Semiconductor Manufacturing Technician Skill Standards

Equipment Technician

Maricopa Advanced Technology Education Center
Maricopa Community College District, Tempe, Arizona

MATEC

Sponsors and Contributing Organizations

The development of the Semiconductor Manufacturing Technician Skill Standards - Equipment Technician was sponsored with major funding from the Maricopa Advanced Technology Education Center through a grant from the National Science Foundation Advanced Technological Education (ATE) Program #DUE 9908419 to the Maricopa Community Colleges.

National Science Foundation

Maricopa Community Colleges Leadership 21st Century

The project was conducted with support and authorization of the SEMATECH and SEMI/SEMATECH Technician Training Council.

SEMATECH

SEMI/SEMATECH

Additional financial support for the project was provided by:

intel

Texas Instruments

Richland College, Dallas County Community College District

Companies that contributed significantly to the development, profiling and validation effort include:

AMD
Applied Materials
Digital
Huntair
IBM
Intel
Microchip
Motorola
ST Microelectronics
Texas Instruments

Acknowledgments

The development and publication of the Semiconductor Manufacturing Technician Skill Standards - Equipment Technician, has been a joint and collaborative effort between the SEMATECH and SEMI/SEMATECH Technician Training Council, the Maricopa Advanced Technology Education Center and Richland College. We are grateful to the many industry participants who participated in the development and validation process. These technicians and supervisors donated their time and effort to insure the relevancy and currency of the standards.

The following members of the SEMATECH and SEMI/SEMATECH Technician Training Council contributed to the development of these skill standards.

Gayle Bowles Haecker - ATSI
Jeff Dauphinee - IBM
Brent Donham - Richland College
Dick Harris - Texas Instruments
David Hata - Portland Community College
Pamela Hull - Richland College
Deonis James - Intel
Brent Kesterson - Richland College
Michael Lesiecki - MATEC
Wendi Martin - Huntair
Randy Metevier - Applied Materials
Dawn-Mechelle Nold - Texas SOICC
Peter Parsons - PRI Automation
John Paul - Motorola
Ezra Penermon - Texas Instruments
Fred Schuneman - Pierce College
David Silver - Synopsys
Diane Stone - Intel
Jim Thompson - IBM
Gayland Thorn - Intel
Mike Torrez - Intel
Ngoc Truong - Richland College
Keith Whiteside - Texas Instruments

Brent Kesterson at Richland College was primarily responsible for the process of development and validation. He and his colleagues from industry and academia are acknowledged as the key contributors to this document.

Michael Lesiecki, Ph.D.
Director
Maricopa Advanced Technology Education Center

Cover photo courtesy of SpeedFam-IPEC.

For More Information

Maricopa Advanced Technology Education Center
2323 West 14th Street
Tempe, Arizona 85281

http://matec.org
matec@maricopa.edu

480.517.8650 phone
480.517.8669 fax

SEmiconductor MAnufacturing TECHnology
2706 Montopolis Drive
Austin, Texas 78741

http://www.sematech.org

National Science Foundation

Any opinions, findings and conclusions or recommendations in this material are those of the authors and committee and do not necessarily reflect the view of the National Science Foundation.

To order additional copies or for more information on MATEC Curriculum Products, visit our web site at: http://matec.org, or call us at 480.517.8650.

Design and Layout by: Leslie Jabara

Table of Contents

Background

The SEMATECH and SEMI/SEMATECH Technician Training Council **(1)** Taskforce was formed in 1997 to address the problem statement:

> "There is a lack of defined skill standards for semiconductor equipment technicians that can be communicated to economic and workforce initiatives and educational institutions."

The objective of the taskforce was to develop industry defined and validated skill standards for entry level equipment technicians focused on skills needed in the first six months on the job. The taskforce asked Brent Kesterson of Richland College to facilitate the project using the Performance Criteria Analysis List (PCAL®) approach.

The final skill standard statements are designed to establish performance and are directly related to what technicians actually do at the worksite. Many of the standards are designed for using information, communication and interpersonal skills. In addition, some of the standards are related to the technician's ability to apply basic principles of chemistry, physics and math.

