The uniqueness of this system is the TurboNet *DASH 1®* application software.

3.2.2 Custom System Components

Custom input/output modules have been designed by TDS for the specialized inputs and outputs required for speed detection/overspeed protection, the feedback loop control of a servo controlled valves with LVDT position feedback, and vibration monitor analysis of the vibration detection equipment on the machine. The specialized design allows for the interface of special diagnostic feedback signals that will provide diagnostic alarms.

These custom components are designed to interface with the processors through the ethernet input/output data highway (EIO) operating at 10MBPS.

The Speed/Overspeed module (OS) is designed to receive the speed input from one or two speed signals depending on whether the turbine is a single or two shaft machine. The speed input is translated to digital value and compared with a programmable overspeed setpoint. The detection of the overspeed condition is done locally at the module level for fast response and causes the operation of a digital output from the module. The use of three modules wired in a two out of three trip logic scheme provides

the redundancy necessary for overspeed protection. The digital outputs power two 24 Vdc trip relay (ETR) that are used to trip the machine. The speed input derived on the board is communicated to the processor via the EIO data highway as the speed input to the control system. This eliminates additional speed probe requirements. This module has enough sensitivity to detect turning gear speed off the magnetic pickups. This allows the system to detect whether the pickups are connected and operational before the system is started. If the speed probe signal is lost diagnostic alarms are generated and trips the machine based on the simplex or triple redundant logic programming of the application sequencing and the overspeed protection wiring.

The Servo Amplifier Feedback Loop module (SVO) is used to interface the customer valves for position feedback servo loop control, pilot valve control, fuel regulator control (Gas Turbine) or LVDT monitoring of uncontrolled valves. These boards interface the processor through the EIO data highway. The processor provides the calibration data to the SVO module to determine the scaled valve position. Based on the scaled valve position calculated on the SVO board and the demand signal generated by the processor the servo current is driven to control the servo output current as required to control the valve position in a stable manner. The dynamic gains and offsets for the position loop stability adjustments are signals tuned in the processor and communicated to the SVO module. The SVO module is designed to communicate diagnostic faults back to the processor for communication to the alarm summary.

The vibration input and analyzer module receives the seismic or proximity probe signals from the turbine supervisory instrumentation (vibration probes) and processes the data in the module. The module breaks out the 1X and 2X vibration components from the unfiltered signal. The module puts the unfiltered magnitude, 1X & 2X magnitude and phase angles, and proximity probe gap voltages on the data highway (EIO) to allow for the data to be processed onto polar or shaft centerline plots on the HMI station. This data is also collected in the HIST to allow for long term trending. This module also uses an on board processor to complete the signal breakdown and analysis before placing the data on the data highway.

3.2.3 System Versatility and Expansion

This system is quite versatile. It is applicable for balance of plant control process needs and for the higher scan rate needs for turbine generator speed and load control.

The ethernet data highway (EDH) and the ethernet engineering data highway (EEH) are capable of expansion to 253 drops. These drops can be composed of any combination of unit processors, HMI's, EWS and HIST.

This system is capable of expansion to conduct all plant or mill process control for most plants and mills and utilizing multiple HMI control stations.

The ethernet input/output data highway (EIO) is expandable to access inputs from up to 64 Ethernet bases.

Equipment applications with greater than the max case I/O requirements would simply have another control processor added to the main data highway with additional I/O capability.

3.2.4 Custom Control System Design Capability

The big block sequence programming for process controls integral with the TurboNet *DASH 1®* control system makes this system universally capable of adapting to balance of plant controls and to turbine generator speed, load and emissions control.

TDS engineers have extensive experience in the design and implementation of balance of plant control logic as well as the philosophy behind turbine generator speed and load control. The logic development is not limited to the TDS engineers, as the system is user friendly and allows for knowledgeable customer engineers to implement changes.

The same graphical big block sequencing tools allow the engineer to inspect the big block sequencing during operation to monitor the real time signal values in the processor and troubleshoot malfunctions.

A wide range of general I/O types are available from our I/O vendor.

This system is easily modified to accept additional inputs and outputs and add multiple drops for control and monitoring HMI's. The system is expandable beyond the needs of most applications found in power plants.

3.2.5 Power Supply Versatility

Standard Lambda power supplies are used for single or redundant power supply design. The input power sources can be 120Vac or 125Vdc or both. Power supplies provide individual +24Vdc monitored and diode gated together for a redundant capability. This is the standard offering, however other COTS power supplies can be specified for customer needs.

3.2.6 Computer and Processors

The computers and processors in the control system are standard COTS single board. Desktop and rack mounted computer modules are available. The control processors are rack mounted and located in the 19" control system cabinet.

