Y-12

**OAK RIDGE
Y-12
PLANT**

MARTIN MARIETTA

A Computerized Welder Qualification Record and Tracking System

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ABSTRACT

Accurately tracking welder qualification and assigning welders to jobs for which they are qualified is becoming more important as customers increasingly demand improved quality and conformance to industry standards. A computerized welder qualification records and tracking system (WPQ) was developed at the Oak Ridge Y-12 Plant[3] to assist the user in this process. The system enables the user to consistently generate welder qualification records with minimal effort and increased accuracy, relate the welder qualification limits with the limits of the welding procedure specification, generate a printout which reports essential information for selecting qualified welders, and provide a method for updating welders based on process usage as permitted by the codes. Codes addressed by the system include American Society of Mechanical Engineers (ASME) Section IX, American Welding Society (AWS) D1.1, AWS D1.3 and AWS D9.1

INTRODUCTION

Several problems were identified in the Weld Test Shop at the Oak Ridge Y-12 Plant which ultimately resulted in the development of a computerized welder qualification database and tracking system. These problems included the following:

- Welder qualification forms filled out manually required approximately 70 entries.
- Frequent personnel turnover resulted in incomplete and inaccurate records.
- Existing PDP 10 mainframe computer system used for welder certification printout is being phased out.
- Existing system contained inadequate information to determine if welders had limited qualifications (i.e. positions or diameters)
- Existing system only addressed ASME codes, AWS codes were not supported.
- Existing WPSs required the welder to be qualified for each procedure.

The Weld Test Shop requested that the Engineering group assist them in solving these problems. A team was assembled including weld test shop personnel, engineering department personnel, and computer services personnel. Several meetings were held to

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better define the problems and needed solutions. A temporary computer system was developed to generate weld records. Industry was then surveyed to identify any off the shelf software which could be used to solve the problems. No existing software was found which would meet their specific needs.

The American Welding Institute (AWI) having extensive experience in developing computer applications for the welding industry was contracted to develop the system. AWI had also developed another welder qualification tracking system. Experience gained during that job was used as a basis for the new system.

SYSTEM REQUIREMENTS

The team worked together to further define the system requirements for a computerized welder qualification record database and tracking system. The following list includes some of the most important requirements identified.

- Operable by a person with minimal computer skills.
- Require minimal keyboard data entry.
- Require minimal knowledge of welding code by weld test shop personnel to generate records and printouts.
- Welding engineer is responsible for code compliance.
- Password protected.
- Critical data must reside on the mainframe for security and backup.
- PC based for easy use and flexibility.
- Welder data available over a network for other plants.
- If limits of WPSs change because of additional qualification tests, the system must automatically reflect changes for all welders in the system.

One of the most difficult requirements to define was the implementation platform. A mainframe computer is heavily relied on for many of Y-12's systems and is accessible to all the plants. However, many features of a PC-based system are also attractive. The first phase of the project performed by AWI was to perform an economic analysis and show the advantages/disadvantages of a PC based system, mainframe (VAX) system, and a combination system.

AWI recommended a combination system which runs on a PC with the centralized database residing on the VAX for backup and security. The following includes a list of some of the advantages and disadvantages of implementing the combination system.

Advantages

- This option allows AWI to utilize existing software packages and tools developed or acquired during the development of other welding engineering computer

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applications. This accelerates development, improves the quality of this system and any upgrades to the system, and reduces development costs.

- Data processing (such as updating qualifications and searching to provide reports) is faster on the PC, especially at peak times of VAX use(i.e. during the day).
- An inexpensive, high quality printer output is easily provided for the PC at the Weld Test Shop so that forms may be printed.
- A more user-friendly, mouse driven, graphical interface is available on the PC. This interface is more intuitive, thus requiring less training for those using or entering the data.
- All of the centralized data resides on the VAX and is accessible through out the Oak Ridge facilities and to contractors. Thus, data management including data back up and security is handled by existing VAX central facilities and procedures.

Disadvantages

- A small communications delay (i.e., VAX processing and data transfer time) occurs each time the database is downloaded. This typically takes only a few seconds.

