NOV 22 1995 (21) ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT 602256

| 2. To: (Receiving Organization) | 3. From: (Originating Organization) | 4. Related EDT No.: |
|---|---|---|
| Distribution | Characterization Equipment Development | NA |
| **5. Proj./Prog./Dept./Div.:** | **6. Cog. Engr.:** | **7. Purchase Order No.:** |
| 75250 | GF Vargo N4H4F | NA |
| **8. Originator Remarks:** | | **9. Equip./Component No.:** |
| For approval and release | | NA |
| | | **10. System/Bldg./Facility:** |
| | | NA |
| **11. Receiver Remarks:** | | **12. Major Assm. Dwg. No.:** |
| | | NA |
| | | **13. Permit/Permit Application No.:** |
| | | NA |
| | | **14. Required Response Date:** |
| | | 11/17/95 |

**15. DATA TRANSMITTED**

| (A) Item No. | (B) Document/Drawing No. | (C) Sheet No. | (D) Rev. No. | (E) Title or Description of Data Transmitted | (F) Approval Designator | (G) Reason for Transmittal | (H) Originator Disposition | (I) Receiver Disposition |
|---|---|---|---|---|---|---|---|---|
| 1 | WHC-SD-WM-SFR-010 | ALL | 0 | SOFTWARE REQUIREMENTS SPECIFICATIONS FOR SURFACE MOISTURE MONITOR | QAS | 1/2 | 1 | |
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**16. KEY**

| Approval Designator (F) | Reason for Transmittal (G) | Disposition (H) & (I) |
|---|---|---|
| E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7) | 1. Approval 4. Review<br>2. Release 5. Post-Review<br>3. Information 6. Dist. (Receipt Acknow. Required) | 1. Approved 4. Reviewed no/comment<br>2. Approved w/comment 5. Reviewed w/comment<br>3. Disapproved w/comment 6. Receipt acknowledged |

**17. SIGNATURE/DISTRIBUTION** (See Approval Designator for required signatures)

| (G) Reason | (H) Disp. | (J) Name | (K) Signature | (L) Date | (M) MSIN | (J) Name | (K) Signature | (L) Date | (M) MSIN | (G) Reason | (H) Disp. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | Cog/Proj. Eng. GF Vargo | G.F. Vargo | 11/21/95 | H5-09 | PR Deichelbohrer | | | S7-12 | 3 | |
| 1 | 1 | Cog/Proj. Mgr. CE Hanson | C.E. Hanson | 11/21/95 | H5-09 | WT Watson | W.T. Watson | 11/21/95 | HO-38 | 1 | 1 |
| 1 | 1 | QA ML McElroy | M.L. McElroy | 11/21/95 | S7-07 | | | | | | |
| 1 | 1 | Safety LS Krogsrud | L.S. Krogsrud | 11/21/95 | R3-08 | | | | | | |
| 1 | 1 | TI Stokes | T.I. Stokes | 11/21/95 | L6-37 | | | | | | |
| 1 | 1 | M Gimera | M. Gimera | 11/21/95 | L6-37 | | | | | | |
| 1 | 1 | SC Cantrell | S.C. Cantrell | 11/22/95 | S2-02 | | | | | | |

| 18. | 19. | 20. | 21. DOE APPROVAL (if required) Ctrl. No. |
|---|---|---|---|
| M Gimera<br>Signature of EDT Originator — Date 11/21/95 | GF Vargo<br>Authorized Representative for Receiving Organization — Date | DW Hamilton<br>Cognizant Manager Program — Date 11/22/95 | [] Approved<br>[] Approved w/comments<br>[] Disapproved w/comments |

A-6400-073 (08/94) WEF124

BD-7400-172-1 (07/91)

# SOFTWARE REQUIREMENTS SPECIFICATION FOR SURFACE MOISTURE MONITOR

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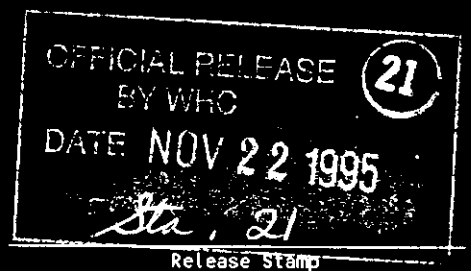
U.S. Department of Energy Contract DE-AC06-87RL10930

EDT/ECN: 602256 UC: 802
Org Code: 75250 Charge Code: N4H4F
B&R Code: EW3120074 Total Pages: 13

Key Words: SOFTWARE, REQUIREMENTS, MOISTURE TANK FARMS, SURFACE

Abstract: Provides the software requirements for the Surface Moisture Measurement System (SMMS).






