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COMPUTERIZED APPLICATION OF STANDARDS

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Newport News Shipbuilding

ABSTRACT

A computer program has been developed which provided for the elimination of manual applications of standards by integrating previously developed standards into existing computer-aided design systems. Standards for the pipe shop were developed between 1978 and 1979 using Manual MOST (Maynard Operation Sequence Technique). Since 1979, these standards, along with information obtained from existing production computer systems have been used by engineering Personnel to manually apply standards to pipe shop work packages which are part of a production control system used to schedule and track the progress of pipe details through each shop work center.

The Computer Center, Industrial Engineering, and Production Engineering worked together to develop a computer program to apply standards to the pipe detail work packages for operations in the pipe shop. Prior to the program's development, the existing manual application system, including computer-aided design drawings and manual standards application matrices were reviewed. Next, the link between the existing computer system and manual application process was established by standardizing the input data through the development of type codes. The development of the computer program emphasized the application of standards to the bending, fabricating, welding, and machining operations in the pipe shop.

The implementation of this program into the computer-aided design system has resulted in improved accuracy and consistency of standards application. Other benefits resulting from the computerized application of standards include: increased manhour productivity, standardization of pipe detail part terms; capability to apply detailed standards, and the capability for computerized transfer to the Production Scheduling and Control System.

The opinions presented in the Paper are those of the authors and do not necessarily reflect those of Newport Mews Shipbuilding and Dry Dock Company.

EXECUTIVE SUMMARY

The computerized application of standards project successfully proved that previously developed standards could be applied by an existing computer-aided design system to eliminate manual application of standards. At Newport News Shipbuilding, the Computer Center, Industrial Engineering, and Production Engineering at Newport News Shipbuilding worked together to develop a computer program to apply standards to the pipe detail work packages for the bending, fabricating, welding, and machining operations in the pipe shop.

The implementation of this program into the computer-aided pipe detail design systems has resulted in improved accuracy and consistency of standards applications. Other benefits resulting from computerized application of standards include: increased manhour productivity, standardization of pipe detail part terms, and capability to apply detailed standards.

The development of the program took approximately eight months and involved extensive communications between the computer programmer and the Production Engineering pipe shop planners. This level of effort was based on the existence of a computer-aided pipe design system generating pipe detail work packages and a well-established manual standards application system. Although the transferability of the program software may be minimal, the approach and techniques used to develop the program should be highly transferable.

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INTRODUCTION

Traditionally the application of standard times to specific operations in work packages has been a manual process. However, the increasing use of computer-aided design systems in the development of work packages lends itself to the computerized application of standard times. This concept is the basis for a project performed by Newport News Shipbuilding and funded by the Maritime Administration Ship Production Panel on Industrial Engineering (SP-8).

By January 1985, Newport News Shipbuilding had successfully implemented a project to develop a computerized standards application program. This program utilizes standards that were previously developed by Maynard Operation Sequence Technique (MOST) and existing computer-aided design (CAD) systems to eliminate the manual application of standards. This paper will describe the development of the computer program and the results obtained from its implementation.

There were three key elements essential to the successful implementation of the computerized standards application program:

- previously developed standards
- existing computer-aided design system
- a well established manual standards application system

At Newport News Shipbuilding, the area of standards application best meeting these criteria was the yard's pipe shop operations. The pipe shop had a well established work package system that utilized manually applied standards as part of a production scheduling and control system. This work package system was supported by a CAD system which generated pipe details with the pipe manufacturing data required for standards application.

Having; these elements in place enabled the effort on this project to be focused on development of the interface program and not on data or standards development. To promote a better understanding of the program, background information on the piping CAD system, MOST time standards, pipe shop work packages, and standards application will be provided. This will he followed by an overview of-the program development and a description of the program content. Results and benefits derived by Newport News Shipbuilding as a result of the implementation of this program will be provided at the end of this paper. For an in-depth review of the program, an appendix is provided that includes a detailed flowchart of the program and a step-by-step explanation of 'the flowchart.

BACKGROUND

One of the early objectives of the SP-8 Panel was to demonstrate the benefits of standards development and application in selected areas of shipbuilding.. Various methods of developing standards were considered hut the amount of time for the average shipbuilding_ work process is so long that traditional work measurement systems (such as MTM) are not appropriate. Stopwatch time studies are time consuming and not very effective since shipbuilding does not tend to be a repetitive, assembly line type operation. The system chosen to establish the standards was Maynard Operation Sequence Technique (MOST). MOST is a pre-determined work measurement system that concentrates on the movement of objects. It is a fast, accurate technique that is methods conscious and easy to learn and apply. For these reasons, as well as its adaptability to shipbuilding processes, MOST was selected for standards development.

In support of this objective, Newport News Shipbuilding had projects authorized in the early 1980's to develop and apply MOST standards. Having completed these projects, interest at Newport News was directed toward two areas: reducing the repetitive costs associated with standards application and reducing the manpower burden of standards application, thereby allowing more resources to he directed toward planning and standards development. To address this need, Newport News Shipbuilding proposed a project to develop a computerized pipe standards application program. This was a timely project for SP-

8 since it provided a means of using Newport News Shipbuilding's greater experience in MOST standards application to expand the panel's activity beyond standards development and manual application of standards. This project would also act as a guide for the standards effort in other shipyards participating in the panel. In November 1983 funding was provided to Newport News Shipbuilding for a twelve month project to develop a program for computerized application of pipe standards.

The pipe shop standards application process was selected for this project because the shop had a well established pipe work package system utilizing manual application of standards. The pipe shop standards had been developed between 1978 and 1979 using MOST. During this development major emphasis was-placed on minimizing the complexity and time required to manually apply standards. To this end, standards were categorized and combined into matrices for ease of application by Production Engineering. Since 1979, the standards, along with the information obtained from existing production CAD systems, have been utilized by Production Engineering personnel to manually apply standards to pipe shop work packages for bending, fabrication, welding: and machining operations.

It was anticipated that the computerized application of standards project would provide two benefits: the elimination of manual application of standards to the pipe shop work packages at Newport News Shipbuilding and an example for other yards to follow when making the transition from manual standards application to computerized standards application.

APPROACH

To accomplish this project in the time allotted, it was recognized that personnel well qualified in the areas of standards application, work packages, and CAD systems must be assigned to the task. Three departments were identified to work on this project:

- Industrial Engineering

  To provide their expertise in standards development and application, and to provide project management and control.

- Production Engineering

  To provide their knowledge of work packages and production control systems, and to perform the implementation, testing and acceptance of the program.

- Computer Center

  To provide a programmer/analyst to develop the computer program.

Newport News Shipbuilding was fortunate to have highly skilled, quality personnel to assign to this project, particularly the computer programmer who had been responsible for the piping CAD system for a number of years. His in depth knowledge-of the piping CAD system, particularly the many yard specific details, proved to be invaluable in the successful development of the program..

Initial contact between these three departments resulted in the establishment of a three phase plan for accomplishing the development of the computer program to interface standards application with the piping CAD system:

- Review existing standards application and CAD systems to develop program parameters
- Program development
- Test and implement program

Each of these phases will be expanded in the following sections.

EXISTING SYSTEM

The existing manual standards application system for the pipe shops involved interfaces between the piping CAD system, Production Engineering and pipe shop foremen. The standards were applied to pipe details by Production Engineering and then organized into work packages for use by the shop foremen.

The pipe details were created from piping design drawings by the piping CAD system. Two documents were generated for each detail: a pipe detail manufacturing record and a working drawing. of the pipe detail. The pipe detail manufacturing record provides the following data:

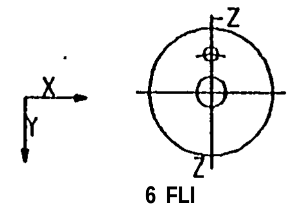
- how the pipe is bent:
  - number of bends
  - bend radius
  - bend angle
- Layout of pipe detail:
  - distance between centers
  - distance been tangents
  - X, Y, Z coordinates
- how the pipe is fabricated
- end preparation required for welding

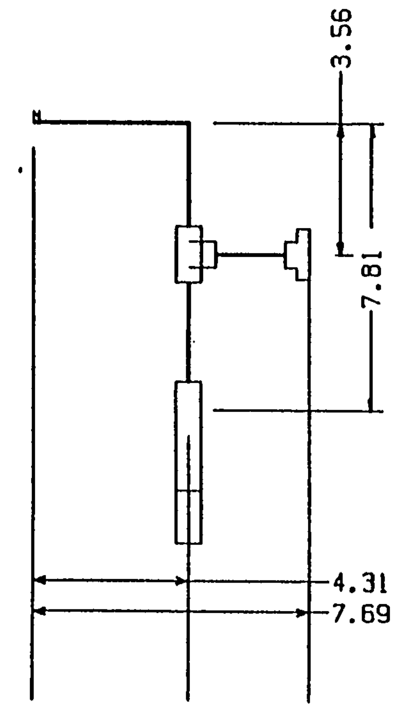
- size and description of pipe and fittings
- material type and part number of pipe and fittings
- miscellaneous fabrication notes

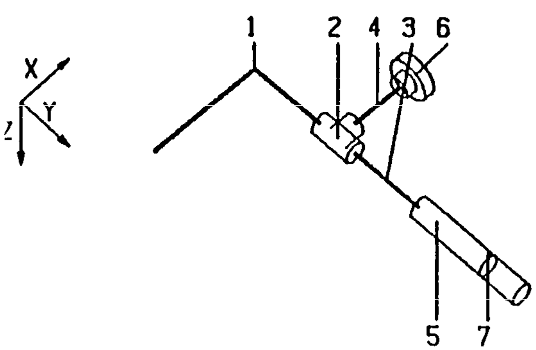
The working drawing (Fig. 1) provides dimensioned views and an isometric sketch of the pipe detail.

After the pipe details were generated by the CAD system, they were sent from the computer center to the Production Engineering shop planners. The standards hours were organized on a pick sheet (Fig. 2) and were used along with the information generated on the pipe detail manufacturing records to manually set the standards for each pipe detail. (It was this step in the process that was computerized by the interface program, allowing the planners more time for pipe shop work package planning.) Work package folders were then established for each pipe detail. Each work package folder included: the pipe detail manufacturing record, the working drawing of the pipe detail, the standard hours for bending, fabrication, welding and machining operations, the parts list, and the material schedule. The material and scheduling information from the pipe detail manufacturing records and the standard times for each work center on each pipe detail were transferred to the production scheduling

ID	PIECE NO	LOCATION	ORIENT	JT TY	JOINT NO.	NOT
1	PI46-1	MAIN PIECE				
2	F2	B END1	90.0-Z	BP		VT
3	P91-1	WITH A F2		BP		VT
4	P91-2	WITH C FZ		BP		VT
5	F18	B HITH P91-I		BP		VT
6	FLI	A WITH P9I-2	IS-Z	BP		VT
7	F5	B WITH A F18	90.0+X	BP		VT







DATE-
SIGNATURE-
LOCATION-

P9I-1

DETAIL	F	PAGE 2	OF 2
ARR. DWG. NO.	2282 -	299X1	
DET. DWG. NO.	J2282 -	160	REV. A

Bending

Nominal Pipe Size	Number of Bends 1	2	3	4	5
Applies To All Bending Machines					
1/2" Thru 3 1/2"	1	1	1	1	1
4" Thru 6"	1	1	1	1	1
8" Thru 12" +	1	1	1	1	1

MACHINING
PER PIPE END
1 Man Operation

Nom. Pipe Size	Straight Bevel Operation	Combination J Bevel & Counter Bore
1/2" - 1"	1	--
1 1/2" - 4"	1	1
5" - 8"	1	1
10" - 14"	1	1
15" - 20"	1	1

DRILL HOLES: 1 MHRS/HOLE

WELDING

Joint Dia. or Nom. Pipe Size	Socket Weld: Carbon Steel: First Joint	Each Add-on	CUNI, Cres: First Joint	Each Add-on	Chrome-Moly: First Joint	Each Add-on	Flange: First Flange	Each Add-on	Butt Weld: Carbon Steel: First Joint	Each Add-on	CUNI, Cres: First Joint	Each Add-on	Chrome-Moly: First Joint	Each Add-on	Boss: Each Joint
1/2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3/4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1 1/4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1 1/2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2 1/2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3 1/2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4 1/2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
24	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

FABRICATION

A	B	C	D	E				F		G	H
Pipe or Fitting Diam.	Set-Up The Job	Fittings	Slip on Flange	Special Fittings: Branch	Boss	Weld-o-let	Sleeve	Brazing: Fitting	Flange	Template Set-Up	Assemble Flange To Flange
1/2" Thru 3"	1	1	1	1	1	1	1	1	1	1	1
3 1/2" Thru 5"	1	1	1	1	1	1	1	1	1	1	1
5 1/2" Thru 8"	1	1	1	1	1	1	1	1	1	1	1
8 1/2" Thru 12"	1	1	1	1	1	1	1	1	1	1	1
12 1/2" Thru 16"	1	1	1	1	1	1	1	1	1	1	1
16 1/2" Thru 20"	1	1	1	1	1	1	1	1	1	1	1
20 1/2" Thru 24 1/2"	1	1	1	1	1	1	1	1	1	1	1

Fig 2

and control system by the planners. The work package folders were then sent from the planners to the shop foremen.

