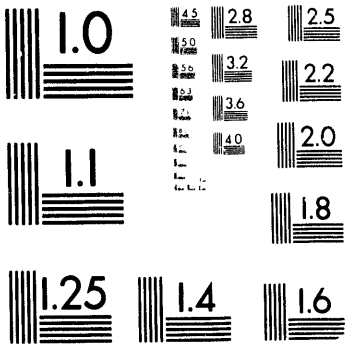
1.0
2.8
2.5
3.2
2.2
3.6
2.0
4.0
1.1
1.8
1.25
1.4
1.6

1 of 1

2

Conf-930780--2
Y/AMT-53

Development of Calibration Training and Procedures Using Job-Task Analysis

Rosanne A. Smith

INTRODUCTION

The Physical and Electrical Standards Laboratory (Standards Lab) is a part of the Electronics Maintenance Organization in the Oak Ridge Y-12 Plant, a manufacturing concern operated for the Department of Energy (DOE) by Martin Marietta Energy Systems, Inc., in support of national defense. The Standards Lab has been in existence for over 30 years, formed in order to ensure that measurement equipment and instrumentation for control of manufacturing processes is accurate and reliable.

In 1992, the Standards Lab supported 27 measurement disciplines, with a work force comprising 13 electrician metrologists and two engineers. Standards Lab personnel became concerned that 16 years' experience and valuable knowledge would be lost as people retired from the payroll because of reductions in defense program requirements. Past practice had allowed for on-the-job training of new people, with very little written documentation. Also in the past, a larger number of people on staff meant that cross-training could occur. By the 1992 time frame, however, a 17% reduction in work load had been accompanied by a 50% reduction in manpower (during the previous six years). The Standards Lab staff found itself overworked, understaffed, and facing even more downsizing.

Concurrently, all DOE facilities across the U. S. were charged with becoming more rigorous and formal in their operations. The Standards Lab already worked in compliance with the DOE Albuquerque Operations Guideline AL57XA, "Standards and Calibration Program." Additional DOE customer requirements were due to impact the Standards Lab, including "Conduct of Maintenance," "Conduct of Operations," "Selection and Qualification of Personnel," and "Quality Assurance" guidelines, all in the form of newly issued DOE orders.

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Seemingly, this heretofore excellent Standards Lab was located in the junction between a rock and a very hard place! It appeared that even more time would be taken from an already strained operation for additional training, auditing, and other requirements.

EMPOWERMENT AS A SOLUTION

The advent of Total Quality Management (TQM) within the Y-12 Plant encouraged empowerment of workers through team participation. Standards Lab personnel were brought together to broach the problems facing its operation. It was apparent to management that training and improved procedures were needed, but in order for these improvements to be of real value to the staff, the affected workers themselves would have to implement them. A team was formed, comprising the Standards Lab staff (electricians—known as metrologists, engineers, summer students, and supervisors) and representatives from the MMES Training Performance Support Group. The electricians and engineers were termed as "subject-matter experts" (SMEs) in training vernacular, with the training representatives being "instructional technologists."

Many factors made this project difficult to assess and plan. Procedures in place were outdated and extremely general in nature; reliance on the expertise and knowledge of individuals had been the mode of operation for many years. Metrologists were expected to be trained journeyman electricians, but specialized training in the area of calibration had been limited and infrequent. The broad range of active measurement areas elicited questions about priorities and where the project should begin. Lastly, personnel input to determine specific concerns and probable solutions had to be foremost in implementing a program. Meetings and discussions began in this atmosphere, which was further complicated by the imminent threat of employee layoffs and transfers.

THE PROCESS BEGINS WITH A SURVEY

A needs analysis was conducted using a written questionnaire completed by 15 Standards Lab personnel. General needs were identified in a "Standards Lab Needs Analysis Report" dated January 9, 1992:

- Write or update Standards Lab procedures.
- Develop a system for tracking and organizing departmental documentation (i.e., vendor manuals, equipment certification histories).
- Identify vendor and in-house courses currently available.
- Ensure that work areas are well organized for co-workers who replace or fill in occasionally.
- Facilitate communications with field customers.
- Determine plan for cross-training as needed.

As a result of dialogue and discussions incurred through the interview process, the following recommendations were made.

1) Prioritize job areas for task analysis work, in order to draft job procedures.

2) Conduct detailed job-task analyses (JTAs) according to the priority list.