PCAL Process

The PCAL process is an effective method developed by Richland College to determine specifically what skills graduates will need to be successful on the job. In addition to identifying the specific performance criteria (skills or behaviors) required, the PCAL includes data concerning how important each skill is for success, how proficient a worker needs to be at each skill, how difficult each skill is to learn, and how frequently each skill is used. After researching many pertinent documents the Richland Instructional Design staff drafted a list of over 200 skills required to be successful as a semiconductor equipment technician. This list was presented to the SEMI/SEMATECH Technician Training Council Task Force. The taskforce members reviewed and revised the draft list in collaboration with subject matter experts (SMEs) around the country. The final PCAL contained 247 performance criteria (observable and measurable behaviors).

Validating the PCAL

The next step was to validate the PCAL with more SMEs. A total of 41 SMEs from Arizona, New Mexico, Texas and Vermont were gathered in 5 focus group meetings and rated each of the 247 performance criteria for importance, proficiency level, difficulty to learn and frequency of use. A ranking scale of 1 lowest, to 4 highest was used to rate the criteria (see Appendix A for details). The performance criteria were ranked for significance using an algorithm, called the Emphasis Rating (ER, see Appendix A), based on importance, level, frequency and difficulty.

Committees then met to draft the actual skill standard statements using the ranked PCAL list.

Validating Skill Standard Statements

The final step was to insure that industry representative SMEs agreed with the skill standards as stated. To accomplish this, focus groups were conducted at 5 locations in Arizona, Oregon, Texas and Vermont. 20 representatives rated their agreement or disagreement with the skill standards. Significant agreement was documented with the list of skill standard statements. On a Likert Scale of Agreement (-2 = Strongly Disagree, -1 = Disagree, 0 = No Opinion, +1 = Agree, +2 = Strongly Agree) there were only 6 statements that had an average rating of 0 or less (see Appendix B for further details). These six statements were dropped from the final list that is published here. The bulk of the remaining ratings fell between +0.5 and +1.5, indicating strong agreement overall. The final statements were renumbered for convenience to account for the dropouts.

(1) Currently the Technician Performance Improvement Council

Business Applications for Skill Standards*

Skill Standards are not only useful for educators and students, many businesses are finding the Standards helpful in employee hiring, evaluation and development processes. Listed below are applications provided by businesses of possible uses of Skill Standards.

- Review the Functional Job Analysis, specifically assess the functions and tasks for relevancy, frequency and importance for a particular job at your worksite. Develop hiring criteria, identifying which ones are most critical for a new job opening in your company or department.

- Use the scenarios to trigger relevant in-house situations in which an employee may be required to solve typically occurring problems or critical incidents. Customize the scenarios for the particular job; include scenarios during an interview or an in-house problem solving training session.

- Communicate performance expectations for specific tasks by adapting the performance criteria for the particular job in your firm. Define specifically what the employee is expected to know and do, define what success looks like using the Standards.

- Use the performance criteria for evaluating job and task performance.

- Create individual criteria for evaluating job and task performance.

- Create individual development plans based on the identified gaps in performance and skill level; chart an employee's progress toward achieving the skill standard.

*used with permission from the Skills Standards Guidebook I and II, 1997, Washington State Board for Community and Technical Colleges.

- Ask for evidence of achievement for a particular function or task. This could be a demonstration, a portfolio or a description of accomplishments with appropriate documentation.

- Update job descriptions based on the information in the Skill Standards.

- Update compensation based upon the level of complexity required to perform successfully in a given occupational cluster.

- Use the Skill Standards as a benchmark for expected performance; a means for measuring progress.

- Use the Skill Standards as the basis for a certificate or credential to assure employers of the level of proficiency of a new hire or transferred employee.

- Articulate goals based on the Skill Standards for future work performance as roles and responsibilities expand.

- Stimulate strategic thinking about workforce reorganization - evaluate how work gets done using the major functions identified in the Skill Standard.

SEMICONDUCTOR EQUIPMENT TECHNICIAN
JOB DESCRIPTION

Required Education and Experience

Associate degree in electronics, semiconductor manufacturing, microelectronics or related technical field ***or*** equivalent experience.

"Equipment technicians like to solve problems."

General Job Duties

Monitors, maintains and performs a variety of complex repairs on semiconductor wafer fabrication equipment to ensure uninterrupted production flow. Also performs periodic preventative maintenance procedures as defined by specifications.