APPROACH

Standard Performance Qualification Tests (PQT) as shown in Figure 1 were developed to cover the full range of welding procedure specifications (WPS). The standard tests give a welder the widest range of qualification consistent with the appropriate code and sound judgment. A database file was created which relates each PQT to the Thickness limits of each WPS the welder could use based on that particular PQT. An example of this relationship is demonstrated in Figure 2. After a welder successfully completes a PQT, a Welder Certification Report (WCR) as shown in Figure 3 is automatically updated to list every procedure the welder is qualified to use based on that PQT. The printout further lists other limitations such as position, diameter, minimum thickness, maximum thickness and expiration date necessary to select a welder who is qualified for a particular job. Update of the welder qualification printout is based primarily on process usage as permitted by the codes used. The computer system was developed as a Microsoft Windows application to ensure a user friendly interface. As with most Windows applications, the learning curve for the WPQ record system was found to be small for any user with or without previous Windows application experience.

TECHNICAL OVERVIEW AND IMPLEMENTATION

Y-12 worked very closely with AWI during the development of the software. AWI provided Y-12 with the incremental system software updates at three different stages of development for evaluation. This close working relationship ensured that the needs of Y-12 would be met with the software. Many Y-12 personnel involved with beta testing of this

software are also the end users of the system, thus the application has become a familiar tool instead of another application to learn.

The system was designed to run on an 80x86 based personal computer. Minimum requirements include 5Mb of hard disk space, 8Mb RAM, 3.5" floppy drive (for software installation and file backup), and a VGA color monitor. A Network Interface Card (NIC) with appropriate software drivers connected to a Local Area Network (LAN) is required for server based file sharing. The WPQ application requires the Microsoft Windows version 3.1 (or 100% compatible) operating system. The WPQ application relies on the Asymetrix Runtime Toolbook application to provide the Graphic User Interface (GUI). Database management functions are provided through the use of Dynamic Link Libraries (DLLs). These DLLs provide functions to operate on standard dBase III files. The application also contains functions to convert dBase III files into plain ASCII text files which may be manipulated by other applications including mainframe based database applications.

The WPQ application is designed to allow access to database files from multiple workstation locations. This design allows the WPQ application on each workstation PC to be custom configured based on individual machine characteristics and user preferences. To accomplish these goals, the WPQ application requires each workstation PC to be connected to a network file server with full read/write access privileges on a portion of the server's hard disk storage area. Although storing the database files on the server is not strictly required, it is a very good idea since the server's hard disk space is backed up to tape on a daily basis. This file space must be logically assigned to an available DOS drive identifier (i.e. "N:"). This is a very common network file sharing method used by many Network Operating Systems (NOS) including DEC Pathworks, NFS, Novell Netware, Artisoft Lantastic, etc. The WPQ application may be configured to use the network file server as little or as much as necessary, but as with any network application, higher network bandwidth results in greater application performance. The WPQ application has been tested on various networks including DEC Pathworks and the Artisoft Lantastic "peer-to-peer" NOS.

The data flow diagram shown in Figure 4 represents the basic flow of information through the WPQ application. The PQT, QMatrix, and Limits database files are restricted to changes made by authorized personnel (Welding Engineer). These personnel must have thorough knowledge and understanding of welding code requirements. The PQT database contains all information required for individual Performance Qualification Tests for any specific welding code (ASME, AWS D1.1, AWS D1.3, or AWS D9.1). The QMatrix database contains information which relates the type of welding test and the position taken to a range of thickness values, etc. The Limits database defines a range of material thickness valid for a particular PQT or welding process.

The Welder, Inspector, Current, Process, WPQ, and WCR databases may be changed by authorized users in the Weld Test Shop. These personnel need not have an extensive

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knowledge of qualification requirements. The Welder database is populated with information pertaining to individual welders employed by MMES or a sub-contractor. Likewise, the Inspector database contains information concerning individual welding inspectors who are authorized to oversee welder qualification activities at the Weld Test Shop. These database files are queried by the system to produce the WPQ database, which is a combination of individual welders, tests, and qualification ranges. The Current and Process database files contain information relating individual welders with the date a specific process was last used by the welder. The system queries the WPQ database and the Current database to generate the Welder Certification Report (WCR) database, which contains accurate information on each welder, including all WPSs for which the welder is qualified including positions, ranges, and thickness variables. The WCR database can be exported as a plain ASCII text file for use in other MMES mainframe based applications such as distribution of the WCR data to all plants (Figure 5).