3) Based upon task analysis, determine specific job performance and training needs.

4) Determine options for meeting job performance/training needs—for example:

- vendor courses,
- in-house seminars,
- videotaped lessons,
- on-the-job training (OJT),
- equipment history database development,
- performance support system development, and
- computer simulation of key tasks.

5) Develop a long-range training plan for each area.

6) Derive support for the training program through full involvement of laboratory personnel.

TEAM WORK IS IMPLEMENTED

At the time of the project's initiation, two measurement areas were facing potential near-term manpower shortfalls.

In the temperature calibration area, the SME was anticipating his upcoming retirement and trip to Australia. No cross-training had been done in the temperature area. Thus, a discipline area—temperature—was given high priority.

In the mass section, DOE auditors had focused on calibration of scales used to weigh special materials. The result was that training requirements had to be defined and implemented for personnel who perform mass-related calibration. The second priority was hence established. Temperature and mass calibration tasks were regarded as pilot projects.

With general agreement that temperature and mass were two critical areas for focus, the team also agreed that their recommendations could be tackled concurrently through several sub-teams. The smaller groups diverged to address specific issues, including: 1) computer hardware acquisition and network access, quite limited in the labs at that time; 2) commercial calibration course availability, especially in videotaped format; 3) benchmarking of other calibration labs' training methods and overall metrology education programs in the U.S.; 4) procedure and process requirements for metrologists to be considered qualified to perform specific calibration tasks; 5) JTA for each calibration task in the Standards Lab, the core project activity; 6) videotaping of job tasks in the process of being analyzed; 7) budget considerations and costs inherent in time spent on training issues.

While this plethora of sub-teams provided successful outcomes, several were short-term, with their greatest value in their role of involving personnel in achieving relevant and tangible goals. This role included travel in order to benchmark external organizations, training in various software programs, development of a "Glossary of Terms," access to and use of computer networks and spreadsheets, and brainstorming ideas about other laboratory improvements. These sub-teams also assisted in boosting morale and demonstrated management's seriousness about actual employee involvement. However, even with all the benefits listed, one specific team proved to have the single greatest value-added activity with regard to training and procedure development.

JOB-TASK ANALYSIS

By far, the most long-term, complex, and extensive assignment belonged to the JTA team, still in place today. This team began its work with a week-long training course, "Analysis Workshop," offered by an outside vendor. The JTA team members from the Standards Lab and the training group attended this course together in order to learn the technicalities of task analysis and a common set of theories and vocabulary and to build their internal relationships. The long-term mission of the JTA team was to empower each metrologist to conduct his/her own job-task analyses, even while completing customer jobs. This would ensure that every metrologist's work would have double value: customer satisfaction and calibration procedure documented.

JTAs are performed to document the detailed step-by-step procedures for completing specific tasks. The JTA forms a basis for training and qualifying others to perform a job efficiently and effectively; it also provides the technical detail necessary for written procedures. Qualifications required to perform a task are elicited through a question regarding prerequisite skills and knowledge—safety issues, equipment needs, environmental issues, reference documents, quality standards, and consequences are addressed in a similar fashion.

The Standards Lab JTA team started with training personnel (instructional technologists) actually doing the analysis interviews and being observed by the JTA team members from the Lab. Eventually the entire JTA team began interviewing and documenting job tasks according to the format shown (Fig. 1). For any measurement area, the first step is for the metrologist or SME to systematically break down the overall discipline into major job areas and then compose a task list for each major job area. Once job task listings are established for each area, a checklist is developed for counting and tracking progress. At the time of this report, over 575 individual tasks have been identified in 27 measurement areas, including an administrative/generic category. Each JTA document is cross-checked by other experienced SMEs, with final review by the supervisor and engineers for technical verification. Once approved, the JTAs are added to a master file and data base for future reference.

Completion of the JTAs has been steady and continuous, with over 150 written, reviewed, and available for use. The Standards Lab metrologists have established a process wherein each person qualified to perform a specific task at a workstation has a binder on hand containing those JTAs applicable to his/her station. These JTAs are used as "work instructions" or procedures and have instituted a much greater consistency in how a particular job is done, regardless of the person doing the work or the frequency of the task (some tasks are done once every two years). In addition, these documents have been used to improve and upgrade calibration procedural steps, as each documented process undergoes extensive review by several SMEs. Cross-training of personnel is greatly simplified through use of the JTA in concert with observation from the current SME. In cases where an experienced person is training a novice on a particular task, the SME can write the analysis while explaining the work steps to the trainee.

