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**SOFTWARE REQUIREMENTS SPECIFICATION
FOR
LOW MOISTURE MONITOR**

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Issued by

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SOFTWARE REQUIREMENTS SPECIFICATION FOR LOW MOISTURE MONITOR

1. INTRODUCTION

1.1. PURPOSE

This Software Requirements Specification describes the required functions of the Liquid Observation Well (LOW) moisture measurement system software and has been prepared following WHC-CM-6-1, "Standard Engineering Practices" and IEEE Standard 830-1984, "IEEE Guide to Software Requirements Specifications." The SRS defines the individual requirements for the software, and provides a basis of agreement as regarding the software to be developed. It will establish the basis for preparing the Software Design Description document and will be a basis for verification and validation testing.

The individual requirements will be unambiguous, complete, verifiable, consistent, modifiable and traceable. The aforementioned characteristics are defined in IEEE Standard 830-1984. This SRS describes requirements for software that will be used to acquire data to develop moisture profiles of the contents of waste tanks at Hanford.

The intended audience for this document is the Liquid Observation Well Moisture Profile development team and reviewers from such organizations as Quality Assurance and Safety.

1.2. SCOPE

This document covers the product, "LOW Moisture Profile Data Acquisition Software." This software being developed will have the ability to position a neutron probe and acquire position and neutron count data. The software will also calculate moisture content from neutron count data.

1.3. DEFINITIONS AND ABBREVIATIONS

ASCII American Standard Code for Information Interchange

ISA Industry Standard Architecture

IEEE The Institute of Electrical and Electronics Engineers, Incorporated

LOW Liquid Observation Well

NIM Nuclear Instrumentation Module

SRS Software Requirements Specification

SDD Software Design Description

WHC Westinghouse Hanford Company

1.4. OVERVIEW

Section Two of this document discusses the general task of measuring moisture in waste tanks at Hanford. Section Three discusses the specific requirements of the software that are to be developed to satisfy the moisture measuring task.

2. GENERAL DESCRIPTION

This section of the SRS describes the general factors that affect the product and its requirements. This section does not state specific requirements; it only makes those requirements easier to understand. Specific requirements are discussed in Section Three.

2.1. PRODUCT PERSPECTIVE

The LOW Moisture Profile data acquisition system is an independent system and not a sub part of any other system. For economy, the computer is to be shared with the surface moisture measurement system (SMMS). This sharing is practical because these two systems will never be operating simultaneously. Each use of the Liquid Observation Well Moisture Profile data acquisition system is to be temporary (less than 15 days in duration). Although used temporarily, this system will be used repeatedly.

The LOW Moisture Profile system is a mobile data acquisition system that can easily be transported from waste tank to waste tank. Mobility is provided by a Ford Econoline van that houses the instrumentation. This van houses an industrial computer and a NIM bin with a multichannel analyzer. The computer serves as an interface for the operator.

Mounted on a platform on the front of the van is a boom and draw works that are used to deploy a neutron probe in a liquid observation well. A "spider" is an attachment to the LOW that centers the probe cable in the LOW. Operation of the system will consist of lowering the neutron probe to the bottom of the LOW. A moisture measurement will be taken, then the probe will be raised to the next monitoring location where another measurement will be taken. This process will be repeated until the probe is above waste level. Finally, the probe will be withdrawn from the tank.

Probe position will be tracked with a multi-turn absolute encoder. It will be zeroed with a proximity sensor. Both the encoder and the proximity sensor are located on the spider.

2.1.1. Computer

The computer provided for data acquisition and control is an industrial computer with the following features:

- Pentium®¹ processor operates at 90 MHz.
- 40 MBytes of Random Access Memory.
- One GByte Hard Disk Drive
- 3.5 inch 1.4 MByte floppy disk drive.
- 3 ISA bus slots.
- 3 PCI bus slots.
- 1 ISA/PCI slot.
- Two serial ports and one parallel port.
- A flat panel active matrix touch screen.

These features are not the minimum features required to operate the software, but are the features on the computer that is provided for this task.

2.1.2. NIM Bin

The NIM bin is a backplane in a chassis. Together with modules it is used to provide instrumentation for nuclear applications. It houses three amplifiers (two of which are used on the LOW moisture profile system) and a multichannel analyzer (MCA). The MCA communicates with the computer through a ISA bus circuit card that contains dual-ported memory. This communication includes both commands to the MCA from the computer and detector data from the MCA to the computer.