PROGRAM DEVELOPMENT

Before a computerized system to apply the standards could he developed, it was necessary to standardize the input data stored by the CAD system. It was discovered that the information on the pipe detail manufacturing record was referenced from a computerized catalog of pipe detail parts. This catalog originally contained the part numbers, descriptions, and material types of all pipe detail parts. For the computer program to apply the correct standards to the pipe detail, it had to be able to use the information in this catalog to accurately identify the parts. However, the information contained in the parts description was not standardized:

- different abbreviations were used for the same part
- the placement of the part name varied in the description field
- many part names were similar (reducer, reducing flange, reducing elbow), therefore not easily identifiable

Without a method of standardizing and cross referencing the pipe detail parts in the catalog to the standards application matrix, it was not possible to begin development of the application program.

To solve the problem of non-standard data required the cooperation of Production Engineering and the Computer Center. Together they were able to devise a solution that minimized the impact on existing computer records and data input. A coding system was developed that provided the necessary interface between the piping CAD system and the standards application matrices. The type code, which was added to each pipe detail part in the catalog, consists of three letters used to identify the piece type, weld joint type, and additional description of the piece (Fig 3). The type code allows the part to be accurately identified regardless of how it is abbreviated within the description of each pipe detail part. This code was then utilized by the interface program to accurately select the correct standard from the standards matrices.

The development of a type code provided the link between the piping CAD system and standards. application so that the development of the computer program could begin. The program was developed as part of the existing piping CAD system. In this program, standards are automatically applied to each pipe detail as they are developed by the CAD system. The program is divided into four major sections (bending, fabrication, welding, machining) which calculate the standard times for these four pipe shop operations. Each section of the program corresponds to one

EXPLANATION OF TYPE CODES

There are 3 letters to the type code. The first letter identifies the type of piece, and is listed alphabetically. The second letter gives the weld type. Since the weld types do not specifically modify any one piece type, they are listed as a group first. The third letter is used to describe the piece. Since reducing and union are general purpose modifiers, they are listed first.

Piece Type Codes

1st Letter Piece Type	2nd Letter Joint Type	3rd Letter Modifier
A = Adaptor	B = Butt Weld	R = Reducing
B = Boss	F = Flanged	U = Union
C = Coupling	S = Socket Weld	9 = 90° Radius
E = Elbow	T = Threaded	4 = 45° Radius
F = Flange	Z = Sil - Brazed	D = Raised Face
H = Bushing	M = Mixed	O = Slip on
N = Nipple	N = N/A	T = Foundation
P = Pipe		I = Concentric
R = Reducer		E = Eccentric
S = Sleeve		M = Male
T = Tee		W = Female
U = Union		A = Angle
V = Value		B = Ball
W = Weldolet, Sockolet, Brazolet,		C = Check
		G = Gate
X = Cross		L = Globe
Y = Lateral		P = P Trap
Z = Traps		S = S Trap
M = Misc		N = Running Trap
		1 = 1 Node
		2 = 2 Node
		3 = 3 Node

of the standard matrices used in the manual application of standards.

The general flowchart of the computer program (Fig. 4) highlights the areas of standards application:

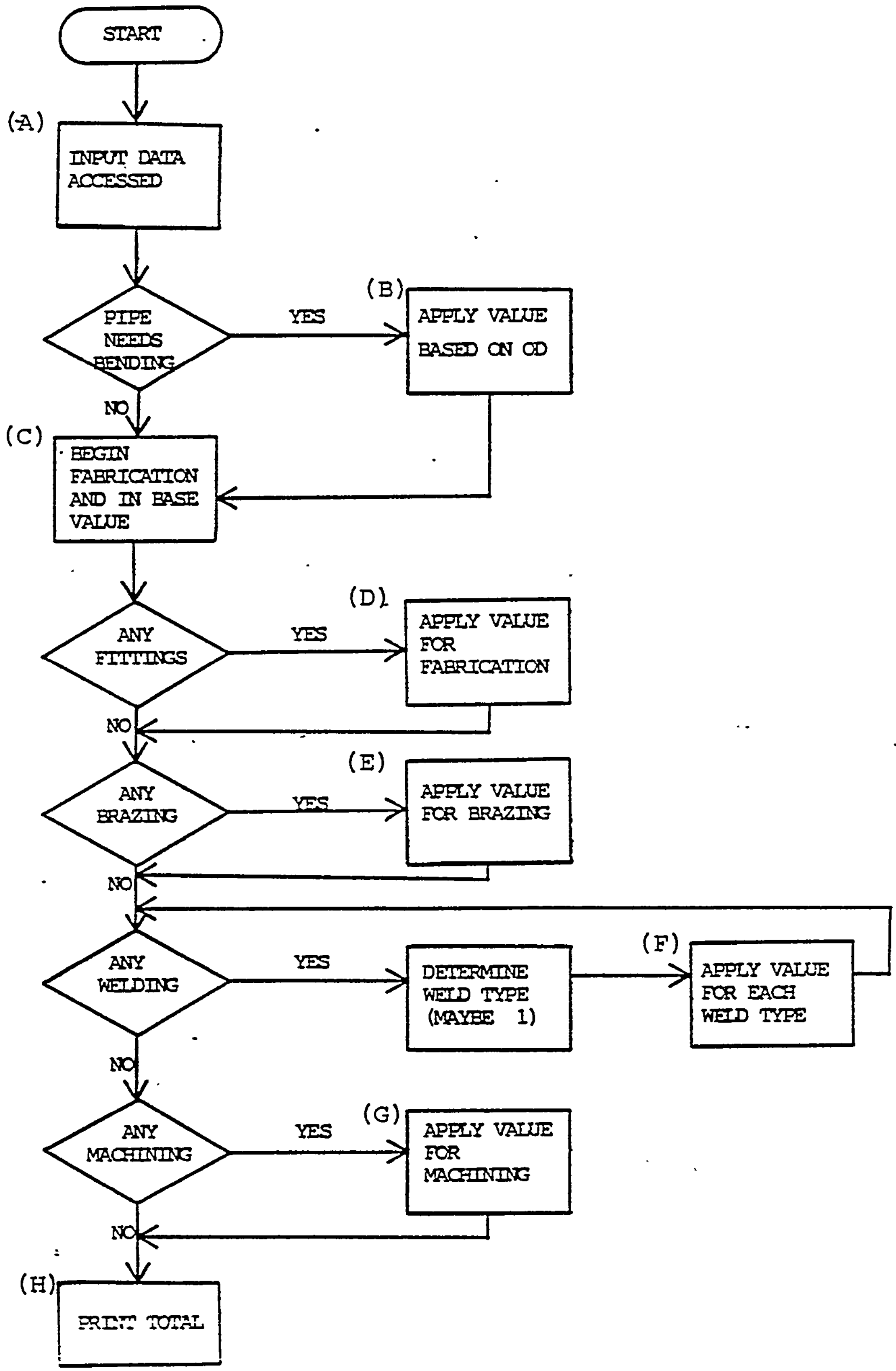
- A pipe detail is selected from the piping CAD system. (A detail maybe a single piece of pipe or may include a main pipe piece with up to 25 fittings.) All data needed to apply the pipe standards is collected from the piping CAD system. (Block A)

- If the pipe requires bending, the pipe diameter and number of bends specified in the input data are used to extract the bending times from the standards matrix. (Block B)

- The base value for the fabrication set up times are applied. (Block C)

- If fittings are included as part of the detail, the piece diameter and type of fitting specified in the input data are used to extract the fabrication values for each fitting. (Block D)

- If brazing is required, the piece diameter and type of fitting specified in the input data are used to



START
(A)
INPUT DATA ACCESSED
PIPE NEEDS BENDING
YES
NO
(B)
APPLY VALUE BASED ON OD
(C)
BEGIN FABRICATION AND IN BASE VALUE
ANY FITTINGS
YES
NO
(D)
APPLY VALUE FOR FABRICATION
ANY BRAZING
YES
NO
(E)
APPLY VALUE FOR BRAZING
ANY WELDING
YES
NO
DETERMINE WELD TYPE (MAYBE 1)
(F)
APPLY VALUE FOR EACH WELD TYPE
ANY MACHINING
YES
NO
(G)
APPLY VALUE FOR MACHINING
(H)
PRINT TOTAL

extract the brazing time from the fabrication standards matrix. (Block E)

a If welding is required, the type of weld (butt weld or socket weld) is determined and the piece diameter, material type, and joint description specified in the input data are used to extract the weldine. time. (Block F)

- If machining is required, the type of bevel and pipe diameter specified in the input data are used to extract the machining time. (Block G)

- The standard time values for each operation are printed out and included with the piping CAD documents. These documents are delivered to the planners to be used when developing the pipe shop work packages. (block H)

A detailed flowchart of the program and explanation of the flowchart are included in the Appendix.

TESTING AND IMPLEMENTATION

After the development of the standards application program was completed, the program was tested for completeness anti accuracy. Testing was accomplished by comparing the standard time results from the program with those applied manually by the planners. Initial tests resulted in requirements for only minor modifications to the program. Once these modifications had been made, the comparisons between standards application continued: A cross section of pipe details were tested in this manner until the results were consistently correct.

When the computer applied standards were compared to the manually applied standards, the computer application proved more accurate in many cases than manual application. An added benefit is that the program will not attempt to calculate the standards with incorrect input data. A data error message is printed with the pipe detail so the data corrections can he made. Generally these types of errors were overlooked during manual standards application.

After the testing was complete, the program was put into production use. A follow-up review of the production system has shown the application of the program to be very successful.

BENEFITS

This project successfully proved that MOST developed standards could be applied by an existing computer-aided design system to eliminate the manual application of standards. Computerized application of standards has resulted in improved:

- accuracy

- consistency
- productivity

Preliminary results indicate that the costs, excluding program development, for computerized application are approximately equal to the costs for manual application. There are several reasons why both application processes appear to result in equal costs.

- The standards application pick sheets were designed for ease of manual application. The detail of the standards were compromised so they could he categorized for easier application.

- The planners are-organized into specialized groups according to the standards application pick sheets. Therefore, over a period of time, each planner becomes highly skilled and proficient in standards application within his areas.

- The computerized application processing costs are temporarily high since this program was written to be compatable with a new computer system and not most efficient under the existing system. A system changeover is occurring which will reduce processing costs.

Benefits resulting from the computerized application of standards include:

- Increased manhour productivity
  The manual application of standards has been eliminated resulting in additional time for the planners other work. Computer costs do not directly correspond to manhour costs.

- Improved accuracy and consistency
  The computer is not prone to fatigue and mistakes present in manual application.

- Standardization of pipe detail part terms
  The capabilities of the existing computer-aided pipe detail manufacturing system is expanded by being able to accurately identify parts.

- Capability to apply detailed standards
  The standards are currently used as targets by the pipe shops. If more detailed standards were required, the matrices on the application pick sheets would be expanded, making it difficult for manual application but having little or no impact on computerized application.

CONCLUSIONS

This project successfully proved that previously developed standards could be applied by an existing computer-aided design system to eliminate manual application of standards. Computerized application of standards proved superior to manual application and particularly beneficial if concerned with accuracy, consistency, and application of detailed standards.

The transferability of this program depends on the computer-aided design systems and standards application processes in use. Due to the company-oriented nature of these systems and processes, the transferability of the actual program software is probable minimal. However, the approach and techniques used to develop this program should-be highly transferable. This information should reduce the time and effort required to develop the program. However, before a project of this type is undertaken, good in-house knowledge of standards, standards application, CAD systems, and their uniqueness to a specific shipyard should be assured.