Karen L. Noland 11/22/95
Release Approval Date

Release Stamp

**Approved for Public Release**

# SOFTWARE REQUIREMENTS SPECIFICATION FOR SURFACE MOISTURE MONITOR

IMPACT LEVEL QS

Issued by

Michael Gimera
(HiLine Engineering & Fabrication Inc.)

November 1995

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# SOFTWARE REQUIREMENTS SPECIFICATION FOR SURFACE MOISTURE MONITOR

## 1. INTRODUCTION

### 1.1. PURPOSE

This Software Requirements Specification (SRS) describes the required functions of the surface moisture measurement system (SMMS) 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 determine moisture in the contents of waste tanks at Hanford.

The intended audience for this document is the SMMS development team and reviewers from such organizations as Quality Assurance and Safety.

### 1.2. SCOPE

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

NIM Nuclear Instrumentation Module

SMMS Surface Moisture Monitor System

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 SMMS 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 LOW moisture measurement system. This sharing is practical because these two systems will never be operating simultaneously. Each deployment of the SMMS is to be temporary (less than 15 days in duration), however, repeated deployment is expected.

The SMMS will physically consist of two assemblies that are connected via electrical cable. The first assembly is a deployment system that is comprised of an arm that is lowered into a waste tank through a riser. At the lower end of the arm is a probe that returns neutron counts and temperature data. At the upper end of the arm is an enclosure that houses a winch to lower the probe from the arm to the waste surface. The arm can be rotated with a second winch enabling the probe to be placed as far as six feet from the riser centerline. The angle of rotation can be measured with an inclinometer installed in the arm. The deployment system can be swiveled radially to any compass point. The direction is determined from an electronic compass installed on the enclosure.

The second assembly is a data acquisition system located in a panel van. Among other instrumentation, the van houses an industrial computer and a NIM bin with a multichannel analyzer capable of reading four channels. The computer serves as an interface for the operator.

### 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 pre-amplifiers (one for each detector) and a multichannel analyzer. The multichannel analyzer communicates with the computer through a ISA bus circuit card that contains dual-ported memory.

The pre-amplifiers increase the power of the return signals from the neutron probe and the multichannel analyzer processes these return signals.

### 2.1.3. Neutron Probe

The neutron probe contains a Californium source that emits neutrons. Some of these neutrons travel 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 count neutron strikes and return a signal to the modules in the NIM bin.

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[1] Pentium® is a registered trademark of Intel.

Two thermisters are located in the probe in addition to the detectors. These thermisters return a temperature signal that is used to assist interpretation of the signals from the detectors.

#### 2.1.4. Encoders

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 Instruments®[2] digital input/output board model PC-DIO-96.

#### 2.1.5. Electronic Compass

An electronic compass is installed on the enclosure of the deployment device. It measures the direction of the arm in the tank with respect to north. The compass communicates with the computer through an RS-232 serial interface.

#### 2.1.6. Inclinometer

An inclinometer is mounted in the arm to record the angle with the mast. This angle can be converted to a distance from the riser centerline. The inclinometer is actually a potentiometer, that connects to an intrinsic barrier. The barrier outputs a 4 to 20 mA signal to the computer through a signal conditioner.

### 2.2. PRODUCT FUNCTIONS

The SMMS data acquisition software will allow the operator to acquire data from the neutron probe to calculate the moisture content of the waste surface. The acquired data will be recorded to a disk file. Operator controls are described in Section 3.1.1, "Operator Interface."

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

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

### 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 will depend on TMAD software as 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

Take Measurement

A graphic control will be located on the computer screen. Pressing this control will cause the software to acquire data from the multichannel analyzer for each of the three detectors. The detector X-Y graphs on the computer screen will be updated. Using the data, the software will calculate the moisture for each detector and display it on the computer screen. Finally data and calculation results will be written to a data file as described in Section 3.1.2.