Monitors of any type, size and style can be implemented into the construction of the HMI's. The Monitors are supplied in single, double or quadruple arrangements. The double and quadruple monitor arrangements allows for the operators or engineers to pull up different data or graphics on each monitor and each monitor can have several screens open. The cursor moves from one screen display to the other and from one monitor to another. These interactive monitors are driven from the same HMI or EWS computer.

The computer HMI stations can be supplied with a track ball or mouse. Left mouse clicks are used to select, actuate, drive, or drag functions on the graphic screens. Right mouse button clicks pulls up a drop down menu that allows for the user to select from point configuration information, default graphic for the point clicked or real time trends of the point. While all setpoints can be changed by clicking on raise and lower targets, the setpoint accuracy is a function of the last position of the integrated signal. A keyboard is provided at both the operator HMI and EWS. The keyboard allows the operator to set in precise setpoint values such as 3600 or 100. Also, a virtual keyboard utility is located on the screen, and when clicked on, drops down to allow mouse clicks to select a text or numeric values. After completion of the alpha/numeric entry the operator would simply click and drag the number to the setpoint desired. Many other functions of the HMI allows the operator or engineer to click and drag a point to another function for display or entry.

The HIST is a standard computer of minimum system requirements with large hard drives for data storage. (Ref Section 3.2.18)

3.2.7 Processor Operating System

The TurboNet *DASH 1®* control system is constructed using the Linux operating system for the HMI processors, HIST processor and EWS processor. TDS has found that this operating system is much more reliable than the other non-UNIX operating systems available on the market today. The LynxOS operating system is loaded onto the control processors PROC1 & PROC2.

TDS has had Linux based computers running for well over 5 years without interruption. The programs that make up TurboNet *DASH 1®* are written in “C” and “C++”. These programs are copyright protected and are transparent to the operators. However, engineers may use some of these programs as tools to make or modify point directories, configure processors and drops, construct sequencing, stop loops on line and to download information to the different drops on the system whether on or off line. There should be no need to access the program code. In the unlikely event there are problems with the software code, changes will be made and implemented to the entire fleet of TurboNet *DASH 1* controllers.

3.2.8 Redundant Processor Capability

The control processors are supplied in a redundant processor arrangement with one processor controlling and one in hot backup.

The control system has means from the EWS to select which processor, PROC1 or PROC2, is in control and which is in hot backup/standby mode. The processors can be switched or taken out of service at any time with a bumpless transfer to the operation of the machine.

The two processors communicate across the ethernet input/output data highway (EIO). The standby processor writes the values of the primary processor to its memory until it detects that the primary is no longer communicating to control the process and the hot backup standby processor takes over the control of the unit in a bumpless transfer. The communications failure of the primary processor and the transfer to the standby processor is indicated on the alarm summary to notify the operator of the condition.

3.2.9 Input/Output Capabilities

The TurboNet *DASH 1* control system uses Ethernet based input modules which interrogate the field devices and feedback information through the Ethernet communications to the processors. The processors then feed information to the Ethernet based output modules to regulate the process with control of digital and analog outputs to the field devices. An Automation Direct Terminal I/O Ethernet bases I/O modules provides an interface to digital and analog I/O to supply information to the control processors for process control. The inputs and outputs are directed through standard I/O modules supported by Automation Direct. TDS has implemented the following I/O capabilities for communication on the Ethernet Input Output (EIO) data highway:

Digital Inputs-
- 16 channels per module-
- 24 VDC Interrogation Voltage
- 110 VAC Interrogation Voltage
- Individually Fused
- 3-9 msec detection time
- Non-Isolated
- 125 VDC Inputs optional

Digital Outputs-
- 8 channels per Module
- Relays w/form C dry contacts
- 120 VAC/VDC Contact Ratings
- Devices can be powered from system power supply or external power supplies

Analog Inputs-
- Milliamp Inputs-
- 8 channels per module
- -20 to 20 MA
- Individually Fused
- Can be powered from external power supply

Voltage Inputs-
- 8 channel per module
- 0-5 VDC
- 0-10 VDC

+5/-5 VDC
+10/-10 VDC
Can be powered from external power supply

Thermocouples-
14 channels per module
Types J,E,K,R,S,T,B,N,C
Cold Junction Compensated
Can have a 24 VDC Isolator for grounded thermocouples

Resistance Temperature Detectors-
3 wire type
4 wire type wired as 3 wire
Platinum
-Pt100
-Pt1000
-jPt100
-Copper
-Cu10
-Cu25

Analog Outputs-
Milliamp Outputs-
8 channels per module
0-20 MA
Individually Fused

Voltage Outputs-
8 channels per module
0-5 VDC
0-10 VDC

The ethernet input and output (EIO) data highway communicates with the processors to transmit data from the TDS custom I/O boards such as the speed/overspeed module (OS), a servo feedback loop control module (SVO), and a vibration input monitor and analyzer module (VIB). The capabilities of the EIO inputs and outputs are as follows:

EIO

Max case- EIO supports 64 connections
Processor Ports- 2 supported
Speed Inputs- limited to max case EIO hubs
Servo/LVDT I/O- limited to max case EIO hubs
Vibration/VIB I/O- limited to max case EIO hubs

Speed/Overspeed (OS)

-Two Speed Pickup Supported per Module for two shaft machines. Can be daisy chained for machines with more shafts.