The amplifiers increase the power of the signals from the neutron probe and the multichannel analyzer processes these signals. The NIM bin and multichannel analyzer consist of the following:

- EG&G Ortec 4001A NIM Bin

¹Pentium® is a registered trademark of Intel.

- EG&G Ortec 4002D Power Supply
- EG&G Ortec 671 Amplifier
- EG&G Ortec 919 Spectrum Master Multichannel Analyzer

2.1.3. Neutron Probe

The neutron probe contains a Californium source that emits neutrons. Some of these neutrons travel through the LOW wall and into the waste and are deflected by the hydrogen atoms in water. With enough deflections a few neutrons will strike the detectors in the probe. These detectors produce a signal in response to neutron capture events and this signal is transmitted by a pre-amp and line driver to the modules in the NIM bin.

Two thermistors are located in the probe in addition to the detectors. These thermistors return a temperature signal that is used to adjust the signals from the detectors before a moisture interpretation is made.

2.1.4. Encoder

Probe position will be monitored with a multi-turn absolute rotary encoder. The encoder generates a serial output which will be converted to parallel data format with a serial-to-parallel converter. In each case, 21 bits of data will be provided as an input to the computer via a digital input/output board occupying one ISA slot. The equipment is identified as follows:

- Lucas Ledex^{®1} rotary encoder model AAF-100.
- Lucas Ledex[®] serial-to-parallel converter model SPA-2.
- National Instruments² digital input/output board model PC-DIO-96.

2.1.5. Proximity Sensor

As previously mentioned, a proximity sensor is located on the spider to determine the "home" position for the probe. This proximity sensor is supplied by Square D and is part number XS2 M3ONA371.

The sensor behaves as a switch. When nothing is detected, it is open. When something is detected in the proximity of the sensor, the "switch" closes. The computer reads this sensor as a digital input that is processed through an optical isolator.

¹Lucas Ledex[®] is a registered trademark of.

²National Instruments[®] is a registered trademark of National Instruments, Austin, Texas.

2.1.6. Bar Code Reader

Each LOW will have a bar code for unique identification. The bar code will be read prior to lowering the probe into the LOW. A Symbol LS 3070 bar code reader is used for this purpose. The bar code reader operates over radio frequencies to a base station located in the data acquisition van. The base station communicates with the computer through a keyboard port.

2.2. PRODUCT FUNCTIONS

The LOW moisture profile software will allow the operator to acquire data from the neutron probe to calculate the moisture at various elevations in the tank. The acquired data will be recorded to a disk file. Operator controls are described in Section 3.1.1, "Operator Interface."

2.3. USER CHARACTERISTICS

The users of this software will be engineers that will perform the data acquisition tasks. Although the user interface will be simple to operate, it is assumed that the operators will already have a familiarity with the use of computers.

2.4. ASSUMPTIONS AND DEPENDENCIES

The development of this software is based on the assumption that :

- development can be performed on National Instrument's® LabVIEW™¹ development environment.
- this software depends on the TMAD software described in WHC-SD-WM-CSRS-028, "System Design Description for the TMAD Code."

3. SPECIFIC REQUIREMENTS

3.1. FUNCTIONAL REQUIREMENTS

3.1.1. Operator Interface

3.1.1.1. Inputs

Probe Selection

¹LabVIEW™ is a registered trademark of National Instruments, Austin, Texas.

The LOW moisture profile system can use one of two neutron detectors. A control will be provided on the computer screen to choose between a thermal probe and an epithermal probe.

Start/Stop

A button control will be located on the computer screen. Pressing this control will cause the software to retract the probe until the "home" position is detected with the proximity sensor. The software will then lower the probe to one inch above the bottom of the LOW, take a reading, raise the probe to the next position, take another reading. This sequence of events will continue until the probe returns to the "home" position.

Each reading will acquire data from the multichannel analyzer for each of the two detectors. The detector stripcharts will be updated. Finally the data will be written to a data file as described in Section 3.1.2.