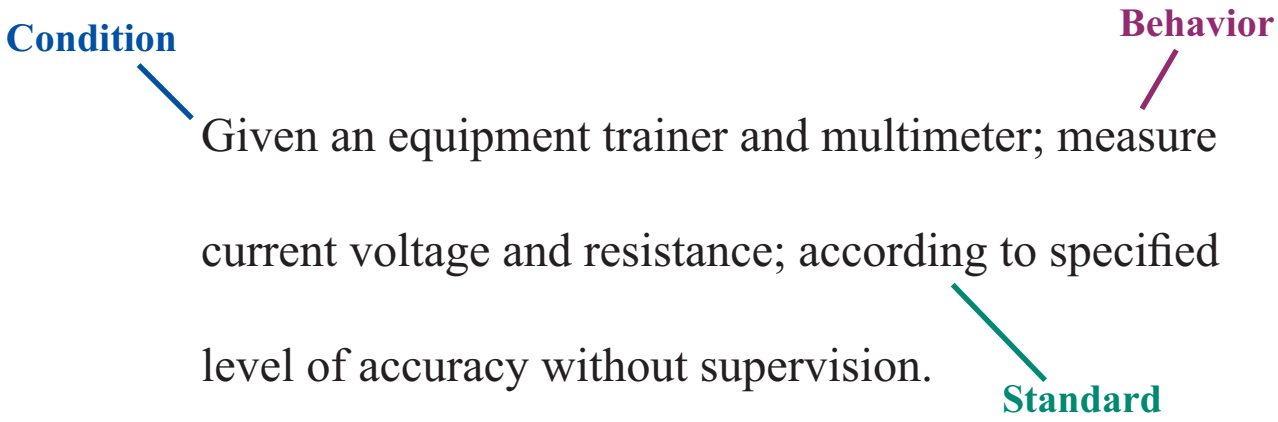
Provides technical support in the form of troubleshooting, installation, diagnostics, adjustment, repair, modification, assembly and calibration of equipment according to specifications, blueprints, manuals, drawings and verbal or written instructions. Utilizes a structured and comprehensive method to identify the root cause of process or equipment malfunction; implements corrective action after thorough analysis to increase probability of the right fix the first time based on product quality parameters. Performs electrical, mechanical, software troubleshooting and maintenance for related equipment, tools, cable assemblies and fixtures. Checks and calibrates tools, equipment and fixtures using test and diagnostic equipment as required. Cleans and lubricates shafts, bearings, gears and other parts of machinery. Assists in the layout, assembly, installation and maintenance of pipe systems and related equipment. Maintains and monitors maintenance parts stock. Maintains accurate records and logs of work performed, modifications, calibrations, adjustments and parts inventory.

May perform equipment and fixture modifications as directed by manufacturing engineers. Equipment used includes office equipment, power supplies, oscilloscopes, logic analyzers, volt meters, soldering irons, hand tools, power tools and personal computers or other hand/power tools and test equipment. Maintains proficiency in programmable controllers, microprocessors, control circuits, analog/digital circuits, motors and troubleshooting skills.

Skill Standards are quality standards applied to people. They are specific statements of desired skill and knowledge presented in an observable and measurable form.

The statement contains a condition that defines under what circumstances it will be observed and measured. The desired behavior is defined and the standard criteria is stated in terms of "how good is good enough."

An example of a skill standard statement is:



The ranking information in terms of importance, proficiency, frequency and difficulty are shown for each statement.

Skill Standard Statement

1.1 Condition: Given a series of control charts and process specifications
Behavior: Interpret data of SPC control charts
Standard: Determining if action is required

1.2 Condition: Given a case scenario of unacceptable product quality
Behavior: Communicate trends of machine performance
Standard: Identifying appropriate action

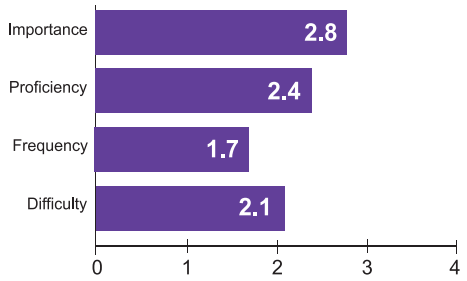
1.3 Condition: Given a set of flow charts and input conditions
Behavior: Analyze flow charts
Standard: Identifying correct conclusion