-Speed Signals are sent to the processor for process control
-One Overspeed relay output per module driving three relays connected in a 2/3 Trip Logic

-24 VDC Interposing OS Trip Relays
-Servo Amplifier/LVDT Feedback (SVO)
-Two servo feedback loop per Module
-Two LVDT feedback per board
-3 wire, 4 wire, and 5 wire LVDT's
-200 Hz (minimum) internal loop update speed
-Uncontrolled valve LVDT feedback
-Open Valve Control Loop output
0-100 ma definable/0-100%

3.2.10 Turbine Control Scan Rates

The TurboNet *DASH 1®* control system is capable of scanning the max case data inputs and sequencing at a rate of 50 hertz. This is fast enough to provide process control of systems such as speed and load control of steam and gas turbine generator.

The EIO ethernet IO data highway is communicating at 10 MBPS.

The EDH ethernet data highway is communicating at 10 MBPS.

The EEH engineering data highway is communicating at 100 MBPS.

The standard control processor offerings are Advantech single board processor modules.

The computers used to support the HMI, EWS and HIST have minimum processor requirements of Pentium or equivalent processor operating at 100 MHz.

3.2.11 Simplicity of Operation & Configuration

The TurboNet *DASH 1®* control system has been designed for the simplicity of operation. Our experience with other control systems has developed an operator interface that is simple to understand and operate.

The control display is menu driven. The operator selects from choices of displays. The menus are set up to distinguish individual units on the system and the subsystems of that unit.

The operator makes left mouse point and click actions to select control parameters and input setpoints. Setpoints are also input from the keyboard or a drop down keypad on the screen where values are entered and then click and dragged to the desired location.

The engineer working at the engineering work station (EWS) has additional menu selections to choose functions that allow for the configuration, design and troubleshooting of the system.

The development of graphic screens uses a TDS graphical based program to add shapes. These shapes can be clicked and dragged to the desired position and shape. Point value displays are added to the graphic for readout of operating parameters. Control push buttons are added to the graphics to allow for the operators to interface the unit control with command functions and setpoints. The graphic construction does not require written code descriptions that depict the shapes and parameters to display.

The development of sequencing is easily conducted by using the graphic program developed by TDS. The sequencer allows for the engineer to insert big blocks into the sequencing for logic and variable processing based on the preprogrammed algorithms of the big blocks.

On line troubleshooting capability is enhanced with interactive graphical sequencing displays. These displays show the graphical sequencing with actual real time control parameters displayed as the inputs and outputs of the big blocks displayed.

Additional downloading tools are provided to the engineer at the EWS. These tools allow the engineer to choose and download configuration and sequencing to the drops on the ethernet engineering data highway (EEH). (Ref Section 3.2.17)

The addition of points to the point directory and changes to sequencing is made easy by menu selected tools. The engineer does not need to understand the operating system and make changes to multiple files by the edit functions of the operating system. Point descriptions displays provide all configuration data of each point in one place. Gathering point configuration data and making changes in multiple files to implement point additions or changes is not necessary.

These design features are intended to keep a complex system as simple as possible to implement and operate.

3.2.12 Integral Human Machine Interface Software

The TurboNet *DASH 1®* control system software is written specifically for this application. It is not provided by an outside HMI software vendor. The integral software interfaces the data highways to interface with data and other computer and processor drops on the data highways.

This software configures the HMI and is integral to the control system. This software has been developed to provide the necessary tools to configure, program, download and operate commercial off the shelf hardware in the distributed control system.
The HMI provides easy display options to obtain real time plots and point details of all points displayed on the graphics displays. The HMI alarm display is color and sound programmable to set different levels of priority to the individual alarm functions. Alarms are provided for diagnostic problems with processors, I/O and communications. The alarms can be printed to different locations to separate alarm printouts by unit, process or any other logical scheme. The alarms can also be inhibited from printing individually to avoid recurring alarms from filling alarm printer paper bins. The alarms can also be filtered by unit depending on configuration.

3.2.13 Distributed Control System Architecture

The distributed control system architecture allows for all the processors connected to the ethernet data highway EDH to share data on that highway.

Drops on the EDH consist of HMI's, EWS', HIST and the control processors, PROC1 & PROC2, of all the processors for any units controlled by the system. Each of these drops are capable of sending and receiving data on this data highway.