Options

A second button control labeled "Options" will bring up a second screen. This second screen allows the operator to enter parameters regarding the LOW test. These parameters are:

- Boundary for each region of interest. The total length of the LOW will be divided into four regions of interest. The length of each region of interest is expressed as the distance in feet below the "Home" position. An example is the first region of interest would start at home and extend to the user defined value of, perhaps, 10 feet. Regions of interest cannot overlap and there are no gaps between regions of interest.
- Record data for the given region of interest. Each region of interest can have data recorded, or recording can be skipped.
- Data recording intervals. In each region of interest the spacing between recording positions can be specified in inches. The allowable range of values shall be from one inch to 100 inches.
- Data recording duration. For each region of interest the length of time for each recording can be specified in seconds. The allowable range shall be from 1 second to 30,000 seconds.

Setting the options is not required for operation of the LOW moisture profile system. The defaults for each of the parameters are:

- The four default regions of interest will be 0.0 (home)–bottom of riser, bottom of riser–waste level, waste level–three feet above LOW bottom, and three feet above LOW bottom–LOW bottom.

- Record data for each region of interest shall be set to "off" in the vapor space and "on" in all other spaces.
- The default vertical spacing shall be 6 inches in the riser (first region of interest), no spacing in the vapor space (second region of interest has recording turned off) and 2 inches the last two regions of interest).
- Data recording duration shall be default to 30 seconds for an epithermal probe and 15 seconds for a thermal probe.

Calibration

A control labeled "Calibration" will take reading from the multichannel analyzer and write them to a calibration file. This mode is to be used to calibrate the probe in a known standard. The drawworks will not move in this mode.

The calibration file will be identical to the files described in Section 3.1.2, "Data File" except the name of the file shall end in the suffix "C" followed by a sequential number. An example is given below:

C:\DATA\LOWMMS\01-01-96\01-01-96.C01

3.1.1.2. Outputs

Tank/LOW

Two displays on the computer screen shall display in text the tank and the LOW that are subject of data acquisition. This information is provided to the computer by the bar code reader.

Detectors

A X-Y graph display shall be provided to show the spectrum from each of the two detectors. This display may either be two sets of data on one X-Y graph or two separate X-Y graphs with one set of data each. If two sets of data are plotted on one X-Y graph each set of data shall be plotted in a separate distinct color. The X-Y graph information will be updated each time the a measurement is taken.

Probe Position

The probe position shall be graphically displayed to the operator. This information provides as visual feedback to the status of measurement taking in the LOW. The position should be continually updated during the operation.

3.1.2. Data File

The data file will consist of header information and data. The header will contain the filename of the data file, the time and date of the measurements, the version of the

software creating the file, the tank and LOW, and the option parameters. The option parameters consist of length of each region, distance between measurements for each region and sampling time for each region.

The measurement data consists of vertical position of the probe, probe temperatures and an array (spectrum) of integers for each of the two detectors.

The file will be a disk file in a tab-delimited ASCII format. It will be stored in a subdirectory that has the current date for a name. The directory at the root level will be labeled "LOWMMS." Finally the file name will be named by the program and not the user. The file name will be the current date with an extension that consists of a sequential three digit number. An example absolute file path for a measurement file run on January 1, 1996 is given below:

C:\DATA\LOWMMS\01-01-96\01-01-96.001

The ASCII feature allows the file to be read by any text editor. The tab-delimited format allows the file to be read by most spreadsheet programs, including the ones in use at Hanford. The format of each of the data elements will be single precision floating point numbers.

3.1.3. LOW Parameter File

An ASCII text file that contains LOW parameters shall be maintained on disk. This file will be used by the LOW moisture profile software as a look-up table. The file shall contain a bar code number (corresponding to each LOW), the LOW depth, the distance to the bottom of the riser and the distance to waste. All distances shall be in inches.

3.2. OPERATION REQUIREMENTS

3.2.1. Initialization

On program startup, the software will continually loop waiting for input from the bar code reader. Once the input from the bar code reader is received, the software will check a look-up table for that code and identify the tank and LOW. If the bar code is not found in the look-up table, the software will display an error message and return to waiting for a bar code reading after the message is dismissed by the operator.

In the event that the bar code reader is not operational, the operator may enter the bar code information manually.

3.2.2. Options

The options button shall display a screen that allows the operator to change data acquisition parameters. These parameters are described in Section 3.1.1.1, Inputs.

3.2.3. Start/Stop

When the "Start" button is activated, the data acquisition sequence begins and the button is transformed into a "Stop" button. At any time during operations the stop button can be depressed, the probe will stop motion and the data acquisition process will be terminated. Data taken up to the termination shall still be written to the data file. There are three steps to acquiring data. Each is described below.

