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System Design Document

U-AVLIS Control System Architecture

Pam Viebeck - February 10, 1994

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System Design Document

U-AVLIS Control System Architecture

Pam Viebeck - February 16, 1994

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1 Introduction

1.1 Scope

This document describes the architecture of the integrated control system for the U-AVLIS process. It includes an overview of the major control system components and their interfaces to one another. Separate documents are utilized to fully describe each component mentioned herein.

1.2 Purpose

The purpose of this document is to introduce the reader to the integrated U-AVLIS control system. It describes the philosophy of the control system architecture and how all of the control system components are integrated. While the other System Design Documents describe in detail the design of individual control system components, this document puts those components into their correct context within the entire integrated control system.

1.3 Project Overview

The integrated U-AVLIS Control System has been developed over approximately seven years in support of the Uranium-Atomic Vapor Laser Isotope Separation program. The mission of the U-AVLIS program is to develop, demonstrate and deploy the AVLIS technology to enrich nature uranium to fuel commercial power reactors. The development and demonstration phases have been accomplished at LLNL. The deployment phase will be accomplished by the design, construction, and operation of a U-AVLIS production plant. Introduction and integration of the U-AVLIS process into the United State Enrichment Corporation has the potential to substantially reduce enrichment and material processing costs, thereby enhancing the USEC's commercial viability and market share.

The U-AVLIS technology consists of three major subsystems: separators, lasers and uranium processing. Uranium vapor is generated by evaporating metallic uranium contained in a crucible, with an electron beam. The vapor is illuminated by several light beams at precise optical frequencies. These laser beams are generated in a dye laser system that is, in turn, energized by a copper laser system. The dye laser beams are precisely turned to photoionize (i.e. remove an electron from) the U-235 isotope, leaving it electrically charged or ionized. The U-235 photoions are collected on negatively charged product plates; the neutral (i.e. un-ionized) uranium vapor passes through the ion extraction region and is collected on the tails collector. The upstreaming vapor from the crucible contains uranium isotopes at their naturally occurring abundance of .7%

U-235. The photoionization extraction processor provides an enriched product having net enrichment (U-235) of 3-5%.

A major activity of the U-AVLIS program has been the Uranium Demonstration System (UDS) project. This system was developed at LLNL to:

- demonstrate the integrated enrichment performance of separators and lasers in plant-like operations,
- demonstrate the performance of plant scale U-AVLIS systems,
- provide an information database on costs to project the economics of an U-AVLIS production plant.

Figure 1 shows the Integrated Uranium Demonstration System. This system occupies a large portion of B490 and consists of:

- 12 copper laser chains which pump the two dye laser chains, and four advanced copper laser chains which pump the Plant Scale Dye Chain ,
- 2 dye laser chains and the Plant Scale Dye Chain which are combined on the Dye Combination Wall,
- Line of Sight which takes the light from the Dye Combination Wall to the Launch Wall,
- Launch Wall which sends the light to the Module Optics,
- Module Optics which propagate the light through the Separator to photoionize the uranium,
- Separator Pod and all of its utilities which vaporize the uranium,

The result of the control and diagnostic requirements for each of these components and of years of evolution in the control system implementation is a large, complex computer-based controls and diagnostics system. This system, the U-AVLIS Integrated Control System, consists of over 30 key applications supporting Copper Lasers, Dye Lasers, Laser Delivery systems, Separator Controls and Separator Diagnostics in the areas of: process control, beam alignment, diagnostics, wavefront correction, vacuum cooling, thermal and heating, power conditioning, feeder, withdrawal, safety interlocks, vapor rate monitor, diagnostic laser systems, extractor diagnostics, integrated performance monitoring.

1.4 Definitions

1.5 Applicable Documents

All System Design Documents for the U-AVLIS Control and Diagnostics System.

"One Way Link (OWL) Document" - Binder of backup information.

2 System Overview

The U-AVLIS integrated control system is actually the integration of four separate instantiations of a single control system architecture. Specifically, it is the integration of control systems for 1st generation copper laser systems ("Copper Laser Controls"), unclassified laser systems ("Laser Unclassified"), classified laser systems ("Laser Delivery"), and separator systems ("Separator Controls and Diagnostics"). Each instantiation is a highly cohesive system, yet a minimal, but mandatory, coupling is required among the four. This document is organized to follow this implementation:

- Section 3 describes the highest level control system: the Integrated U-AVLIS control system.
- Section 4 describes the second level control systems: 1st generation copper laser system, unclassified laser system, classified laser system, and separator system.