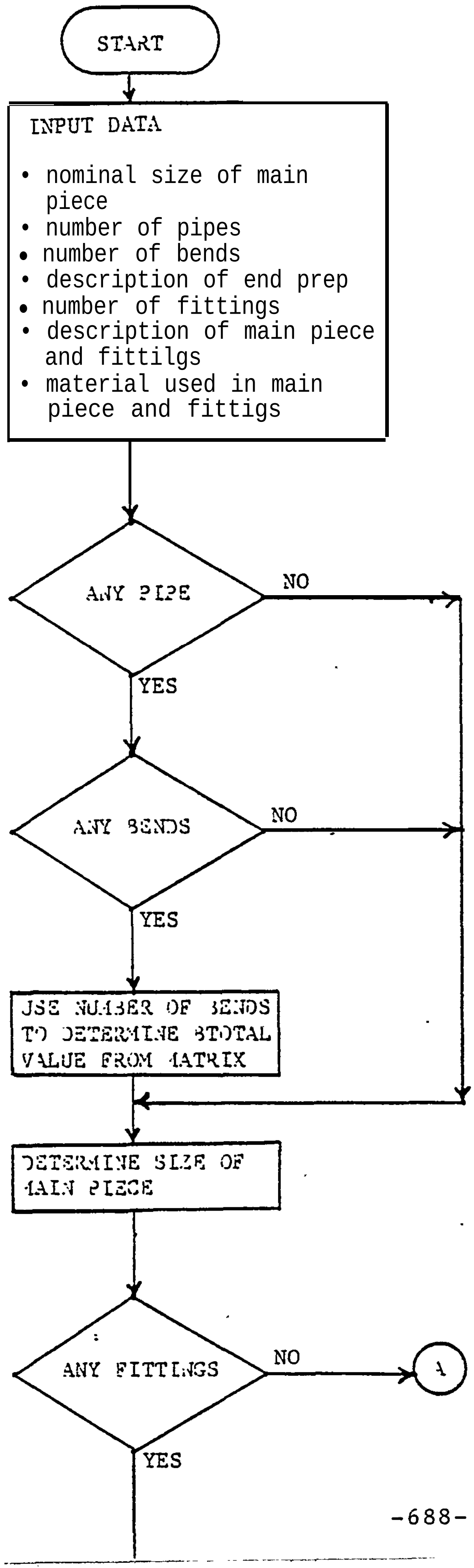
APPENDICES

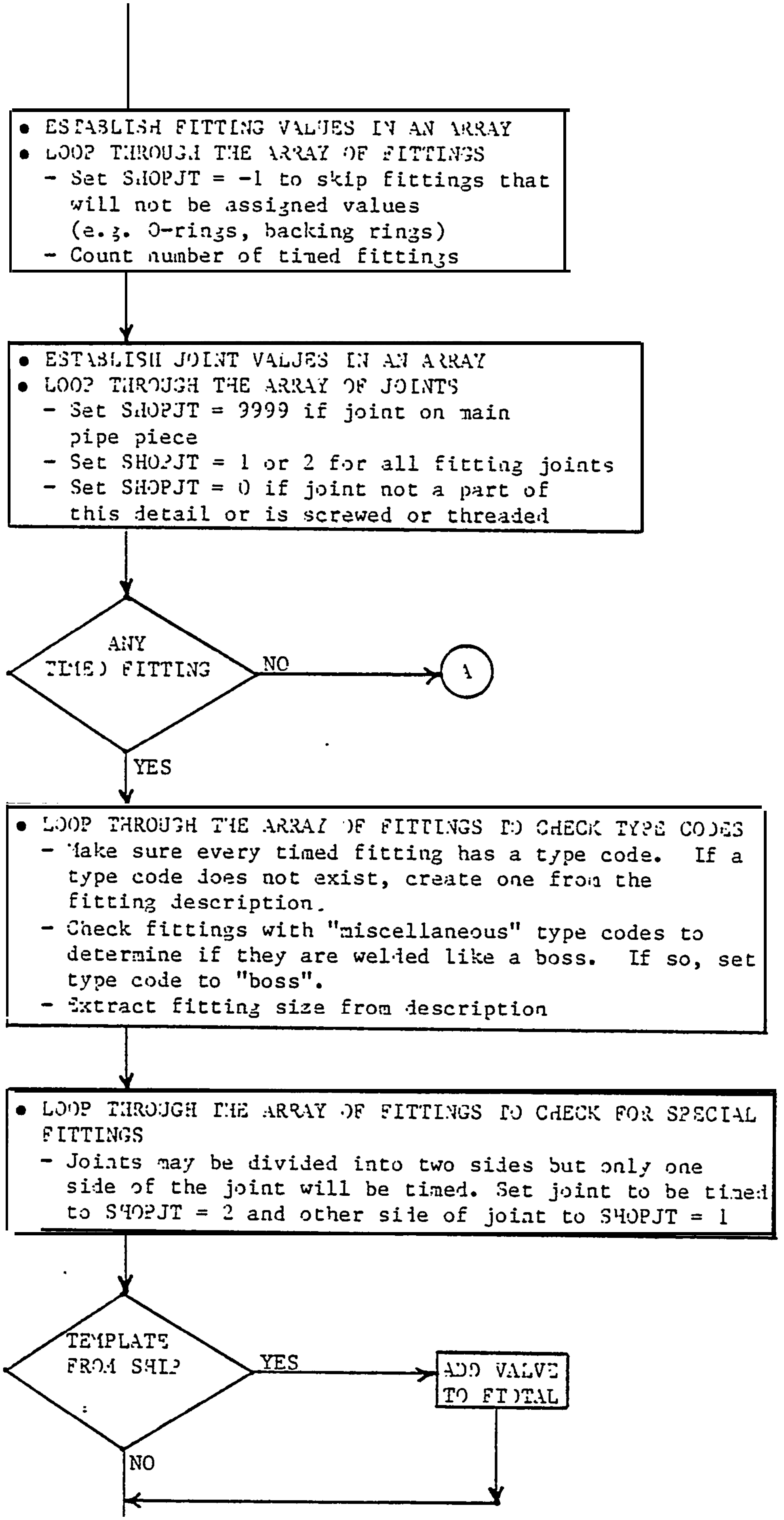
APPENDIX A: Detailed Flowchart

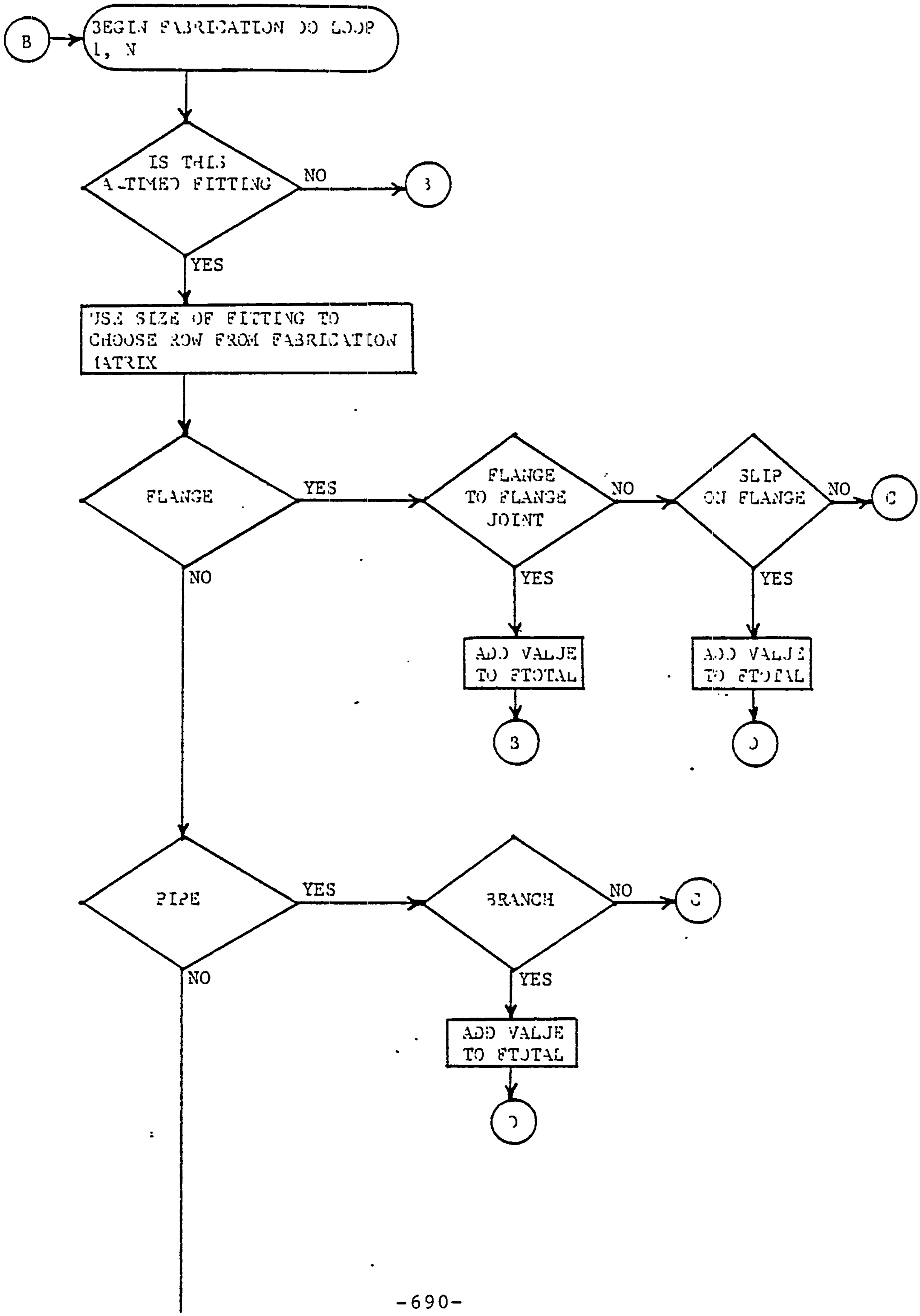
APPENDIX B: Explanation of Flowchart

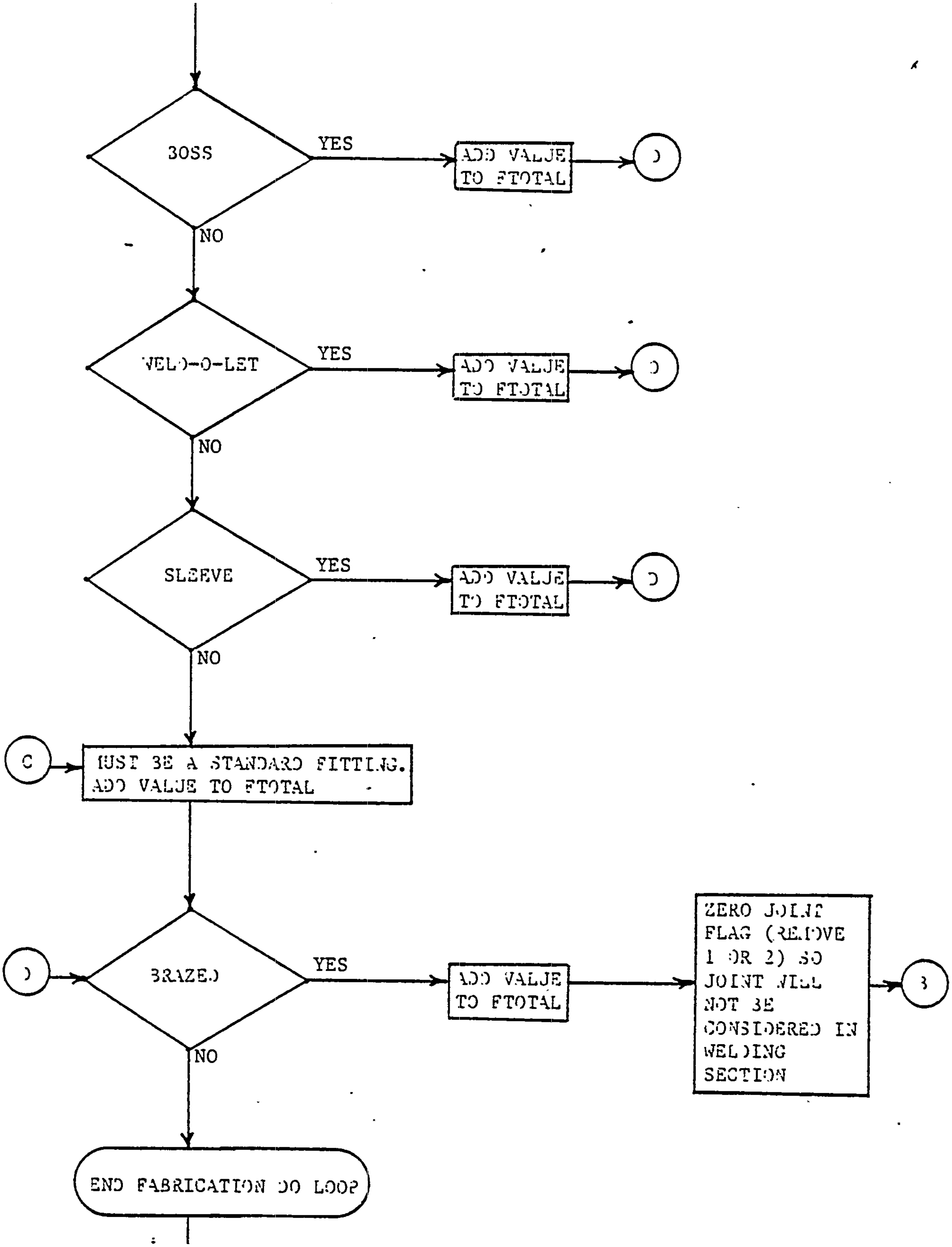
APPENDIX A

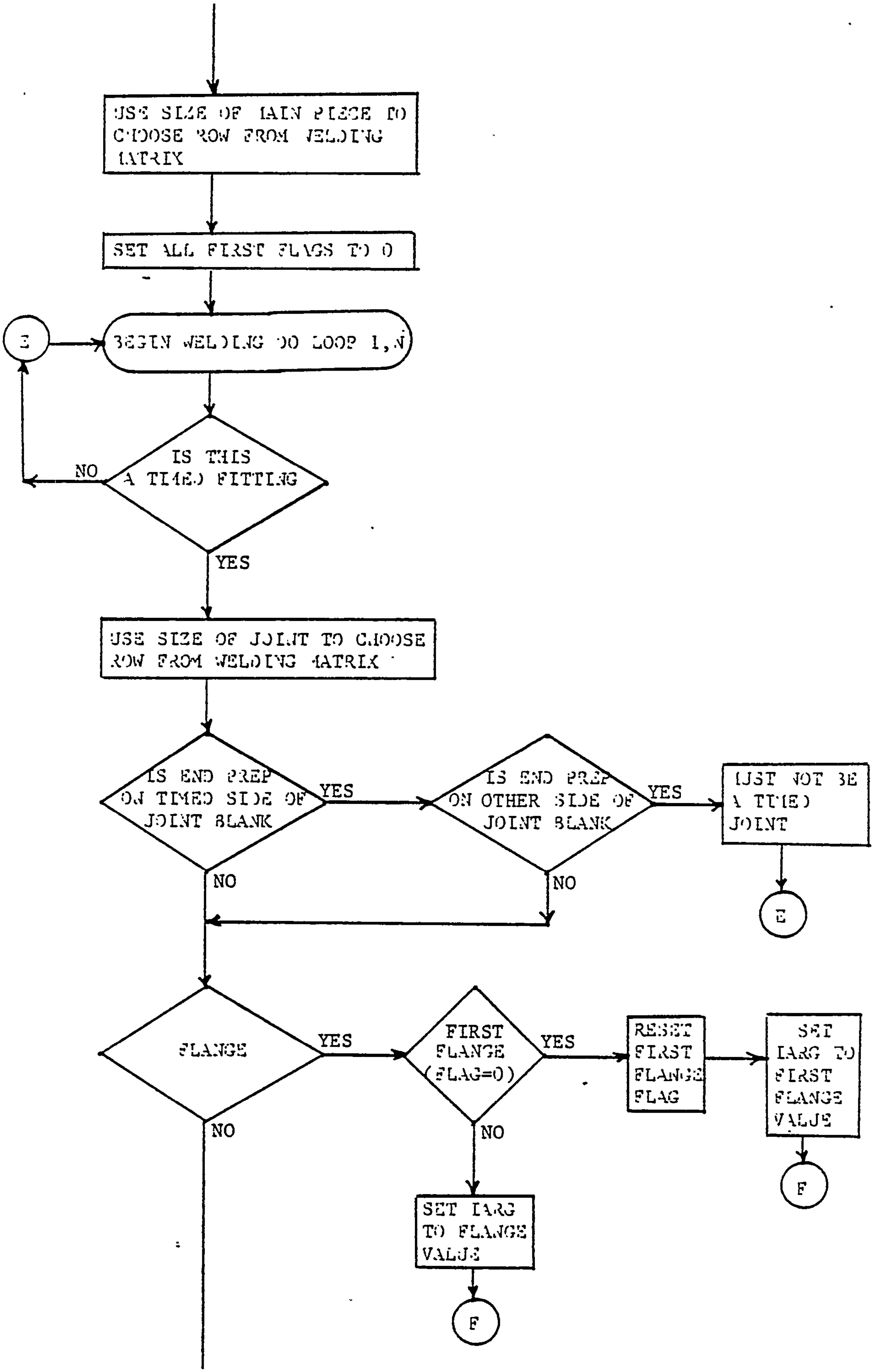
Detailed Flowchart

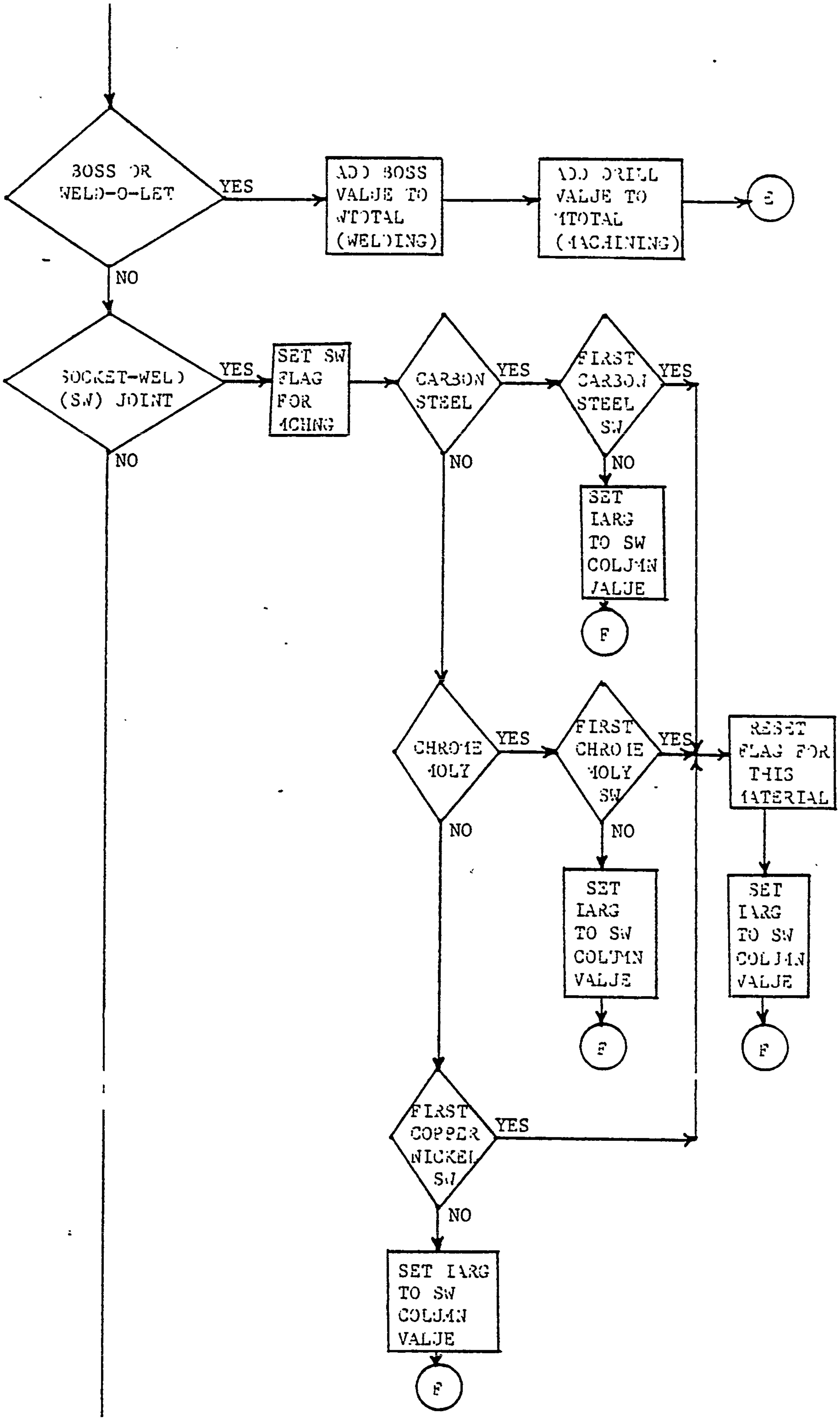

START
INPUT DATA
• nominal size of main piece
• number of pipes
• number of bends
• description of end prep
• number of fittings
• description of main piece and fittilgs
• material used in main piece and fittigs
ANY PIPE
NO
YES
ANY BENDS
NO
YES
USE NUMBER OF BENDS TO DETERMINE BTOTAL VALUE FROM MATRIX
DETERMINE SIZE OF MAIN PIECE
ANY FITTINGS
NO
A
YES

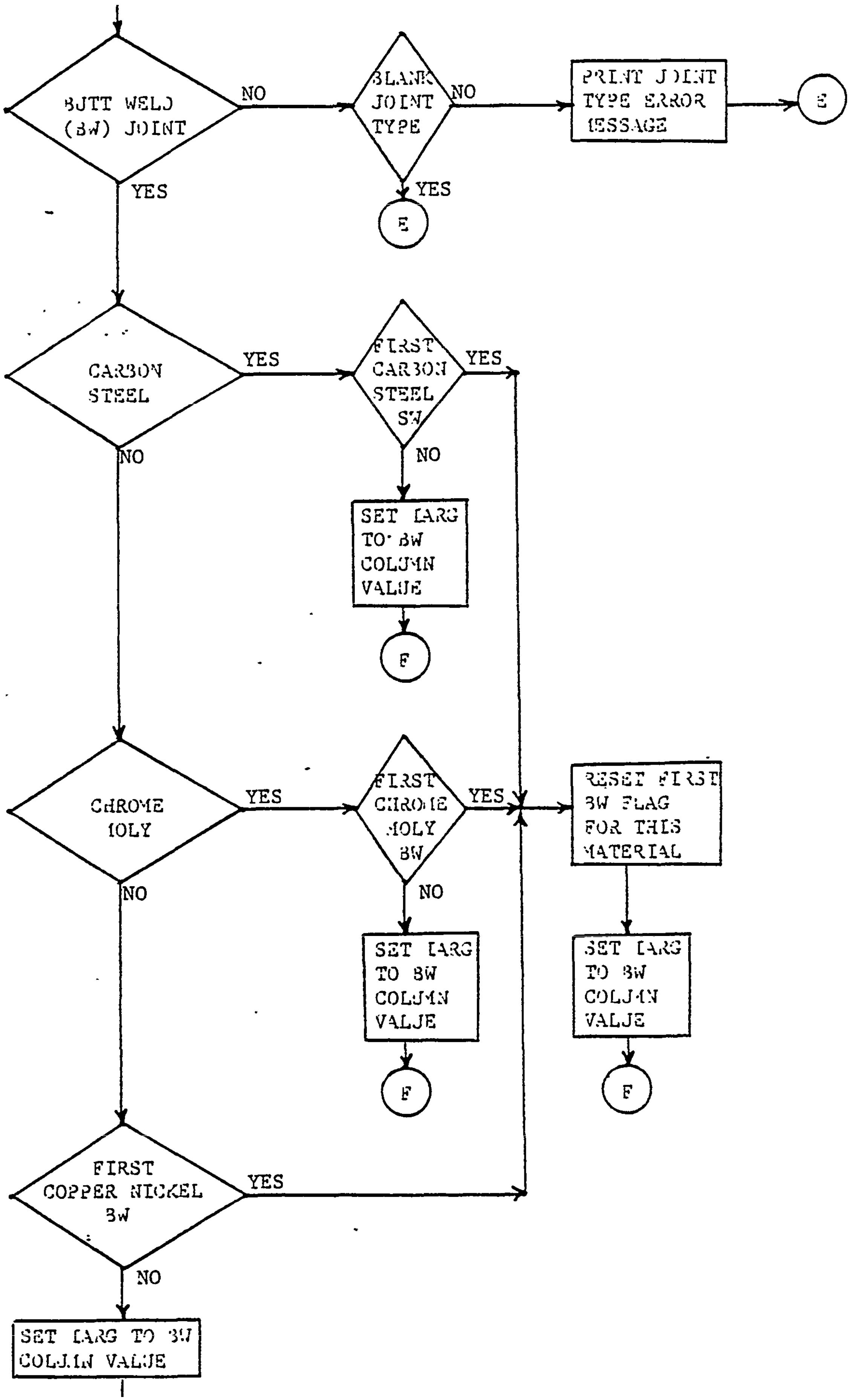

• ESTABLISH FITTING VALUES IN AN ARRAY
• LOOP THROUGH THE ARRAY OF FITTINGS
- Set SHOPJT = -1 to skip fittings that will not be assigned values (e.g. O-rings, backing rings)
- Count number of timed fittings
• ESTABLISH JOINT VALUES IN AN ARRAY
• LOOP THROUGH THE ARRAY OF JOINTS
- Set SHOPJT = 9999 if joint on main pipe piece
- Set SHOPJT = 1 or 2 for all fitting joints
- Set SHOPJT = 0 if joint not a part of this detail or is screwed or threaded
ANY TIMED FITTING
NO
A
YES
• LOOP THROUGH THE ARRAY OF FITTINGS TO CHECK TYPE CODES
- Make sure every timed fitting has a type code. If a type code does not exist, create one from the fitting description.
- Check fittings with "miscellaneous" type codes to determine if they are welded like a boss. If so, set type code to "boss".
- Extract fitting size from description
• LOOP THROUGH THE ARRAY OF FITTINGS TO CHECK FOR SPECIAL FITTINGS
- Joints may be divided into two sides but only one side of the joint will be timed. Set joint to be timed to SHOPJT = 2 and other side of joint to SHOPJT = 1
TEMPLATE FROM SHIP
YES
ADD VALVE TO FITTAL
NO