The JTA team eventually expanded to include every person in the Standards Lab, along with most of a field scales calibration crew, and training department personnel have rotated. The JTA team meets on a monthly basis, documents their achievements and concerns, and tracks JTA completion status through a relational computer data base developed by the training group (see Fig. 2). A sheet entitled "Task Listing Activity by Station" is used as a working progress record to assess percent completion in specific measurement areas (Fig. 3). The Task Analysis Sheet itself has been computerized for on-line input by the SME. During the summer of 1992, student interns were trained to conduct JTA and gained experience in development of these procedures while adding value to the Standards Lab operation. A student took the initiative of developing a JTA Flowchart (Fig. 4) to graphically describe the process.

CONCLUSIONS

In November 1992, the JTA Team was recognized by peers across the Y-12 Plant when its members were awarded the Y-12 Award of Excellence for their accomplishments. A team member has prepared and presented an overview entitled "Why Do JTAs?" that describes the benefits and advantages of developing JTAs. In

addition, various metrologists have expanded their team participation and developed leadership roles in other areas. One person is the guiding force for an Oak Ridge ISO/IEC Guide 25 team; another has developed a basic calibration course to be shared with area high schools through the corporate Adopt-A-School program. Heightened computer knowledge led this same person to automate calibration data sheets and to develop spreadsheet programs for calculation of calibration data.

Most importantly, these broadened responsibilities have benefitted the customers of the Standards Lab. Along with having higher-quality calibration procedures to use, Standards Lab personnel have a greater degree of autonomy and contact with the customers, understanding what questions to ask. The process has created a knowledgeable group of people who have been able to retain valuable knowledge and expertise that otherwise might have been lost to personnel retirements and transfers.

TASK ANALYSIS WORKSHEET

Department_____

Job Area_____ Job Classification Electrician

Task Name_____

Date_____ Analyst_____

SME_____

1. Is this task performed _____on a regular basis? or _____as needed?

On average, it is performed:

1 - Rarely (once a year or less)
2 - Seldom (about three or four times a year)
3 - Occasionally (about once a month)
4 - Often (about once a week)
5 - Very often
6 - Other_____

2. How important is this task? Take into account possible impact on safety and health, the environment, production, etc.

1 - Negative consequences are *insignificant*
2 - Negative consequences are *low*
3 - Negative consequences are *about average*
4 - Negative consequences are *high*
5 - Negative consequences are *extremely high*

3. How difficult is this task? In choosing your rating, consider several factors. For example, are there many steps involved? Is there a lot of hand-eye coordination? Is there a lot of decision-making? Are there many exceptions to the routine?

1 - Easiest–*this task is among the easiest 10% of all in your job*
2 - Easy–*this task is easier than average, but not the easiest*
3 - Average–*this task is about average in difficulty*
4 - Difficult–*this task is harder than average, but not among the most difficult*
5 - Most Difficult–*this task is among the most difficult; it is harder to perform than 90% if all tasks in your job*

Fig. 1. Job-Task Analysis Worksheet

4. Task Performance Steps

Note: Now describe the task in more detail. Think to yourself along these lines: "First I would.....and then I'd....." Write down each step in order, with a brief description. If there are special skills, equipment or knowledge a person would need to have in order to do this job, make a note in the last column. Be as detailed as you can.

Step #	Brief Description	Special skills, equipment, etc.

Fig. 1. (continued)

5. Tools, safety equipment, and materials required to perform this task: (Include M-#'s)

6. References, drawings, procedures, and handouts—identify any resources (such as vendor manuals, electrical or mechanical drawings, DOE orders, etc.) that can be useful when performing this task.

7. How do you know when to perform the task? Does your supervisor tell you? Do you receive a work order? Is it always done at a certain time?

8. Common problems —List any problems that commonly occur while performing this task.

9. How do you know that you have finished the task? Are there criteria to meet? A performance test to pass? Is someone's signature required?

Fig. 1. (continued)

10. How long does it usually take to complete this task?

11. Safety and Health and Compliance Overview—What are the physical and/or mental health concerns while performing the task? Examples: working voltage, safety equipment, tag-out, stress.