2.1 System Level Design Constraints

The U-AVLIS integrated control system must support:

- the integration of data between classified and unclassified systems. Some of the unclassified laser power data is required to calculate process performance. These calculations are classified and are implemented on a classified system.
- continuous operation. Copper lasers operate continuously, dye lasers often run two out of three shifts, and separator systems run frequently. Changes and enhancements to the control system must accommodate this schedule.
- heterogeneous hardware and software. The control system has been developed over many years and includes many different hardware platforms, operating systems, languages and technologies. Upgrades and enhancements must accommodate this variety.
- centralized operation in the Consolidated Control Room, localized operation throughout facility. During an integrated experiment, most operation is accomplished in the Consolidated Control room, with some operation accomplished in the local control areas throughout the facility. During independent laser and separator operations, operation is accomplished throughout the facility depending on the nature of the experiment.
- as much as possible, operation of control system from X Windows/Motif based workstations. To facilitate integration, the integrated control system GUI is window-based, implemented with X Windows/Motif, allowing windows of information to be displayed on various workstations across

the control systems. This capability facilitates operation in both the Consolidated Control Room and in the local control areas.

3 Description of Level One - Integrated U-AVLIS Control System

3.1 Overview

The Integrated U-AVLIS Control System is partitioned into control systems for 1st generation copper laser systems ("Copper Lasers"), unclassified laser systems ("Laser Unclassified"), classified laser systems, ("Laser Delivery"), and separator systems ("Separator Controls and Diagnostics"). Each of these four control systems is an instantiation of a generic control system architecture developed for U-AVLIS.

Other partitioning schemes have been tested over the years. Too little partitioning results in a huge control system that is hard to manage: frequent modifications in support of changing requirements in one area affect operation in other areas. In addition, speed performance may suffer because of the need to process and manage too much data. Too much partitioning results in excessive coupling between the control systems. The current partitioning seems to result in an optimal balance of highly cohesive systems with minimal coupling, and these smaller systems can be changed and enhanced more frequently with minimal disruption to the almost continuous operation of the system.

The generic control system architecture is partitioned into three layers. Layer 1, the lowest layer, consists of Front End Processors which are special purpose systems which perform data acquisition and control for functions such as beam alignment, diagnostics, separator process control, etc. Layer 2, the middle layer, consists of the Supervisory System which collects data from the Front End Processors making it available for integrated global functions such as display, archiving, alarm processing and analysis. The third and top layer, consists of the window-based Graphical User Interface (GUI).

Figure 2 ("U-AVLIS Control System Architecture") shows the hierarchical representation of the generic control system. It includes an overview of the various types of Front End Processors, Supervisory systems and GUIs supported and how they are connected by a network. These systems are implemented on a variety of hardware platforms and are implemented in various languages on various operating systems. The goal of the GUI layer is to integrate the control and monitoring functions of the lower two layers at a window-based workstation, providing a consistent look and feel among applications and across workstations.

Figure 3 ("U-AVLIS Integrated Control System") shows an overview of the Integrated U-AVLIS Control System. It is a high-level view of the four control systems and their interfaces. Though not shown in the high level figure, the Integrated U-AVLIS Control System consists of:

- over 120 computers spread throughout B490
- approximately 30 workstations located in six different control areas
- networks which tie these computers and workstations together
- the 2nd largest video switching system in the world, used for process monitoring, laser alignment and surveillance,
- over 30 key control and diagnostic applications supporting:
 - Copper Lasers, Dye Lasers, Laser Delivery systems
(Applications include: process control of Copper Laser oscillators and amplifiers, beam alignment, power diagnostics, wavefront correction.)
 - Separator Controls and Diagnostics
(Applications include: process control for the vacuum, cooling, thermal and heating, power conditioning, feeder, withdrawal systems.)
 - Separator Diagnostics
(Applications include: Vapor Rate Monitor, Process Diagnostic Laser System, Extractor Diagnostic Workstation, Integrated Process Monitoring "Integrated Workstation".)
 - Safety Interlock systems for lasers and separators

Figure 4 ("Network Topology") shows an overview of the network topology which supports the four control systems.