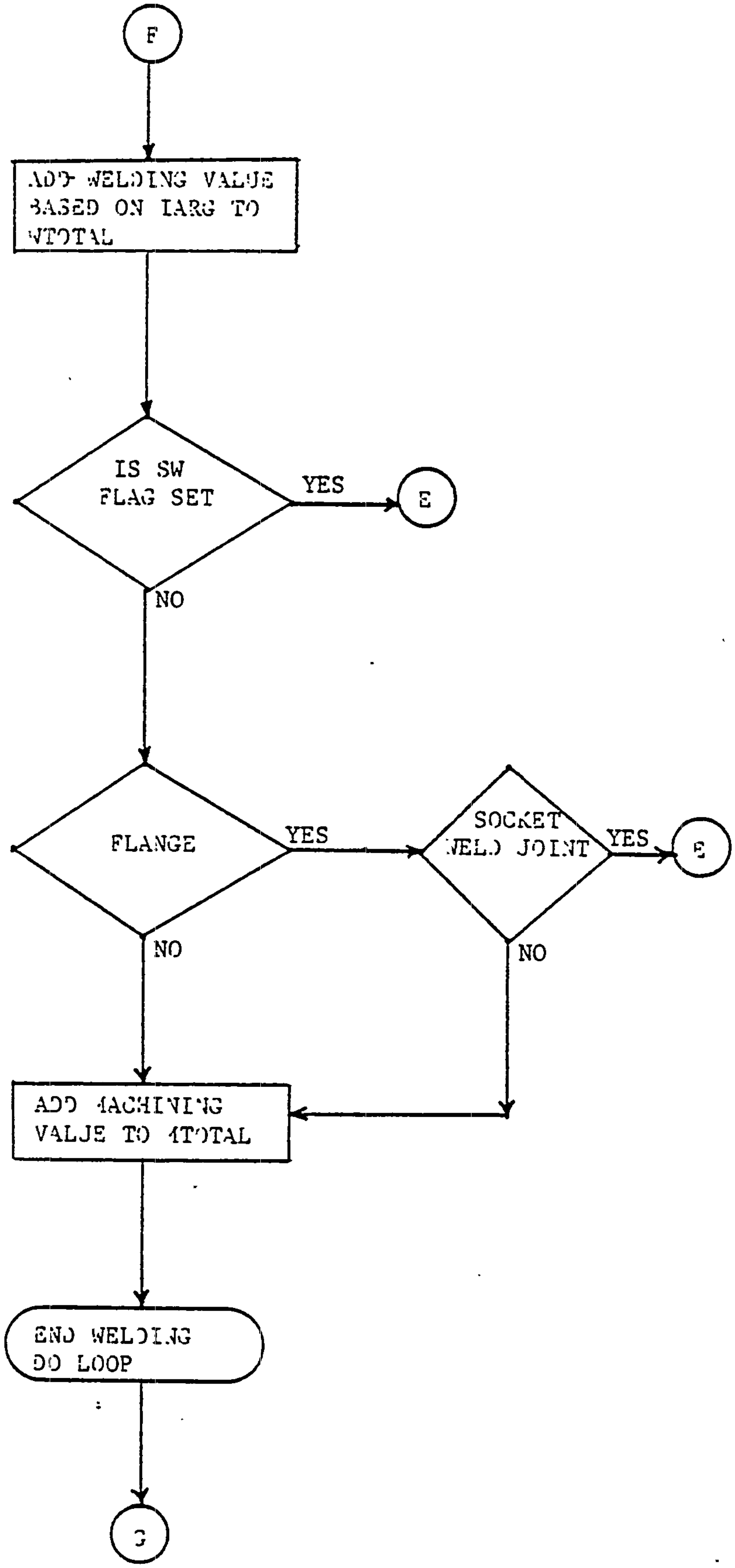

B
BEGIN FABRICATION DO LOOP 1, N
IS THIS A-TIMED FITTING
NO
B
YES
USE SIZE OF FITTING TO CHOOSE ROW FROM FABRICATION MATRIX
FLANGE
YES
FLANGE TO FLANGE JOINT
NO
SLIP ON FLANGE
NO
C
NO
YES
ADD VALUE TO FTOTAL
B
YES
ADD VALUE TO FTOTAL
PIPE
YES
BRANCH
NO
C
NO
YES
ADD VALUE TO FTOTAL

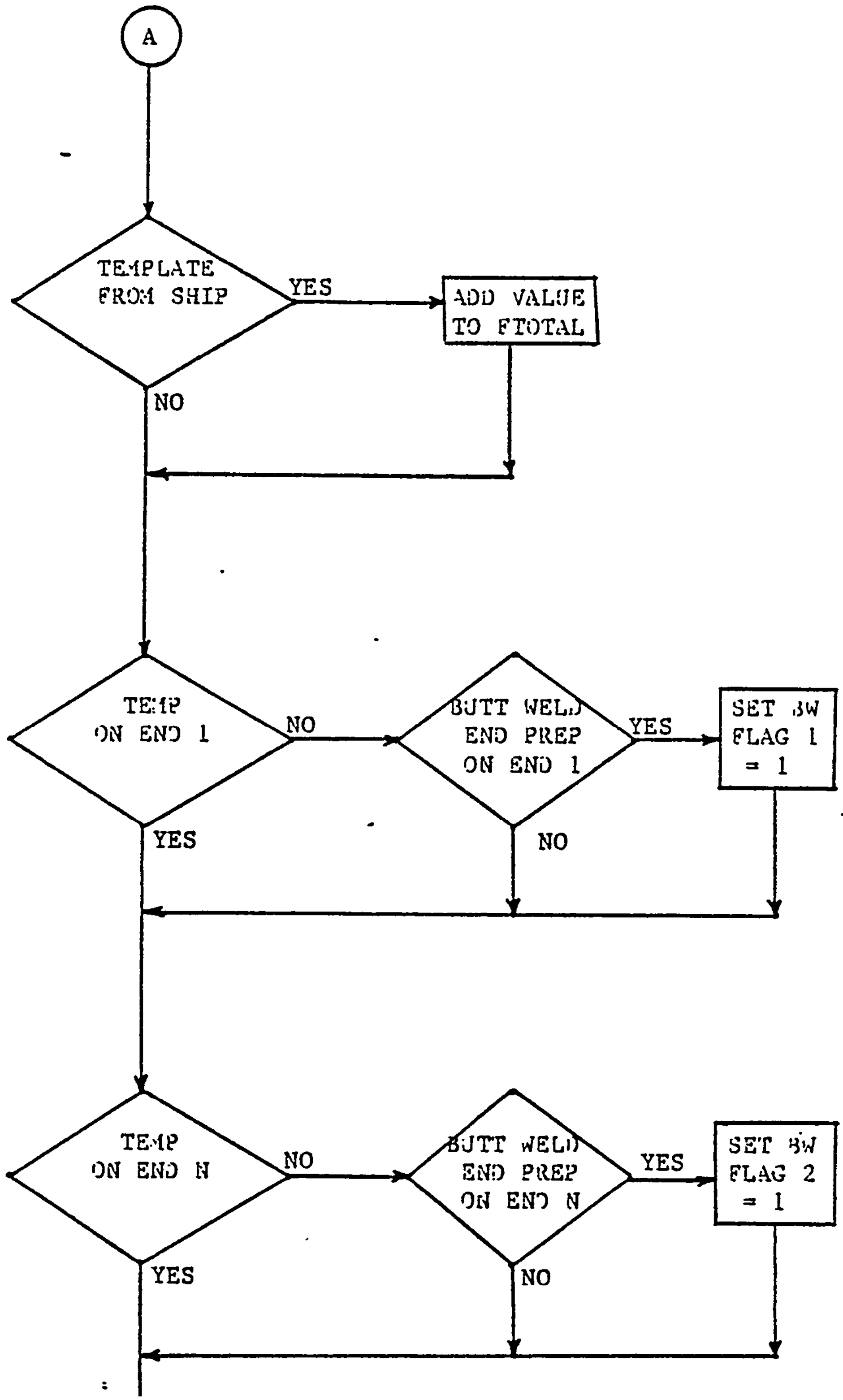

BOSS
YES
ADD VALUE TO FTOTAL
NO
WELD-O-LET
YES
ADD VALUE TO FTOTAL
NO
SLEEVE
YES
ADD VALUE TO FTOTAL
NO
C
MUST BE A STANDARD FITTING. ADD VALUE TO FTOTAL
D
BRAZED
YES
ADD VALUE TO FTOTAL
ZERO JOINT FLAG (REMOVE 1 OR 2) SO JOINT WILL NOT BE CONSIDERED IN WELDING SECTION
B
NO
END FABRICATION DO LOOP

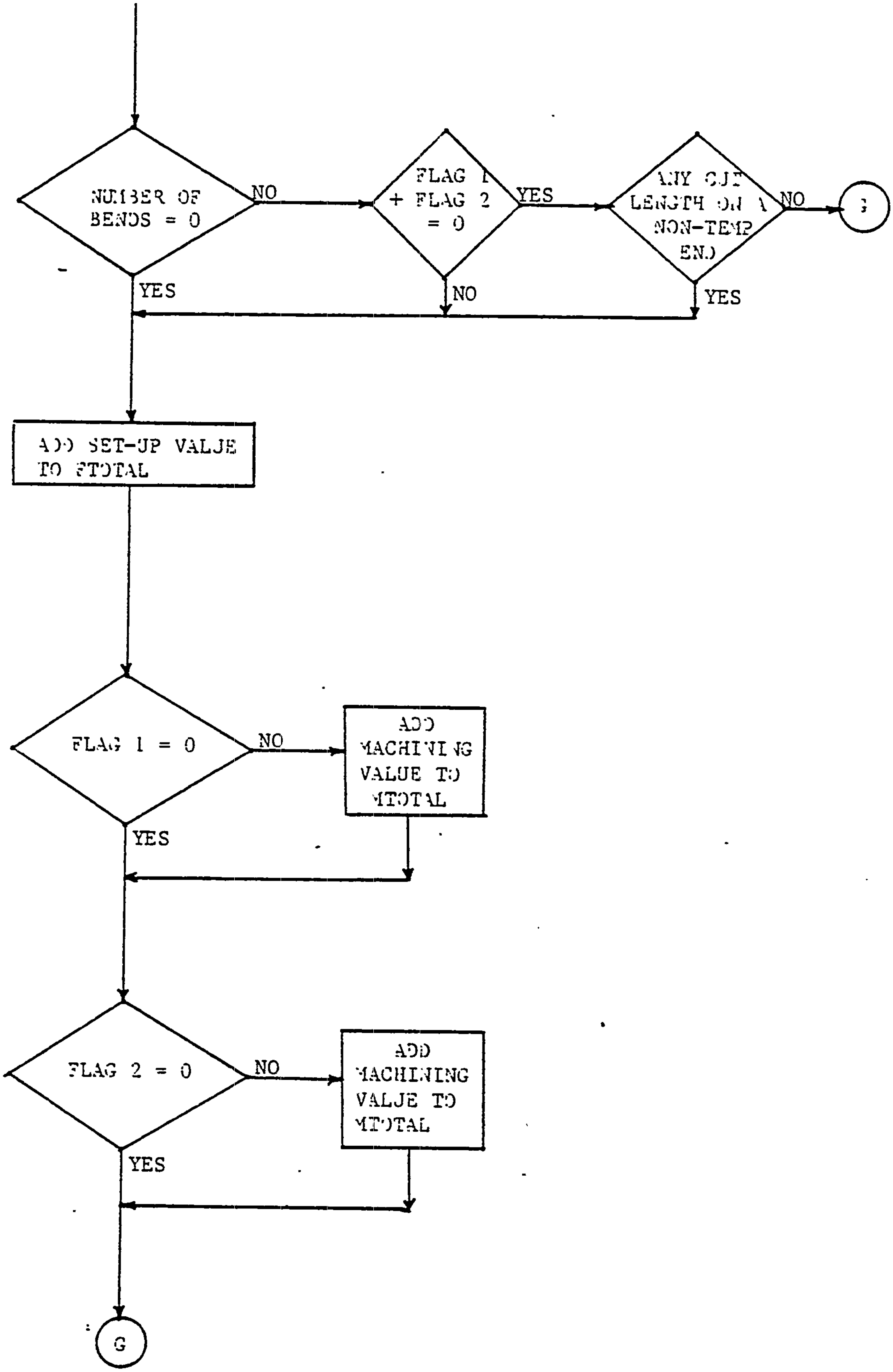

USE SIZE OF MAIN PIECE TO CHOOSE ROW FROM WELDING MATRIX
SET ALL FIRST FLAGS TO 0
E
BEGIN WELDING DO LOOP I,N
NO
IS THIS A TIMED FITTING
YES
USE SIZE OF JOINT TO CHOOSE ROW FROM WELDING MATRIX
IS END PREP ON TIMED SIDE OF JOINT BLANK
YES
IS END PREP ON OTHER SIDE OF JOINT BLANK
YES
MUST NOT BE A TIMED JOINT
E
NO
NO
FLANGE
YES
FIRST FLANGE (FLAG=0)
YES
RESET FIRST FLANGE FLAG
SET IARG TO FIRST FLANGE VALUE
F
NO
NO
SET IARG TO FLANGE VALUE
F