##### 3.1.1.2. Outputs

Probe Position

A plan view of the probe's direction and radial position from the riser centerline shall be displayed on the computer screen. This display shall be constantly updated, except during the taking of measurement data.

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

Detector Graphs

A X-Y graph shall be displayed on the computer screen to show the spectrum from each of the three detectors. This display may either be three sets of data on one graph or three separate graphs with one set of data each. If three sets of data are plotted on one graph each set of data shall be plotted in a separate distinct color. The graph information will be updated each time the Take Measurement control is pressed.

Moisture Readout

The results of the moisture concentration calculation shall be displayed on the front panel for each activation of the Take Measurement control. The percentages shall be displayed as three separate numbers. Each of the three numbers will be the weight percent moisture at a different depth.

Status Indicator

During a moisture measurement the status of the measurement will be displayed graphically on the computer screen. This status, or progress, will give the operator an indication of the time left until completion of the measurement.

#### 3.1.2. Data File

The data file will consist of header information and measurement data. The header will contain the filename of the data file, the time and date of the measurement, the version of the software creating the file and the position of the neutron probe (compass direction, distance from riser centerline and depth.

The measurement data consists of an array (spectrum) of integers for each of the three detectors, probe temperatures and the three resulting moisture percentages.

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 "DATA" and within that directory will be a directory labeled "SMMS." 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\SMMS\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 these three data elements will be single precision floating point numbers.

## 3.2. OPERATION REQUIREMENTS

### 3.2.1. Initialization

On program startup, the temperature of the probe will be monitored through the thermisters located in the probe. Before data acquisition can take place the probe temperature shall be stable. The software will display the temperature stabilization status on the computer screen. Temperature stabilization will be defined as a temperature change of less than one degree Celsius over a period of five minutes.

### 3.2.2. Idle Loop

The idle loop is defined as the time when the software is operating, but the Take Measurement button is not activated. During this idle time, the software shall update the probe position indicator. Updates shall take place at approximate one second intervals.

### 3.2.3. Take Measurement

There are four steps to taking measurement data. During the process of taking measurements, progress will be displayed graphically on the computer screen. Each of the four steps is described below.

#### 3.2.3.1. Poll Detectors (Step One)

The MCA has four inputs or channels (three of which are connected to the three neutron detectors located in the probe), but the data associated with the channels can only be transferred to the computer one channel at a time. This information is available via the multichannel analyzer in the NIM bin. The software shall retain this data to calculate moisture and to record to the data file.

#### 3.2.3.2. Read Thermisters (Step Two)

Signals (voltage) from the two thermisters in the probe are acquired. This information is to be used to calculate moisture content and to record to the data file.

#### 3.2.3.3. Calculate Moisture (Step Three)

Using both temperature data from the thermisters and spectral data from the neutron detectors, the software will calculate the moisture concentration of the waste at three depths. The resulting values will be displayed on the front panel and written to the data file.

#### 3.2.3.4. Write Data File (Step Four)

The final step to taking a measurement is to write the results to a data file. 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 "SMMS.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 operator by use of a dialog box. Depending on the severity of the error, the operator may have the choice to continue. If program continuation is not possible the program will terminate after the operator dismisses the dialog box.

### 3.3. DESIGN CONSTRAINTS

Software constraints due to hardware limitations and system configuration are described in section 2.4 above. 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 one update per second. The detector graph displays will be updated after measurement data acquisition is completed.

### 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 input, although available, should not be required.

#### 3.4.2. Hardware Interfaces

Hardware interfaces shall be through National Instrument's® data acquisition circuit boards, serial ports 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 SMMS 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, Software Design Description for Surface Moisture Monitor, WHC-SD-WM-CSDD-017.

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

#### 3.4.4. Communications Interfaces

The SMMS 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. Platform Portability

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

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

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

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

### 3.5.4. System Configuration Control

The SMMS 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-CSDD-017, "Software Design Description for Surface Moisture Monitor."

5. WHC-SD-WM-CSRS-028, "System Design Description for the TMAD Code."