12. How important is it to do this task quickly?

1 - Critical
2 - Important
3 - Not very important

13. How important is it to be able to do this task from memory?

1 - Critical
2 - Important
3 - Not very important

14. Physical environment—Describe the conditions under which the job is performed. Examples: cramped space, loud, good/bad lighting, etc.

Fig. 1. (continued)

15. **Quality standards** —List criteria. Examples: without vibration, without noise, within departmental guidelines, etc.

16. **Are there any acceptable alternative procedures for completing this task?**

Yes_____ (If yes, please describe.)

No_____

17. **Is it likely that the way the task is performed will change soon?**

Yes_____ (If yes, when?)

No_____

18. **Prerequisite Skills and Knowledge**—What you need to know before doing this task.

19. **Who usually does this task? How many people are involved? Who else has done this job?**

Fig. 1. (continued)

20. Consequence(s) of Deficient Performance – What happens if I do not perform this task correctly? Rate each consequence as:

1 - **Low**—probably not much impact on health, environment or economics, but will still negatively affect performance.

2 - **Moderate**—probably will not injure, cause hazards or considerable economic loss, but will require some correction.

3 - **High**—injury, environmental hazard, some disruption of work.

4 - **Devastating**—loss of life, serious injury, severe environmental impact, significant job impact.

Consequence	Severity

Fig. 1. (continued)

21. Suggested Practice Activities—What could someone do to practice this task? Where would practice take place—at job site or in training room? How would feedback be given to participant? Does this practice need to be demonstrated first?

22. Competency—How would you check to see if a new employee had become competent in completing this task? What specifics would you look for?

Additional Comments:

Fig. 1. (continued)

02/09/93

JOB TASK ANALYSES
LISTED BY PES STATION

JOB AREA	TASK NAME	DATE	ANALYST	SME	MASTER
24 (Temperature)	Acceptance Inspection of Extension Lead Wire	05/12/92	BE Tischler	BE Tischler	Y
24 (Temperature)	Using Thermotron Furnace	05/12/92	BE Tischler	Don Henderson	Y
24 (Temperature)	Acceptance Inspection of Wire (All Types but Tungsten and Extension Lead Wire)	05/11/92	BE Tischler	Don Henderson	Y
Total: 26					
25 (Torque)	Certifying Torque Wrench	02/19/92	BE Tischler	John Elkins	Y
25 (Torque)	Certifying of Torque Calibrator M-207900	12/08/92	John Elkins	John Elkins	Y
25 (Torque)	Calibration of Torque Calibrator M-207900	01/19/93	John Elkins	John Elkins	N
Total: 3					
26 (Vacuum)	Certifying Veeco RE1000 Ionization Gauge M-107875	03/11/92	BE Tischler	John Caddell	Y
26 (Vacuum)	Calibration of Barksdale Vacuum Switch model E15-H-VAC	04/01/92	John Caddell	John Caddell	Y
26 (Vacuum)	Calibration of Hasting Vacuum Gauge (M-129098)	07/09/92	Michael Gray	John Caddell	Y
26 (Vacuum)	Taking VGCS to Atmosphere	09/15/92	John Caddell	John Caddell	Y
26 (Vacuum)	S.R.G. II Initialization	09/21/92	John Caddell	John Caddell	N
Total: 5					
28 (Force)	Certifying Dynamometer (to 30,000 lbs)	02/21/92	BE Tischler	John Elkins	Y

Fig. 2. Sample Page from Job-Task Analysis Database

TASK LISTING ACTIVITY BY PES STATION

PES	Station	Total # of Tasks	JTAs Done	% Complete
1	Ratio	23	2	8%
2	Acoustics	8		
3	Density-Volume	8	8	100%
4	Hardness	5	1	20%
5	Magnetic Flux Density	N/A		
6	Mechanical Shock	N/A		
7	Phase	7	1	14%
8	Power	13	1	7%
9	Surface Texture	12	1	8%
10	Acceleration	N/A		
11	Capacitance/Impedance	13		
12	Voltage and Current	100	20	20%
13	Frequency and Time	32	4	13%
14	Gas Flow	13	2	15%
15	Inductance	4		
16	Leak Rate	13	2	15%
17	LVDT & Carrier Amplifiers	N/A		
18	Mass	53	22	42%
19	Moisture and Humidity	10	1	10%
20	Pressure	25	2	8%
21	Nuclear Radiation (Repair)	(waiting for procedures)	3	
22	Resistance	(ICP under revision)		
23	Oscilloscopes		1	
24	Temperature	26	26	100%
25	Torque	14	1	7%
26	Vacuum	17	5	29%
27	Liquid Flow	9		
28	Force	27	3	11%
29	Photometry			
30	Viscosity	N/A		
31	Gas Analysis	(13)	12	
32	NDT	15	1	7%
XX	Misc.	4	1	25%
	TOTALS	(464)	120	26%