BOSS OR WELD-O-LET
YES
ADD BOSS VALUE TO WTOTAL (WELDING)
ADD DRILL VALUE TO MTOTAL (MACHINING)
E
NO
SOCKET-WELD (SW) JOINT
YES
SET SW FLAG FOR MCHNG
CARBON STEEL
YES
FIRST CARBON STEEL SW
YES
NO
SET IARG TO SW COLUMN VALUE
F
NO
CHROME MOLY
YES
FIRST CHROME MOLY SW
YES
RESET FLAG FOR THIS MATERIAL
NO
SET IARG TO SW COLUMN VALUE
F
SET IARG TO SW COLUMN VALUE
F
NO
FIRST COPPER NICKEL SW
YES
NO
SET IARG TO SW COLUMN VALUE
F
NO

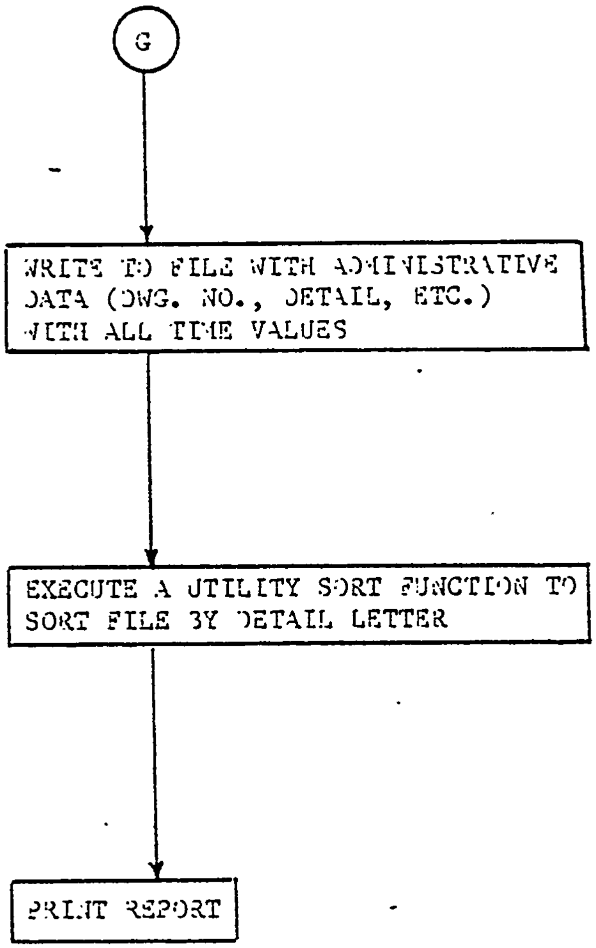

BUTT WELD (BW) JOINT
NO
BLANK JOINT TYPE
NO
PRINT JOINT TYPE ERROR MESSAGE
E
YES
YES
E
CARBON STEEL
YES
FIRST CARBON STEEL BW
YES
NO
NO
SET IARG TO BW COLUMN VALUE
F
CHROME MOLY
YES
FIRST CHROME MOLY BW
YES
RESET FIRST BW FLAG FOR THIS MATERIAL
NO
NO
SET IARG TO BW COLUMN VALUE
SET IARG TO BW COLUMN VALUE
F
F
FIRST COPPER NICKEL BW
YES
NO
SET IARG TO BW COLUMN VALUE


F
ADD WELDING VALUE BASED ON IARG TO WTOTAL
IS SW FLAG SET
YES
E
NO
FLANGE
YES
SOCKET WELD JOINT
YES
E
NO
NO
ADD MACHINING VALUE TO MTOTAL
END WELDING DO LOOP
G


A
TEMPLATE FROM SHIP
YES
ADD VALUE TO FTOTAL
NO
TEMP ON END 1
NO
BUTT WELD END PREP ON END 1
YES
SET BW FLAG 1 = 1
YES
NO
TEMP ON END N
NO
BUTT WELD END PREP ON END N
YES
SET BW FLAG 2 = 1
YES
NO



NUMBER OF BENDS = 0
NO
FLAG 1 + FLAG 2 = 0
YES
ANY CUT LENGTH ON A NON-TEMP END
NO
G
YES
NO
YES
ADD SET-UP VALUE TO FTOTAL
FLAG 1 = 0
NO
ADD MACHINING VALUE TO MTOTAL
YES
FLAG 2 = 0
NO
ADD MACHINING VALUE TO MTOTAL
YES
G


G
WRITE TO FILE WITH ADMINISTRATIVE DATA (DWG. NO., DETAIL, ETC.) WITH ALL TIME VALUES
EXECUTE A UTILITY SORT FUNCTION TO SORT FILE BY DETAIL LETTER
PRINT REPORT

APPENDIX B

Explanation of Flowcharts

APPENDIX B

Explanation of Flowchart

This detailed explanation of the program provides a step bv step analysis of the detailed flowchart presented in Appendix A.

The text is divided into six sections that correspond with the program flowchart:

- Bending Values Development
- Fabrication Values Development
- Welding Values Development
- Machining Values Development
- Pipe Details Without Fittings
- Print Out

Excerpts from the program flowchart are included with each section.

Bending Values Development

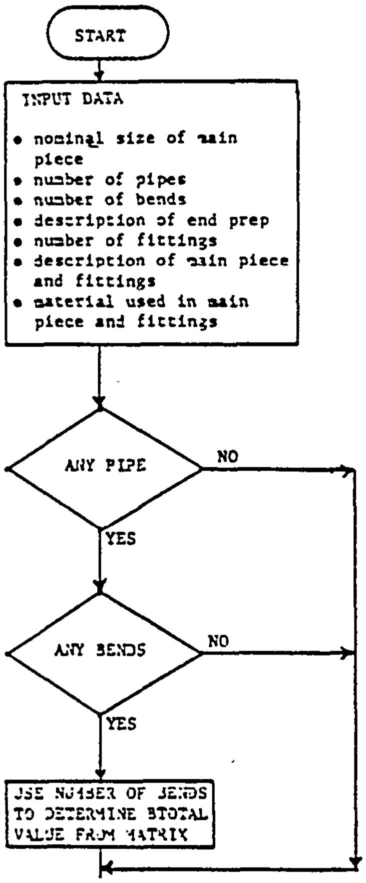


Fig. 1

Bending

Nominal Pipe Size	Number of Bends 1	2	3	4	5
Applies To All Bending Machines					
1/2" Thru 3 1/2"	1	1	1	1	1
4" Thru 6"	1	1	1	1	1
8" Thru 12" +	1	1	1	1	1

Fig. 2

Data from the pipe detail manufacturing system is used to determine the number of bends and the main pipe piece size. The standard times for bending are established in a matrix (Fig. 2) which is identical to the matrix on the planner's pick sheet. The outside diameter of the main pipe piece determines which row is applicable and the number of bends required determines the applicable column. The program accesses the standard time and records the total bending value for the detail.

Fabrication Values Development

Fitting information is collected and organized before the fabrication, welding, and machining values are calculated. Fitting data, including the description, material type, and end preparation, is taken from the computer-aided piping design system where it has already been used to develop the pipe detail manufacturing record. If the pipe detail is bent but has no fittings the program advances to the point immediately following the determination of the welding values (A). If the pipe detail has fittings, the fabrication and welding values are determined.

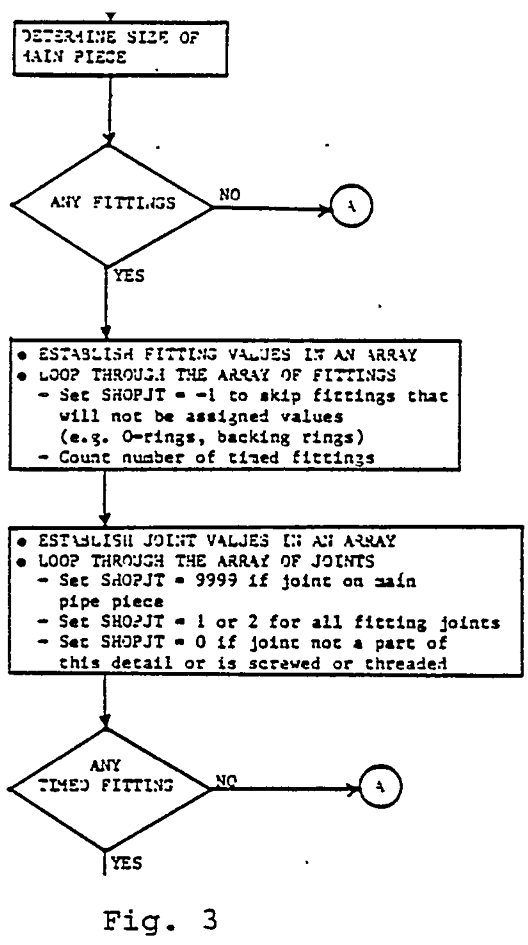


Fig. 3

The input data is reviewed and the fittings are established in an array. Fittings that are designated as having no value (e.g. O-rings, backing rings, etc.) are flagged so they will be excluded from consideration in the remainder of the program. These excluded fittings will be specific to each shipyard depending on the application of their work packages. The number of remaining fittings is then determined by subtracting the number of excluded fittings from the total number of fittings.

After the fitting array is set up, another array containing the information pertaining to the joints (including end preparation) is established. A direct correspondence exists between these arrays. The array of joint sizes allows the program to correctly handle a number of special situations. These situations may exist for reducing fittings, which can be . different sizes on each end, and for bosses, branches, or weld-o-lets which may differ in size from the piece to which they are attached. Joints that are screwed or threaded are designated as having no value and are flagged so they will be excluded from consideration in the program. A loop is made through the array to identify excluded joints, joints on the main pipe piece, and fitting joints.

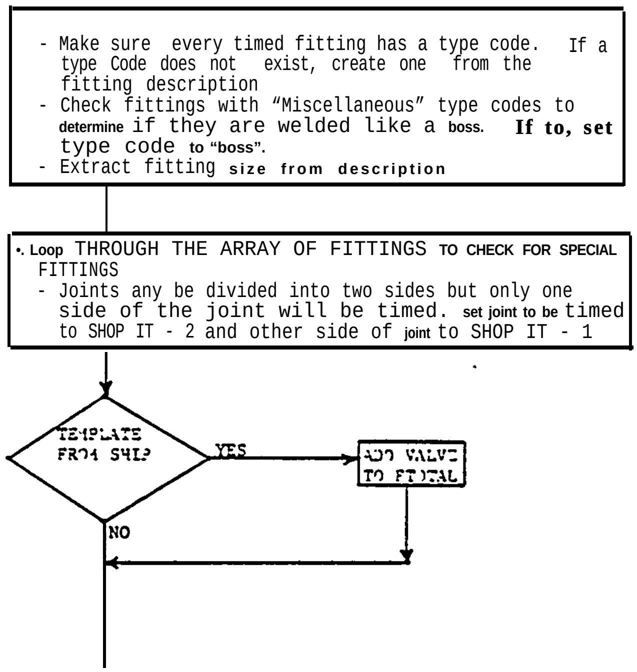


Fig. 4

The next step is to loop through the fitting array to check for type codes. Using the descriptions of the fittings in the array the type codes are ,extracted from the catalog of pipe detail parts. If the fitting type code is not in the catalog, the fitting description is scanned and the type code created.

Another loop is made through the array of fittings to determine how the standards for joints at special fittings will be applied. Each joint is divided into two sides, based on fitting descriptions and size information generated by computer-aided piping design system. Each side of the joint is analyzed to determine which side will be used to determine the standard.

In a separate routine, the notes from the pipe detail manufacturing record are scanned to determine if the detail has a "Template From Ship" note. This note requires that a template be taken from the ship in order to construct the pipe detail. This operation requires that an additional value based on the outside diameter of the main pipe piece be added to the fabrication total.