3.2 Detailed Description

See details in Chapter 4.

3.3 Interface Definitions

The Integrated U-AVLIS Control System has three major categories of interfaces: users, instrumentation, and databases of experiment results.

Within the users category, there are the users that are operating the control system (operators), there are the analysts who are processing the data from the experiments, and there are the developers who are installing and configuring systems and monitoring performance. The operators interface with the control system through the workstations, logging in under a special password that gives them access only to the operational system (AVLISOPS), and through local terminal interfaces. At the workstation interface, the operators see an integrated view of the control system so that the system or layer they are accessing is transparent. At this layer, their major activities include controlling and monitoring via the graphical information diagrams and the specialized control panels, and analyzing performance via real-time trend plots. At the local terminal interface, the operators are accessing a particular front end processor.

The analysts interface with the control system through workstations and terminals, often copying portions of the experimental data to non-production workstations for processing with special analysis tools.

The developers interface with the control system through the workstations, logging in under a special password that gives them the necessary privileges to configure the systems, monitor and control performance, and to correct control system problems (AVLISSYS).

All of the interfaces with control system instrumentation are provided by the Front End Processors and the Separator Diagnostic systems. The requirements for these interfaces are defined in the individual Functional Requirements Documents, and the designs of these interfaces are described in the individual System Design Documents.

3.4 Operational Information

The four control systems which comprise the Integrated U-AVLIS Control System can operate completely independently, and most often do. The data transmitted among three of the four control systems is only necessary for calculating process performance by the Integrated Workstation and by the Video Photoion Mapper (VIPER). Process performance calculations are only required during integrated enrichment experiments (i.e. experiments utilizing both separators and lasers).

4 Description of Level Two - Control System Segments

4.1 1st Generation Copper Laser Control System

4.1.1 Overview

The 1st generation copper laser control system controls the 12 copper laser chains which are upstairs in Building 490 (Room 2045). These copper laser chains were developed in the 1985-1986 time frame and they are used to pump the two dye laser chains in the Upper Dye Corridor (Building 490, Room 2051). Use of these copper laser chains is being gradually phased out over time, replaced by the advanced copper laser chains downstairs in Building 490 (Room 1045). A copper laser chain consists of an oscillator followed by three amplifiers.

The control system for these 12 copper laser chains is termed '1st generation' because it also dates back to 1985-1986. This particular control system was not upgraded with the current technologies as the other control systems were developed because of its known impending retirement. It still follows the three layer architecture, although the GUI layer is not workstation and window-based.

Figure 5 shows the details of the 1st Generation Copper Laser Control System.

At the front end processor layer, the control system includes:

- an embedded controller for each oscillator and amplifier (total of 48),
- an embedded controller for each of the small bore lasers (total of ?),
- controllers for power diagnostics and pointing and centering applications (total of ?),
- controller for the timing system (total of 1),
- controllers for copper laser alignment, diagnostics, and delivery of light to the dye chains (CLADD systems - total of 4).

With the exception of the CLADD systems, all of the other front end processors communicate with the supervisory system via a serial link to a Xyplex terminal server which is then connected to the network. The CLADD systems are connected directly to the ethernet.

At the supervisory layer, the control system includes:

- nine DEC MicroVax 3200s which communicate with the front end processors and drive the Ramtek-based graphics displays,
- data archiving nodes (total of two to provide redundancy).

The functions of the supervisory system include:

- graphical and tabular data display (on the Ramtek display devices),
- data archiving and extraction,
- control commands to the front end processors,
- alarm processing.

At the graphical user interface layer, the control system includes:

- Ramtek graphics drivers (total of 5),
- Ramtek graphics displays (approximately 20).

The 1st generation copper laser control system also includes an independent safety interlock system which is implemented on a Texas Instruments D3 system. The purpose of the safety interlock system is to protect personnel and high value equipment from high power laser light.

4.1.2 Detailed Description

Refer to "Laser Demonstration Facility Overview - Glen Speckert's Video/Viewgraph Talk" - June 22-24, 1988.