SECURITY SPECIFICATIONS

The WPQ application does not contain any classified information and is therefore designated as non-protected software. However, the WPQ application contains internal mechanisms to enforce security and database integrity in the following areas: First, database file integrity is maintained by a "data file checkout" module which ensures that the database files are in use by only one person at any given time. Second, various database files have been assigned password protection against unauthorized alteration. This function ensures that critical database files (such as PQT, Limits, and the Qualification Matrix) may only be modified by authorized personnel (i.e. Welding Engineer). Restricting those database files containing information for specific welding codes to authorized access ensures that a welding engineer is responsible for code compliance.

SUMMARY

The results of the program developed include standardization of welder qualification records, increased accuracy of welder qualification records, welder qualification printouts which relate the limits of welder qualification to the limits of the WPS, and welder update based on code limitations. The daily database maintenance activities, which are performed primarily in the Weld Test Shop by temporary secretarial personnel, have been successful with little training necessary for proper system operation.

CONCLUSIONS

This approach to welder qualification tracking is highly recommended. A series of standardized performance qualification tests reduces costs, saves time, and improves

quality. The computer automatically prints performance qualification records for several codes, provides up-to-date welder qualification information to anyone requiring this information, and minimizes inadvertent qualification expiration. Using this method maximizes use of personnel to establish standard company policies which are programmed into the computer system, allowing weld test shop supervisors more time to monitor and assist with testing welders while increasing the accuracy of the welder qualification records, and requiring less time by supervisors in selecting welders qualified for a particular job.

TEST NUMBER: SM-4-B-1   REVISION 1

1.   WELDING PROCESS: Shield Metal Arc Welding (SMAW) Manual

2.   ELECTRODE/FILLER MATERIAL: E7018 (F-number 4)

3.   BASE MATERIAL: Carbon Steel Pipe (P-number 1), 2 in. NPS,
                                  Sch. 80 (0.218 in. W.T.) with backing

4.   WELDING POSITION(S):   2G and 5G, or 6G

5.   VERTICAL WELDING PROGRESSION:Upward

6.   WELDING PROCEDURE: SM11-1(PP)

7.   INSPECTION: See paras. 3.06 D and E

8.   TESTS(S):   2G requires one face and one root bend; 5G
                                  or 6G requires two face and two root bends
                                  (ASME IX, para. QW-302.3); or, radiographic
                                  examination per ASME IX, para. QW-302.2

LIMITS OF QUALIFICATION:

1.   PROCESS: SMAW

2.   ELECTRODE/FILLER METAL: F1 through F4

3.   BASE MATERIAL: P1 through P11 and P4X

4.   POSITION(S):   All

5.   PIPE GROOVE WELD DIA LIMITS: 1 in. OD (3/4 in. NPS) and larger

6.   JOINT TYPES: Groove welds with backing or backgouged
                                  and fillet welds

7.   DEPOSITED METAL THICKNESS: Through 0.436 in.

8.   PRODUCT FORM   Pipe, plate, and shapes

Figure 1 - ASME WELDING PERFORMANCE QUALIFICATION TEST (PQT)

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Weld Procedure Specification		Performance Qualification Test				Combination Range		
WPS Number	Thick Limits	PQT Number	Thick Max	Dia Min	Comment	Thick	Dia Min	Comment
SM11-1(PP) (E7018)	0.062 - 0.750	SM-4-B-1	0.436	1.000	N/A	0.062 - 0.436	1.000	N/A
		SM-4-B-2	0.750	2.875	N/A	0.062 - 0.750	2.875	N/A
SM11-2(PP) (E6010)	0.062 - 0.432	SM-4-B-1	0.436	1.000	REM	0.062 - 0.432	1.000	Rem
		SM-4-B-2	0.750	2.875	REM	0.062 - 0.432	2.875	Rem