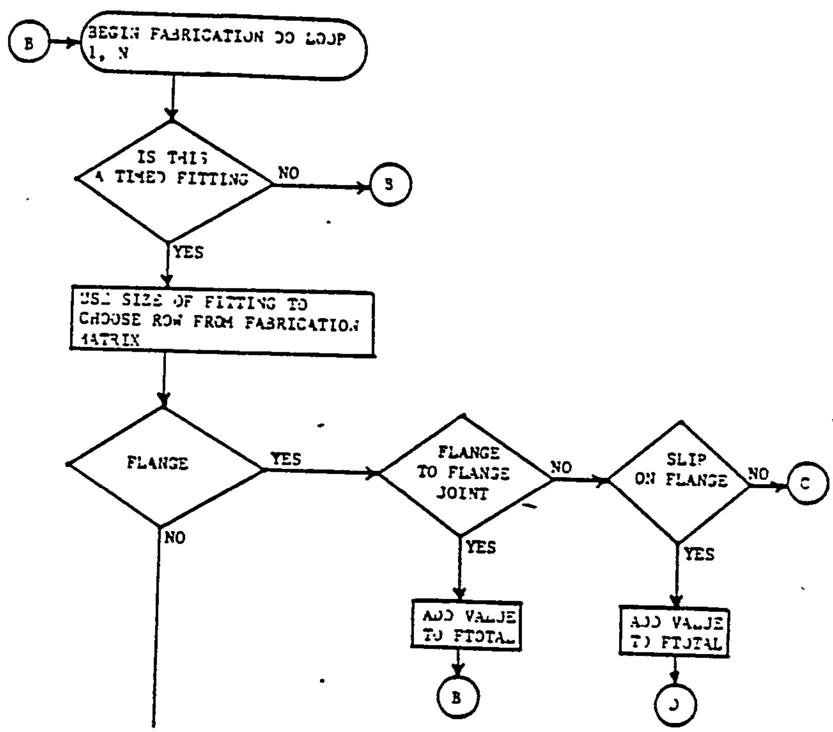


Fig. 5

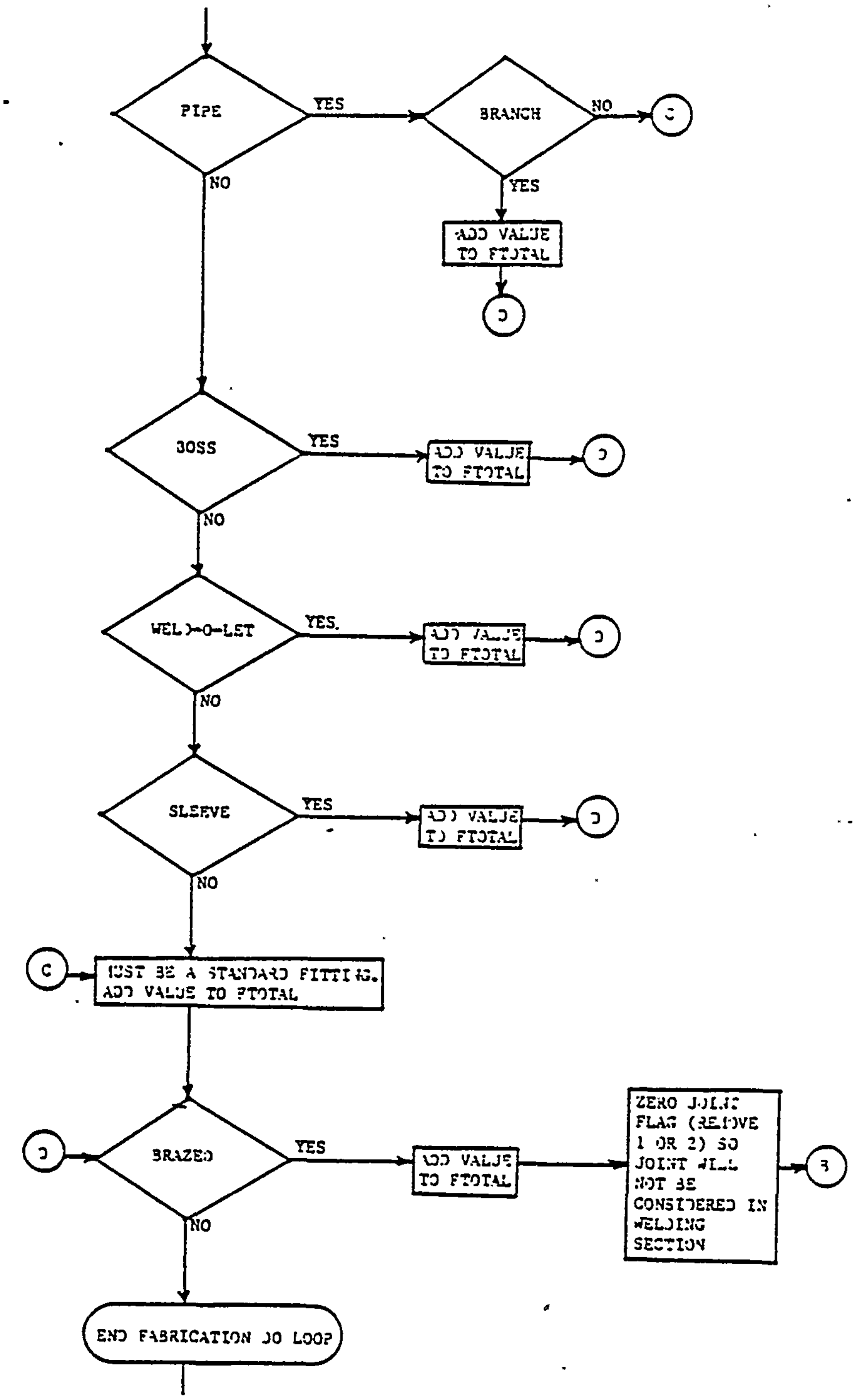

PIPE
YES
NO
BRANCH
NO
YES
ADD VALUE TO FTOTAL
BOSS
YES
NO
ADD VALUE TO FTOTAL
WELD-O-LET
YES.
NO
ADD VALUE TO FTOTAL
SLEEVE
YES
NO
ADD VALUE TO FTOTAL
C
MUST BE A STANDARD FITTING.
ADD VALUE TO FTOTAL
BRAZED
YES
NO
ADD VALUE TO FTOTAL
ZERO JOINT FLAG (REMOVE 1 OR 2) SO JOINT WILL NOT BE CONSIDERED IN WELDING SECTION
END FABRICATION DO LOOP

Fig 6

The fitting outside diameter, description, end preparation, and type code are used to determine the fabrication values from the matrix (Fig. 7). The outside diameter of the fitting determines which row of the matrix is applicable for an operation. Each column is checked until the correct fitting. type is found. All the fittings for the detail are looped through and the standard time for each fabrication activity is added to the overall detail fabrication total.

FABRICATION

A	B	C	D	E				F		G	H
Pipe or Fitting Diam.	Set-Up The Job	Fittings	Slip on Flange	Special Fittings				Brazing		Template	Assembl Flange : Flange
				Branch	Boss	Weld-o-let	Sleeve	Fitting	Flange	Set-Up	
1/2" Thru 3"	1	1	1	1	1	1	1	1	1	1	1
3 1/2" Thru 5"	1	1	1	1	1	1	1	1	1	1	1
5 1/2" Thru 8"	1	1	1	1	1	1	1	1	1	1	1
8 1/2" Thru 12"	1	1	1	1	1	1	1	1	1	1	1
12 1/2" Thru 16"	1	1	1	1	1	1	1	1	1	1	1
16 1/2" Thru 20"	1	1	1	1	1	1	1	1	1	1	1
20 1/2" Thru 24 1/2"	1	1	1	1	1	1	1	1	1	1	1

Fig. 7

The pipe shop specifications require that any brazing be included in the fabrication step. The end preparation required for each fitting is checked to determine if brazing is required. If the fitting is brazed, the joint flag is removed so the joint will not be considered in the welding section of the program. The brazing standard times are added to the fabrication total for each detail.

Welding Values Development

The welding values are determined joint by joint, they are not looped through an array like the fabrication values. The outside diameter of the piece at the joint determines which row of the matrix (Fig. 11) is applicable for an operation. Before the welding values are determined, flags are set to keep track of the first weld of each weld type. This is necessary because the first joint requires preparation and set-up time.

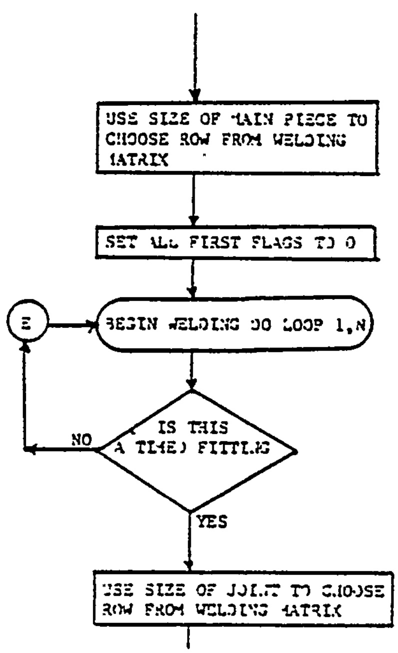


Fig. 8

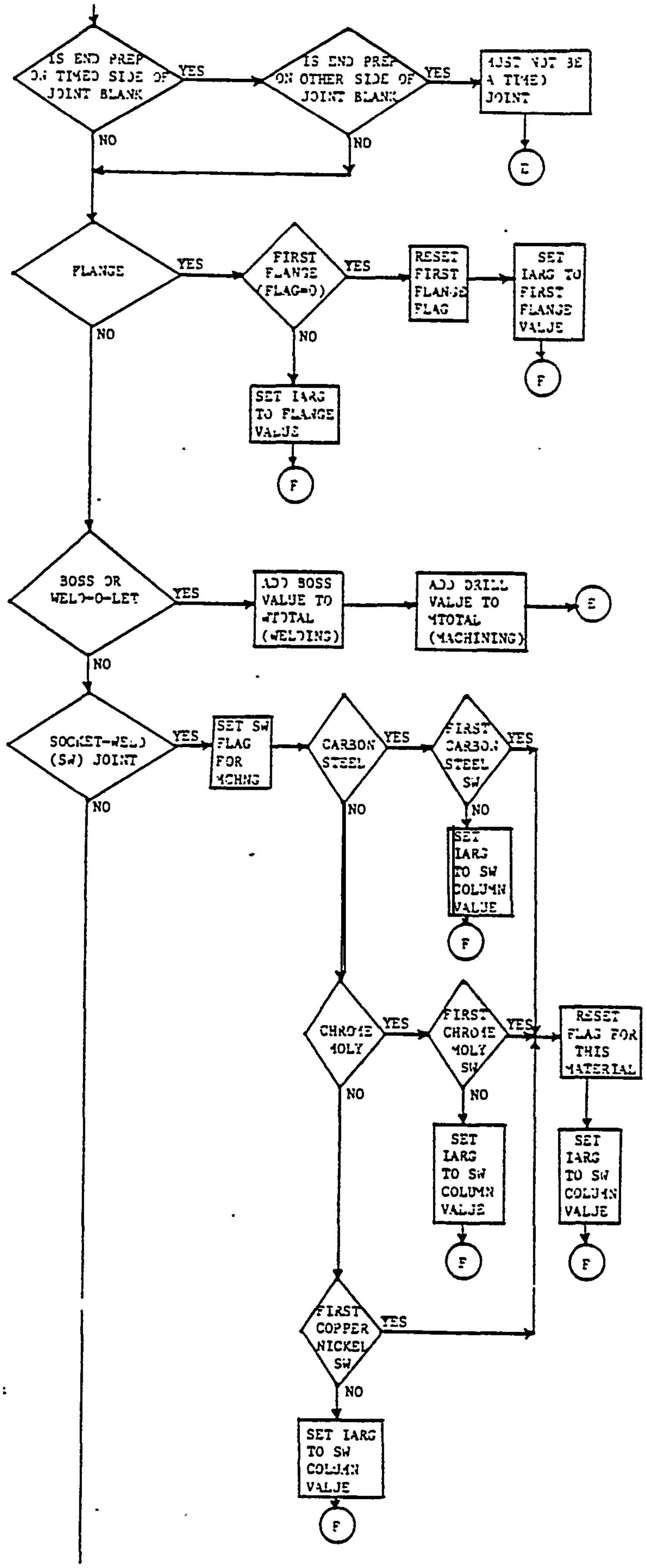

IS END PREP ON TIMED SIDE OF JOINT BLANK
YES
NO
IS END PREP ON OTHER SIDE OF JOINT BLANK
YES
NO
MUST NOT BE A TIMED JOINT
E
FLANGE
YES
NO
FIRST FLANGE (FLAG=0)
YES
NO
RESET FIRST FLANGE FLAG
SET IARG TO FIRST FLANGE VALUE
F
SET IARG TO FLANGE VALUE
F
BOSS OR WELD-O-LET
YES
NO
ADD BOSS VALUE TO WTOTAL (WELDING)
ADD DRILL VALUE TO MTOTAL (MACHINING)
E
SOCKET-WELD (SW) JOINT
YES
NO
SET SW FLAG FOR MCHNG
CARBON STEEL
YES
NO
FIRST CARBON STEEL SW
YES
NO
SET IARG TO SW COLUMN VALUE
F
CHROME MOLY
YES
NO
FIRST CHROME MOLY SW
YES
NO
RESET FLAG FOR THIS MATERIAL
SET IARG TO SW COLUMN VALUE
F
SET IARG TO SW COLUMN VALUE
F
FIRST COPPER NICKEL SW
YES
NO
SET IARG TO SW COLUMN VALUE
F