4.1.3 Interface Definitions

The 1st generation copper laser control system has no interfaces with the other three control systems.

There is a loosely-coupled interface with an information system which tracks the performance and reliability of the copper laser components. This system is called PaRTS (Performance and Reliability Tracking system). The interface is implemented by a special archiver in the copper laser control system which archives data of interest to PaRTS. This archived data is stored on one of the disks of the archiving system and is accessed periodically by the PaRTS software which executes on another computer (LISA).

4.1.4 Design Constraints

The design of this control system was defined in the mid 1980s and was constrained by a lack of high power computers at the supervisory layer, lack of window-based graphical user interface systems, and a requirement for redundancy in communications between the supervisory system and each front end processor. Hence the implementation includes an excess of stand-alone (as opposed to clustered) mini-computers at the supervisory layer to support communication with the front end processors and the capability to drive the graphics displays.

To upgrade this system to be compatible with the other control systems would require purchasing new supervisory hardware (two boot nodes and a powerful processing nodes) and purchasing new GUI hardware (workstations to replace the Ramtek hardware). It would also require redrawing the dozens of Ramtek graphical user interface screens using the X Windows/Motif-based graphical drawing tool used in the other control systems.

4.1.5 Operational Information

The 1st generation copper laser control system is operated from Ramtek display devices primarily located in the Copper Laser Control Room (B490/R2019). Until use of these copper lasers was phased out, they operated 24 hours/day, 365 days/year.

4.2 Unclassified Laser Control System

4.2.1 Overview

The Unclassified Laser Control System controls the four advanced copper laser chains which are downstairs in Building 490 (Room 1045) and the Plant Scale Dye Chain in the Upper Dye Corridor (Building 490, Room 2051). The advanced copper laser chains are being developed to replace the 1st generation copper laser chains currently housed upstairs. The control system also controls the two dye chains (upper yellow and upper green) in the Dye Corridor which are pumped by the 1st generation copper lasers (see section 3.2.1), and some

unclassified functions in the Launch Wall. Finally, the control system also controls the Red Laser System (Building 490, Room 1051).

Figure 6 shows the details of the Unclassified Laser Control system.

At the front end processor layer the control system includes:

- For the four advanced copper laser chains:
 - an embedded controller for each oscillator and amplifier (total of 16),
- For the Plant Scale Dye Chain:
 - an Optical Device Controller (ODC) which provides low bandwidth alignment functions,
 - an Advanced Beam Diagnostic (ABD) which provides laser power measurements.
- For the Dye Laser Chains:
 - Optical Device Controllers (ODCs) which provide low and high bandwidth alignment functions (total of two),
 - an Optical Device Controller (ODC) which provides low bandwidth control in support of Materials Processing and the Laser Guidestar System (LAGOS),
 - Diode-based Deformable Mirror Systems which provide low bandwidth wavefront correction functions (total of three),
 - an Interferometry Data Analysis system (VAAC) which provides analysis for interferograms for wavefront correction,
 - an Advanced Beam Diagnostic System (ABD) which provides laser power measurements.
- For the Launch Wall unclassified systems:
 - an Optical Device Controller (ODC) which provides control functions for wavefront correction optics,
 - Hartmann Sensor-based Deformable Mirror Systems which provide low bandwidth wavefront correction functions (total of two),
- For the Red Laser System:
 - an Optical Device Controller (ODC) which provides low bandwidth alignment functions,
 - an Advanced Beam Diagnostic (ABD) which provides laser power measurements,
 - a safety interlock system which provides personnel and high value equipment protection from high power laser light,
 - a laser vacuum system which provides vacuum for the Red Laser System and the Launch Wall optical systems.

With the exception of the advanced copper laser controllers, the deformable mirror systems, the safety interlock system, and the laser vacuum system, all of the front end processors communicate with the supervisory system via ethernet. The advanced copper laser controllers communicate via a serial link to a Xyplex terminal server which is then connected to the network. The other front end processors do not communicate with the supervisory system.

At the supervisory layer, the control system includes:

- three computers which support GUI applications,
- one computer which supports supervisory applications,
- two computers which support the video switching application,
- several disks for data archival.