Fig. 3. Task Activity Listing by PES Station

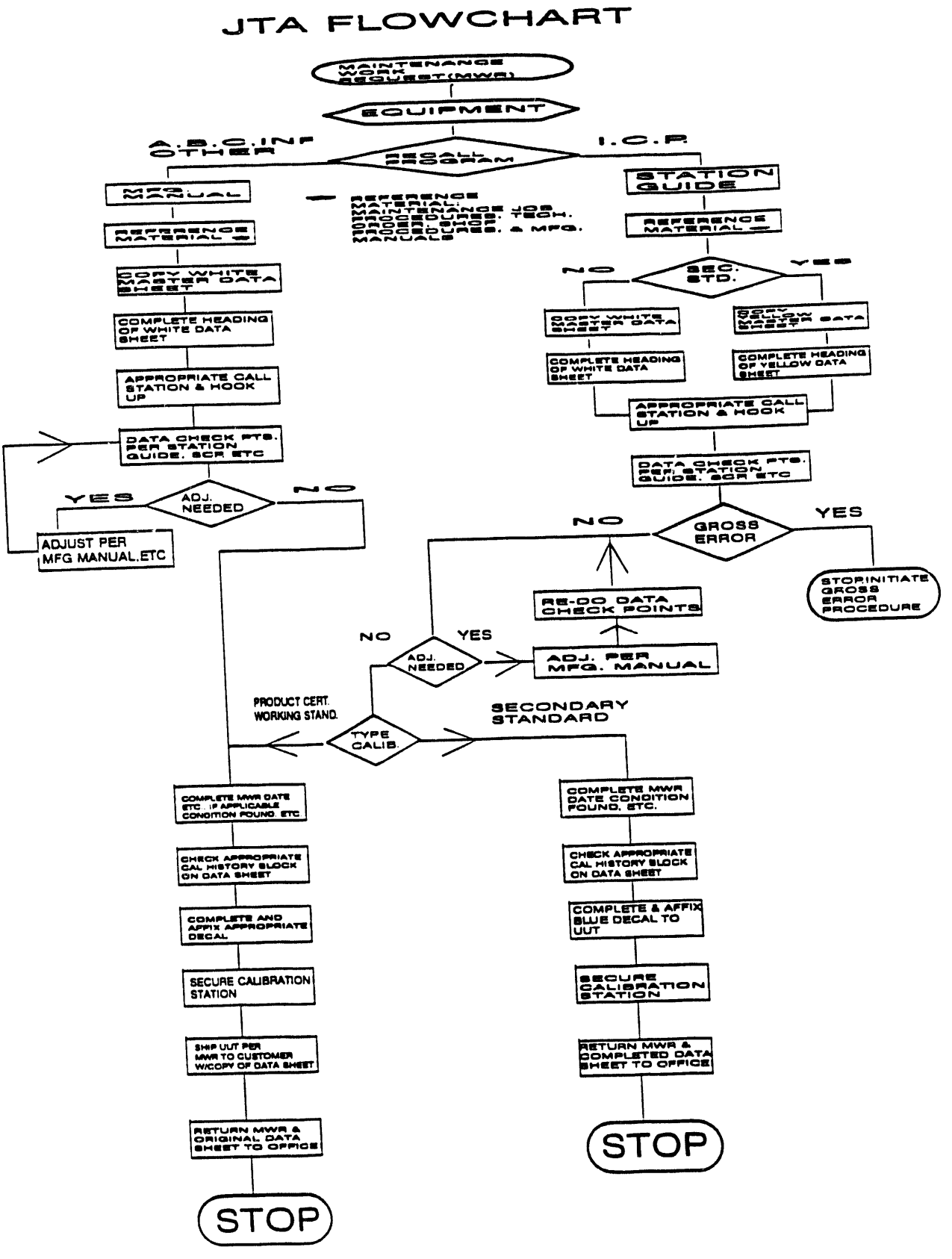

Fig. 4. Job-Task Analysis Flowchart for Calibration Jobs

DATE
FILMED
1 / 10 / 94

END