Dia = Diameter (Inches)
Max = Maximum
Min = Minimum

Thick = Thickness (Inches)
Rem = Remainder Only for Complete Joint Penetration Open Root Butt Welds

Figure 2 - Weld Procedure Specification/Performance Qualification Test Combination Limits

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Welder Certification Report

| EMPLOYEE INFORMATION			WPS	DATE QUAL EXPIRES	THICKNESS		FILLET WELDS			GROOVE WELDS				QUALIFICATION RESTRICTIONS
NAME	BADGE	STENCIL			MIN MATERIAL (WPS)	MAX DEPOSIT	PLATE POSITION	PIPE (ANY SIZE) POSITION	PLATE & PIPE > 24" POSITION		PIPE			
										DIA (O.D.)	POSITION		
Arc, J.D.	9876	A01	SMI1-1(PP)	7/25/1994	0.062	0.438	F,H	F,H	F,H	>= 1.000	F,H	----
			SMI1-1(ST)	7/25/1994	0.125	0.438	F,H	F,H	F,H	>= 1.000	F,H	REM. ONLY
			SMI1-2(PP)	7/25/1994	0.062	0.438	F,H	F,H	F,H	>= 1.000	F,H	----
			SMI1-2(ST)	7/25/1994	0.125	0.438	F,H	F,H	F,H	>= 1.000	F,H	
Welder, I.M.	1234	W01	SMI1-1(PP)	1/22/1995	0.062	0.750	ALL	ALL	ALL	>= 2.875	ALL	----
			SMI1-1(ST)	1/22/1995	0.125	0.750	ALL	ALL	ALL	>= 2.875	ALL	REM. ONLY
			SMI1-2(PP)	1/22/1995	0.062	0.750	ALL	ALL	ALL	>= 2.875	ALL	

* Indicates expiration within 30 days
# Expired: contact weld test shop for renewal test

Figure 3 - Welder Certification Report (WCR)

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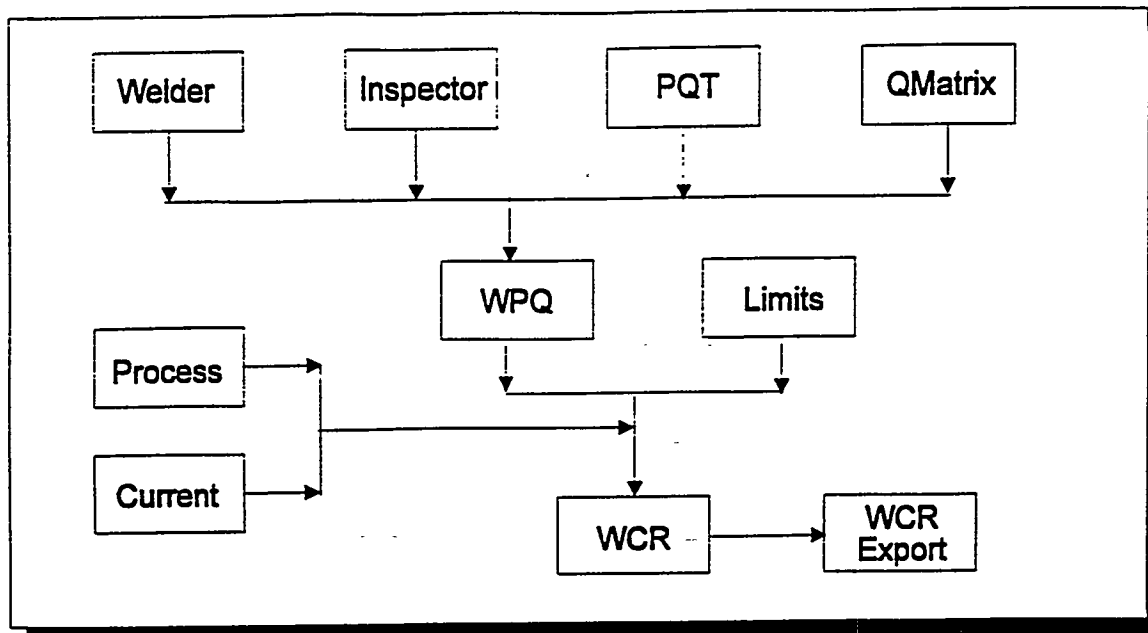
Data Flow Diagram