Fig. 9

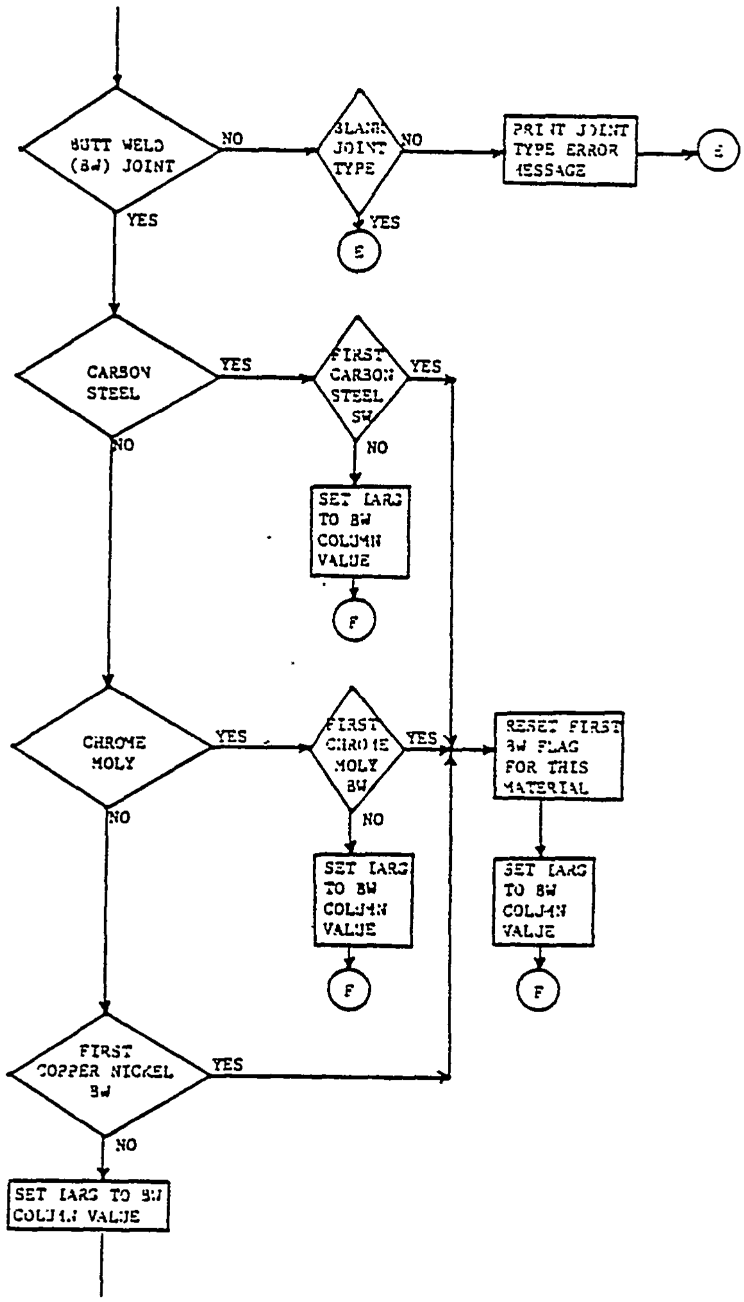

BUTT WELD (BW) JOINT
NO
BLANK JOINT TYPE
NO
PRINT JOINT TYPE ERROR MESSAGE
YES
E
YES
CARBON STEEL
YES
FIRST CARBON STEEL SW
YES
NO
NO
SET IARG TO BW COLUMN VALUE
F
CHROME MOLY
YES
FIRST CHROME MOLY BW
YES
RESET FIRST BW FLAG FOR THIS MATERIAL
NO
NO
SET IARG TO BW COLUMN VALUE
SET IARG TO BW COLUMN VALUE
F
F
FIRST COPPER NICKEL BW
YES
NO
SET IARG TO BW COLUMN VALUE

Fig. 3.0

The end preparation requirements are checked to make sure that the fitting requires welding and to determine the joint type. The type of fitting is checked to determine the column section of the matrix (Fig. 11). If the fitting is a boss or flange the standard time from the matrix is selected according to size, regardless of the joint type. Other fittings are selected according to the joint type and material type. The standard time for each joint is determined and the welding value for the detail is incremented joint by joint.

WELDING

	Socket Weld						Flange		Butt Weld						Boss
	Carbon Steel		CUNI, Cres		Chrome-Moly				Carbon Steel		CUNI, Cres		Chrome-Moly		
Joint Dia. or Nom. Pipe Size	First Joint	Each Add-on	First Joint	Each Add-on	First Joint	Each Add-on	First Flange	Each Add-on	First Joint	Each Add-on	First Joint	Each Add-on	First Joint	Each Add-on	Each Joint
1/2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3/4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1 1/4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1 1/2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2 1/2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3 1/2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4 1/2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
24	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Fig. 11

Machining Values Development

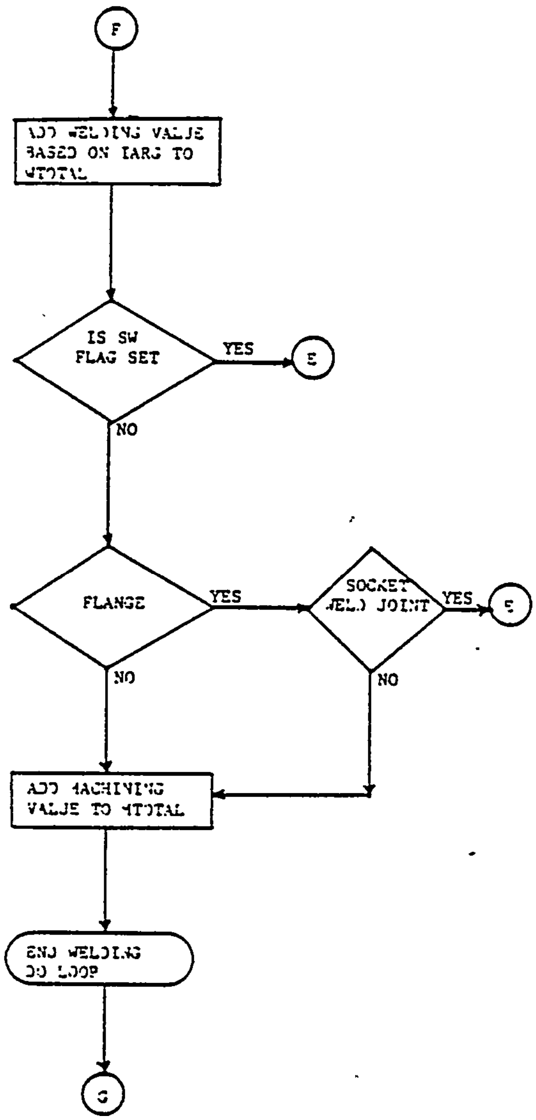


Fig. 12

MACHINING
PER PIPE END
1 Man Operation

Nom. Pipe Size	**Straight** Level Operation	Combination J Level 6 Counter Bore
10" - 14"	[illegible]	[illegible]

Fig. 13

The machining values are based on the type of welding involved and the end preparation required for a piece. Since machining is directly related to welding it is included within the welding section of the program but is considered a separate operation for standards application.

The machining required for each joint is based on the fitting type and the welding involved. If the fitting is a flange, it must be determined whether a butt weld or a socket weld is required. If a socket weld is required for a flange end prep, no machining value is applied. If a butt weld is required for a flange end prep; the machining value is applied. If the fitting is a boss, the drilling value is added to the machining value directly after the welding value for bosses is added to the welding total.

The machining values for the other joints are based on the type of welding required. If a socket weld is required, no machining values are applied. If a butt weld is required, the machining value is for the time spent to bevel the end of the pipe prior to welding. Therefore, a machining value is not applied if the joint is a fitting to fitting joint.

The outside diameter of the piece determines which row of the matrix (Fig. 13) is applicable for an operation. The column is determined by the type of machining operation required for particular weld types. According to Newport News Shipbuilding specifications, the Combination J Bevel & Counter Bore is used only on one particular weld type, all other operations use Straight Bevels. The machining values for each operation are determined and added to the maching total.

Pipe Details Without Fittings

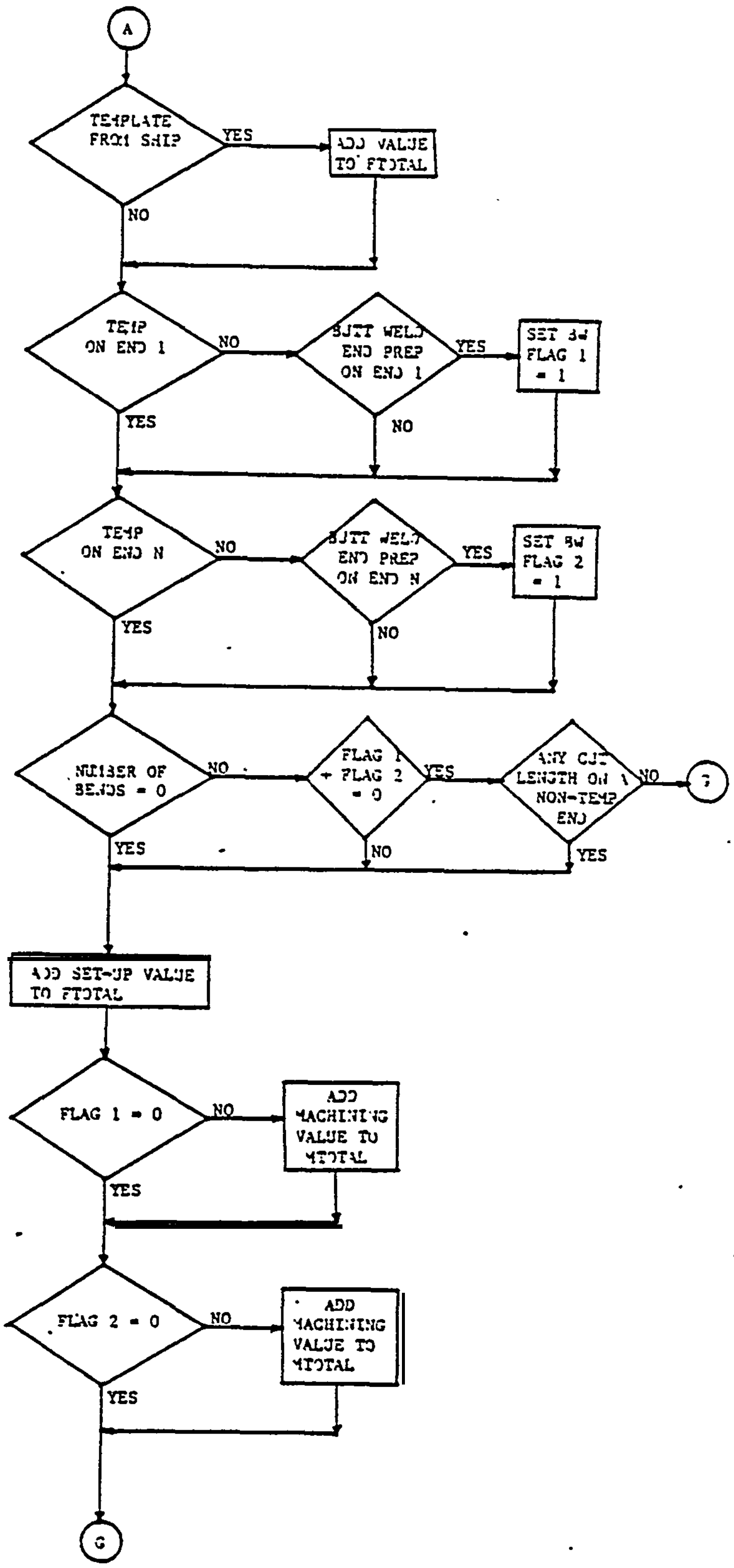


Fig. 14

Before the value totals are printed, the pipe details without fittings are checked for fabrication requirements. If a "Template From Ship" is required, the value for additional set-up time is designated as part of the fabrication value.

Next, the end preparation requirements are checked to determine if a templated end is left on either end of the main pipe piece. This templated end consists of additional length at the end of the piece of pipe that can be cut to fit the work already installed on the ship. If there is a templated end, then that end of the pipe is not prepared and a machining value is not applied. If there is not a templated end, then either one or both ends of the piece may require butt weld end preparation. If the end preparation is required, flags are set so that machining values will be applied.

If the pipe is bent the end preparations are checked. If butt weld end preps were not required and a specified cut length on a non templated end was not specified then the program advances to print out the standard values. If butt weld end preps were required then the set-up value is added to the fabrication total and the machining total. If the pipe is not bent, the set-up value is added to the fabrication total and any required machining values are added to the machining total.

Print Out

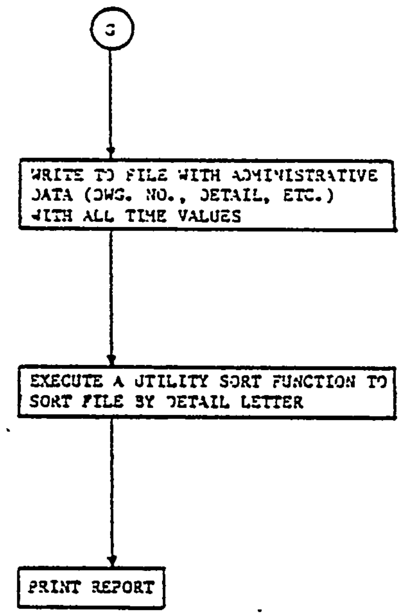


Fig. 15

After the bending, fabrication, welding and machining values are determined, the total value for each operation on a detail is written to a file. This record also includes administrative data, drawing numbers, and the pipe detail identifier. A utility sort function is performed to sort the file by detail identifier. A print out of the details, with the standard time values, is provided to the planner when developing, the work packages.

BIBLIOGRAPHY

"Computerized Application of Standards", Maritime Administration, August 1985.

Zandin, K.B., Most Work Measurement Systems New York: Marcel Dekker, Inc., 1980.

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