3.2.14 System Expansion Capability

The TurboNet *DASH 1®* control system is easily modified to add drops on the system's data highways. These drops could be additional HMI's to control operation from other areas of the plant or additional EWS' for engineers to access and modify the system design and programming.

Most important, additional processor drops can be added to retrofit other units to the TurboNet *DASH 1®* control systems or implement control of other equipment in balance of plant applications.

The system is expandable to a maximum amount of 253 drops on the ethernet data highway (EDH) and ethernet engineering data highway (EEH).

3.2.15 Engineering Work Station

The engineering work station (EWS) is an HMI with functions in excess of that allowed for operators at the operator control HMI stations. The EWS is a standard computer of minimum system requirements loaded with the Linux operating system and the TurboNet *DASH 1®* system programs.

EWS communicates with the processors to receive data from the EDH for displays just as seen by the operator. The EWS also uses this data to provide active sequencing displays

showing the actual parameters of the big blocks that are controlling the units and processes.

Changes to the configuration and control sequencing of the drops is developed on the EWS. The EWS develops the design of the system and programming. The EWS communicates to the drops on the system through the ethernet engineering engineering highway (EEH) to download configuration and programming with the exception of the control processors. The EEH data highway is used to avoid excessive traffic on the EDH where control communications is conducted. The control processors are not connected to the EEH and programming is downloaded from the EWS by way of the EDH. The EWS communicates to specified drops without interruption of the HMI data display and control functions.

The EWS can shut down a specific loop in a specific processor and make loop configuration changes while the machine is on line and in service without interrupting unit control.

The EWS is normally located away from the control operators and used to conduct the design, development and troubleshooting of the control system without interfering with the activities of the operator.

3.2.16 System Diagnostic Alarms

The system is self monitoring for diagnostic problems. The diagnostic problems are displayed on the alarm page located on the HMI and EWS.

The system is capable of alarming on system malfunctions such as power supply failure or processor shutdown/swap over to the backup processor. The system monitors communications of the drops and alarms when data updates have not been received normally from each drop location.

Diagnostic alarms are generated at the unit processor level and communicated to the HMI alarm display via to the EDH. Each processor is programmed to provide diagnostic alarms from deviations of detected speed inputs, deviation from servo demand position, cabinet temperature and from the standard I/O modules.

3.2.17 Configuration Changes On Line

The update tool located in the EWS allows for the engineer to stop a specific loop in the sequencing during on line operation. The individual loop is stopped as the processor continues to run. The engineer downloads changes to the processor. The loop is then put back into service. The processor then continues the operation of the loop with the new configuration.

3.2.18 Historian for Long Term Trending

The HIST is a stand alone computer with a massive amount of storage space in the hard drives. The HIST is connected to the EDH and EEH only for the purpose of collecting data. A minimum of three hard drives are used in a RAID 5 configuration. This sets a section or each hard drive to back up the portions of the other two hard drives. This allows for a recovery of data should one of the three hard drives fail. The configuration of hard drives is not limited and additional on board hard drive memory can be added at customer request at additional cost. The hard drives currently used are 40 gigabyte storage capability. The RAID 5 application provides nearly 80 gigabytes of storage space. The amount of storage space can be increased based on additional cost to the system.

The HIST is supplied with a CD burner for customer permanent data storage. The data is downloaded to the CD and the memory space freed for more on line data collection.

Should the customer desire, the data storage can be set to overwrite the oldest data if the data is not removed from the hard drive by the customer.

The long term data is stored on the HIST and is available for the HMI or EWS to retrieve for long term trending of system data. This is useful for troubleshooting degrading trends in operating parameters.

3.2.19 Utility Dispatch Control Interface Capability

The TurboNet *DASH 1®* control system can be configured to interface with the customer's utility dispatch control signals by either an ethernet or fiber optic links or by means of a raise and lower contacts. The utility can be connected as a drop on the EDH data highway and be provided read and write capability to write directly to load setpoints. The signal can be taken in through hard wired contact inputs and the sequencing logic developed to produce the load following functions.

3.2.20 External Network System Monitoring

The TurboNet *DASH 1®* control system will allow for a router to be added as a drop on the EDH data highway. This router would interface the customer's company network and allow privileged users read only capability to monitor the operating parameters through the same graphics as the operators or through special graphics produced for these network users. This is not part of the TDS standard offering. However, TDS will work with the customer's IT personnel to make the network interface connection. TDS does not specify a router. The customer's IT department has a standard router of their liking which is supported within the company. TDS engineers will assist the customer with the implementation of such a system interface if desired at extra cost.

This capability can be used to implement a remote diagnostic link to the TDS office in Odessa, FL. TDS can then monitor and troubleshoot the control system and the turbines remotely. This can be an invaluable feature in returning the unit back to service.