One of the main functions of the supervisory system is to provide data communications with the front end processors. Data collected from the front end processors is massaged and integrated and used in the other supervisory applications, including: graphical and tabular data display (GUI applications which display on the workstations), data archiving and extraction, and alarm processing. Supervisory control functions include control of the laser oscillators and the advanced laser amplifiers.

At the graphical user interface layer, the control system includes:

- 14 workstations spread throughout the facility.

The graphical user interface layer displays windows of information generated by the supervisory system, the Optical Device Controllers, and the Interferometry Data Analysis system.

4.2.2 Detailed Description

Because many portions of the control system are implemented as VAX/VMS Clusters and the network is partitioned to support this, the different network segments with their control systems have been given 'segment' or 'cluster' names. The Unclassified Laser Control System is referred to as the 'LU' cluster. Within 'LU', there is the 'HI' segment supporting Dye Lasers, the 'GA' segment supporting Red Lasers, and the 'WA' segment supporting the Plant Scale Dye Chain/Advanced Copper Lasers.

See Appendix A for information regarding the specific node names, boot nodes, supervisory system interfaces and user interfaces for the systems which make up the Unclassified Laser Control System.

4.2.3 Interface Definitions

The Unclassified Laser Control System has an interface with the Separator Controls and Diagnostic system. The supervisory system of the former sends laser wavefront data and laser power data to the supervisory system of the latter. This data is then sent from the Separator supervisory system to the Integrated Workstation for the process performance calculations.

In order to support the transfer of unclassified data from an unclassified system to a classified system, a special link was developed called the One Way Link (OWL). This link allows a few unclassified data items to be transferred to the classified system but prevents data to be sent from the classified system. This link is fully described in the "One Way Link Documentation" binder.

4.2.4 Design Constraints

None

4.2.5 Operational Information

The Unclassified Laser Control System is operated from window-based workstations located in the Dye Corridor, the Launch Wall, the Wavelength control room, the RLS corridor, the Consolidated Control room.

4.3 Classified Laser Control System

4.3.1 Overview

The Classified Laser Control System controls the Launch Wall and Module Optics optical systems. The Launch Wall receives light from the Dye Combination Wall via the Line of Sight and formats the light and sends it to the Module Optics. The Module Optics propagates the light through the Separator to photoionize the atoms of interest.

The controls for the Launch Wall and the Module Optics are located in B490, Room 161.

Figure 7 shows the details of the Classified Laser Control System.

At the front end processor layer, the control system includes:

- an Optical Device Controller (ODC) which provides low and high bandwidth alignment functions,
- an Optical Device Controller (ODC) which controls some optical components in support of diagnostic measurements,
- an Advanced Beam Diagnostic (ABD) which provides laser power measurements,
- the Video Photoion Mapper (VIPER) which calculates laser fill through the separator and potential fraction ionized,

- the wave meter, which sets the wavelength for the dye chains. (When looking at the propagation of light from the copper lasers all the way to the separator, the wave meter control system is required as the light enters the dye chains. However, the wavelength data is classified and therefore its control system is part of the Classified Laser Control System rather than the Unclassified Laser Control System),
- a safety interlock system which provides personnel and high value equipment protection from high power laser light.

With the exception of the Wave Meter and the safety interlock system, all of the front end processors communicate with the supervisory system via ethernet. The Wave Meter and the safety interlock system currently do not interface with the supervisory system.

At the supervisory layer, the control system includes:

- one computer which supports GUI applications,
- one computer which supports supervisory applications,
- two nodes which act as boot nodes for the above node and support video applications,
- several disks for data archival.

One of the main functions of the supervisory system is to provide data communications with the front end processors. Data collected from the front end processors is massaged and integrated and used in the other supervisory applications, including: graphical and tabular data display (GUI applications which display on the workstations), data archiving and extraction, and alarm processing. There are no control functions executed from the classified laser supervisory system to the front end processors.

At the graphical user interface layer, the control system includes:

- 7 workstations spread throughout the facility.

The graphical user interface layer displays windows of information generated by the supervisory system, the Optical Device Controllers, and the VIPER diagnostic.