3.2.3.1. Find "Home" Position

The probe shall be raised until the home is detected by the proximity sensor.

3.2.3.2. Lower Probe

The probe shall be lowered to the bottom of the LOW. This distance is obtained from the look-up table that was checked by the bar code reader.

3.2.3.3. Take Measurements

The software shall take a measurement for the time established from the options screen (or the default) for the current region. Scanning progress will be displayed on the computer screen. After the measurements are taken and data is written to the disk file, the probe shall be raised the distance determined from the options screen (or the default) for the current region. This sequence of events shall be repeated until the probe reaches "home" and the probe comes to a stop. During the entire process the probe position will continually be graphically updated on the operator interface screen. The content of the data file is described in Section 3.1.2.

3.2.4. Error Handling

Any error during software operation shall be trapped and logged to an error file. The file shall be located in directory named "ERROR" located in the root directory of the computer's hard disk drive. The file shall be named "LOW.LOG" and shall be in ASCII format. Entries shall be appended to this file to keep a running log of any errors. Each entry shall contain the date and time of the error, the unique error number and a text description of the error.

Error messages will be displayed to the operator by use of a dialog box.

3.3. DESIGN CONSTRAINTS

Software constraints due to hardware limitations and system configuration are described in sections 2.4. Other constraints on the software are dictated by the requirements in this document.

Due to delays involving the updating of the computer screen under Windows™, screen updates will be limited to two updates per second. The detector X-Y graph displays

will be updated after measurement data acquisition is completed at the particular position.

3.4. EXTERNAL INTERFACE REQUIREMENTS

3.4.1. User Interfaces

The user interface will be a graphical interface. For ease of use the screen will mimic an instrument with icons of buttons representing controls and digital readouts depicting current information.

The user can set binary controls with a touch of the screen. Keyboard inputs should be limited to the setting of operational parameters from the options screen.

3.4.2. Hardware Interfaces

Hardware interfaces shall be through National Instrument's® data acquisition circuit boards, the keyboard port (for bar code reader) and a dual ported memory board. The use of National Instrument's® boards eliminates the need for writing drivers since these boards all work fluently with National Instrument's® LabVIEW® software development system.

Each input or output will be routed through a signal conditioning module or isolation device. The one exception to this is the digital input from the encoders. The output from the serial-to-parallel converters does not need to be conditioned.

3.4.3. Software Interfaces

The LOW moisture profile data acquisition system requires existing software from two sources. The first is the operating system and windowing environment from the Microsoft®¹ Corporation. Version 5.0 or later of MS-DOS®² and version 3.1 of Windows™³ will be used. The actual versions will be documented in the SDD.

The second source of software is National Instruments®, Inc. Version 3.1 of LabVIEW® for Windows development system will be used for software development.

¹Microsoft® is a registered trademark of Microsoft Corporation, Redmond, Washington.

²MS-DOS® is a registered trademark of Microsoft Corporation, Redmond, Washington.

³Windows™ is a registered trademark of Microsoft Corporation, Redmond, Washington.

3.4.4. Communications Interfaces

The LOW moisture profile data acquisition system will not communicate with other computers.

3.5. ATTRIBUTES

3.5.1. Security

This system is to be used to acquire moisture data at various waste tanks at Hanford. The data is not classified. No security measures will be implemented regarding accessing the software on the computer or restrictions placed on accessing the collected data.

The software will be protected from alteration or modification because only an executable version will be installed on the computer when it is deployed for gathering data.

3.5.2. Maintainability

It is envisioned that this software will be developed with National Instrument's® LabVIEW® software. LabVIEW® is a self documenting easily modifiable development system.

3.5.3. Portability

No provisions are being made to enhance porting to another platform.

3.5.4. System Configuration Control

The LOW moisture profile data acquisition hardware and software and all related files and documentation will be released via supporting documents per WHC-CM-6-1. All desired changes subsequent to the approval of this SRS will be requested in writing and changes documented by ECN as described in the Software Quality Assurance Plan for Moisture Probe", WHC-SD-WM-QAPP-032.

4. REFERENCES

1. WHC-CM-6-1, "Standard Engineering Practices".
2. ANSI/IEEE Standard 830-1984, "IEEE Guide to Software Requirements Specifications".
3. WHC-SD-WM-QAPP-032, "Software Quality Assurance Plan for Moisture Probe."
4. WHC-SD-WM-CSRS-028, "System Design Description for the TMAD Code."