Figure 4
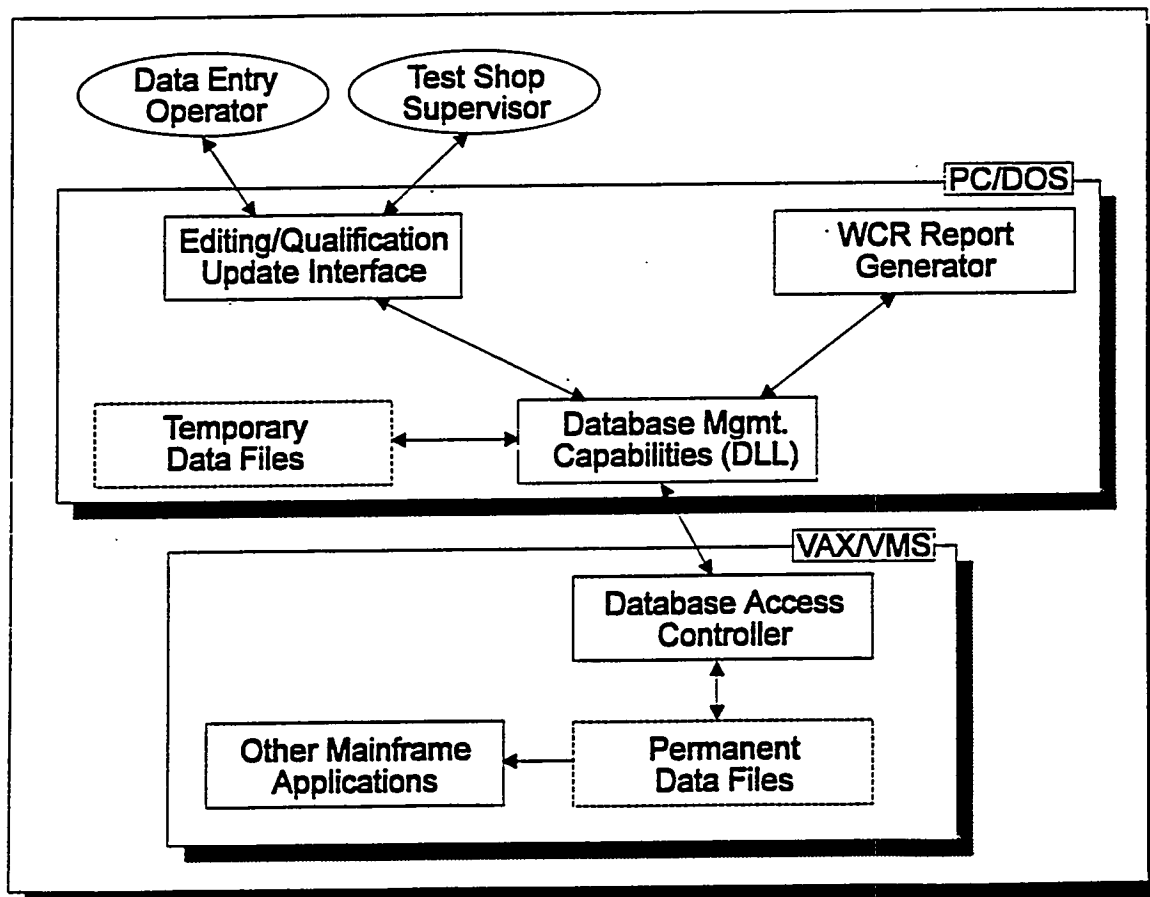
System Overview

Figure 5

INTERNAL DISTRIBUTION

1.   H. C. Beeson
2.   J. N. Davis
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16.   Y-12 Central Files

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