4.3.2 Detailed Description

Because many portions of the control system are implemented as VAX/VMS Clusters and the network is partitioned to support this, the different network segments with their control systems have been given 'segment' or 'cluster' names. The Classified Laser Control System is referred to as the 'PA' cluster.

See Appendix A for information regarding the specific node names, boot nodes, supervisory system interfaces and user interfaces for the systems which make up the Classified Laser Control System.

4.3.3 Interface Definitions

The Classified Laser Control System has several interfaces with the Separator Controls and Diagnostic system. First, the Classified Laser supervisory system communicates with the Separator supervisory system. It sends filterwheel position data from the Optical Device Controller and it receives laser power data which was originally generated in the dye corridor, collected by an Advanced Beam Diagnostic in the Unclassified Laser Control system. The filterwheel position data is sent from the Separator supervisory system to the Integrated Workstation and is used to calculate energy related to polarization. The unclassified laser powers are sent from the Classified Laser supervisory system to the VIPER diagnostic to calculate fill and potential fraction ionized.

Second, the VIPER diagnostic of the Classified Laser System sends fill factor and potential fraction ionized data to the Integrated Workstation in the Separator Controls and Diagnostic system. Similarly, the Advanced Beam Diagnostic sends laser power data to the IWS. This data is used in the process performance calculations.

4.3.4 Design Constraints

None.

4.3.5 Operational Information

The Classified Laser Control System is operated from window-based workstations located in the Launch Wall, the Module Optics, the Wavelength control room, and the Consolidated Control room.

4.4 Separator Controls and Diagnostic System

4.4.1 Overview

The Separator Controls and Diagnostic System is somewhat different from the other control systems because it includes a major component of diagnostic systems which are not tightly coupled with the control system components. However, all of the components support separators and all are on the same network segment. In addition, there are two significant interfaces between the controls and diagnostic components: transmission of data between the supervisory system and the Integrated Workstation for the purposes of data display and process performance calculations, and transmission of data from the Vapor Rate Monitor to the Vaporizer controller for the closed loop vapor control algorithm.

The controls portion of the Separator Controls and Diagnostic system includes controls for the Separator pod and the Separator utilities. For the separator pod, there are controls and diagnostics supporting the feeder system, the heaters,

closed loop heater control, and thermal monitoring system, the splat casters, the magnets, the gas diagnostics system, the melt view shutters and the vaporizer system. For the separator utilities, there are control and diagnostics supporting the vacuum system, the cooling system, the withdrawal system and the e-beam system.

Together the separator pod and utility systems provide the capability for feeding, vaporizing and withdrawing the uranium.

The diagnostic portion of the Separator Controls and Diagnostic system includes the Diagnostic Laser System, the Extractor Diagnostic Workstation, and the Integrated Workstation. The Diagnostic Laser System includes the Vapor Rate Monitor and the Process Diagnostic Laser System. These systems provide critical diagnostic information regarding the performance of the enrichment process.

Figure 8 shows the details of the Separator Controls and Diagnostic System.

At the front end processor layer, the control system includes:

- a separator pod controller which controls all of the separator pod functions,
- a separator utilities controller which controls all of the separator utility functions,
- a Gas Diagnostics system which measures gases within the separator,
- a safety interlock system which provides personnel and high value equipment protection from high voltage electrical systems.

At the supervisory layer, the control system includes:

- one computer which supports GUIs and supervisory applications,
- two nodes which act as boot nodes for the above node.
- several disks for data archival.

One of the main functions of the supervisory system is to provide data communications with the front end processors. Data collected from the front end processors is massaged and integrated and used in the other supervisory applications, including: graphical and tabular data display (GUI applications which display on the workstations), data archiving and extraction, and alarm processing. Supervisory control functions include an interface with the closed loop heater control system.

At the graphical user interface layer, the control system includes:

- 8 workstations located in the Consolidated Control room.

The graphical user interface layer displays windows of information generated by the supervisory system and the closed loop thermal control system which is part of the separator pod controller.

The diagnostic systems span the standard three layers of the architecture. Each diagnostic system implements front end processor, supervisory, and GUI functions. The GUI layer, however, is most similar to the GUI layers of the other control systems because it is window-based, implemented in X Windows/Motif and therefore allows remote display of information across workstations.

The diagnostic systems include:

- The Diagnostic Laser System which includes the Vapor Rate Monitor and the Process Diagnostic Laser system. The Vapor Rate Monitor calculates the rate of the uranium vapor flow inside the separator. The Process Diagnostic Laser System is a diagnostic tool for studying various vapor properties and characteristics.
- The Extractor Diagnostic Workstation which calculates performance of the extraction of the enriched uranium,
- The Integrated Workstation which combines laser and separator data to calculate enrichment performance, comparing results with predefined models.

4.4.2 Detailed Description

Because many portions of the control system are implemented as VAX/VMS Clusters and the network is partitioned to support this, the different network segments with their control systems have been given 'segment' or 'cluster' names. The Separator Controls and Diagnostics Systems is referred to as the 'AZ' cluster.

See Appendix A for information regarding the specific node names, boot nodes, supervisory system interfaces and user interfaces for the systems which make up the Separator Controls and Diagnostics System.

4.4.3 Interface Definitions

The Separator Controls and Diagnostic system has several significant external and internal interfaces.

Externally, the supervisory system communicates with the Unclassified Laser control system by receiving unclassified laser powers. The supervisory system also communicates with the Classified Laser control system by sending those

same unclassified laser powers, and by receiving the filterwheel positions from the Optical Device Controller.

Also externally, the Integrated Workstation receives laser power data from the Advanced Beam Diagnostic and fill factor and potential fraction ionized data from VIPER diagnostic in the Classified Laser Control System. In addition, it receives signal data from the Meltview Video System (pool width information on the uranium melt inside the separator), and from the Wavelength Control System (laser frequencies).

Internally, the Separator supervisory system and Integrated Workstation exchange information. The Separator supervisory system sends data that it has received from the Unclassified and Classified Laser Control Systems to the Integrated Workstation for the process performance calculations. The Integrated Workstation send 'key parameters' to the Separator supervisory system. 'Key parameters' are the critical numbers that are monitored closely during an experiment and are displayed in very large font on workstations mounted on top of the racks in the Consolidated Control Room. The workstations and their data are visible from the key operator positions in the control room.

4.4.4 Design Constraints

4.4.5 Operational Information

The Separator Control and Diagnostics system is operated primarily from window-based workstations located in the Consolidated Control Room. In addition, the diagnostic systems have workstations located in the Diagnostic Laser Laboratory in Building 490.

U-AVLIS Control System Architecture

Figure 1

Code: *xxxx* = *xxxx*
E.P.Q.X.Y = *Vm n*
Part = Part *n*

CVL Laser Bay (New Record):
EM13 - 8026-P-P22A0214-X-P18
OM11 - 4034-P-P17A0331-X-P07
K07 - 4034-Q-P24A0331-P-P18

Display Name: EM1 - 434-O-P25J2831-X-P00
VIN - 434-E-P25J2831-Y-P31

Fiber Injection Room:
YMS - 2247-E-P22/K0620-Y-P22

Plant Seeds Dye Chart:
PM10 - 424-Q-72&R331-P-P19

Dye Cardiac.
PH14 - 3274-FF-P21H247-O-P37

Copper Control Room:
PA2 - passive monitor and Xylolux

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•
•
•
•

002

CH4
PH9

- 3267-E-P15A0328-V-P23
- 4408-O-P13K274-P-P16
- 4408-O-P13K274-P-P16

YMS . 440-X-P44J274-P-P16
OM2 . 400-X-P504431-O-P28

Western Control Room:
CH2 - 404-Y-P20MC07-P-P13
CH3 - 404-Y-P20MC08-P-P17

9048 - 000-0-7254431-X-P08

P23 - TPPortus

- Xylem 3267.116317

- Xylem 3200, L16510

- Xylem 0007, L10525

77

- Xylem 2016, L186317
- Xylem 2017, L186317

10 - Xypoxis 8316, L186821

12 - Xylene 214, L18823

14 - Xylem 3250, L18627

16 - System 8317, L10031

118 - Apple 3227, 120/525

- System 8800, L2062719
- System 360, L2062720

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Unclassified Laser Control System

— PSDC Equipment Area —
(QQ racks)

Classified Laser Control System

Separator Controls and Diagnostic System
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**DATE
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10/14/94

END