1.4 Condition: Given ESD protection devices
Behavior: Observe ESD precautions for product and equipment components
Standard: Demonstrating proper use in accordance with appropriate procedures

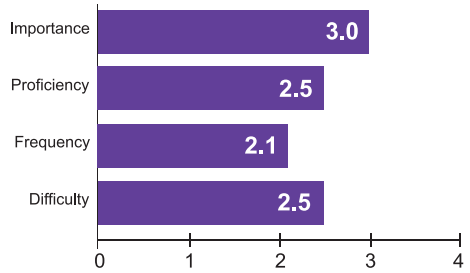
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

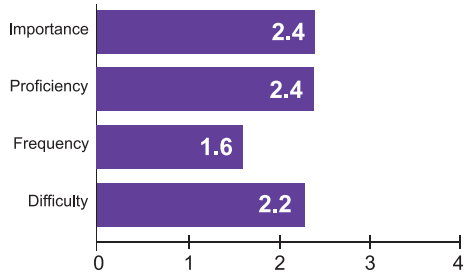
1.1



1.2



1.3



1.4

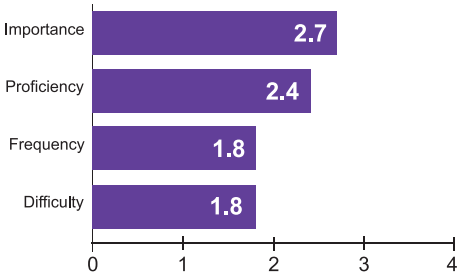


Photo courtesy of Texas Instruments.

2 - Demonstrating Working Knowledge of Basic Electronic Principles

Skill Standard Statement

2.1 Condition: Given an equipment training device and a digital multimeter
Behavior: Measure voltage, current and resistance
Standard: According to the specified level of accuracy, without supervision

2.2 Condition: Given series and parallel circuit schematics
Behavior: Analyze series and parallel circuits containing resistors, inductors and capacitance
Standard: By predicting and verifying waveforms at specified test points

2.3 Condition: Given a digital circuit with schematic, frequency counter (or equivalent) and logic analyzer
Behavior: Analyze digital circuit
Standard: By identifying logic condition, frequency and duty cycle at specified test points

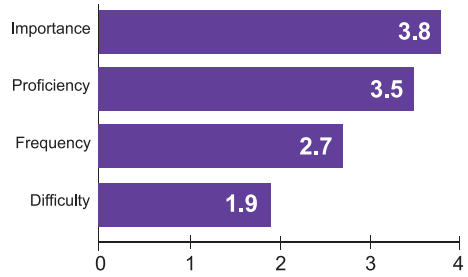
2.4 Condition: Given a circuit with semiconductor components (e.g., diodes, SCRs, triacs) and schematic
Behavior: Analyze semiconductor circuit
Standard: By predicting and verifying waveforms at specified test points

2 - Demonstrating Working Knowledge of Basic Electronic Principles

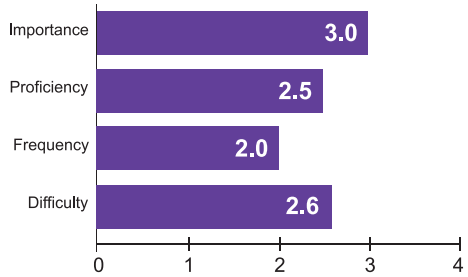
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

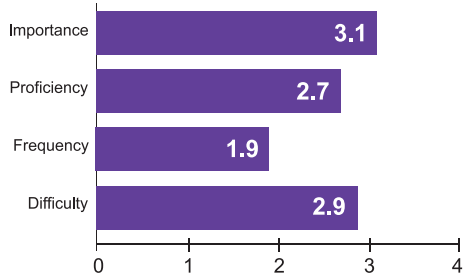
2.1



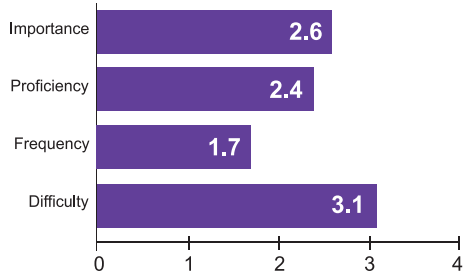
2.2



2.3



2.4



Skill Standard Statement

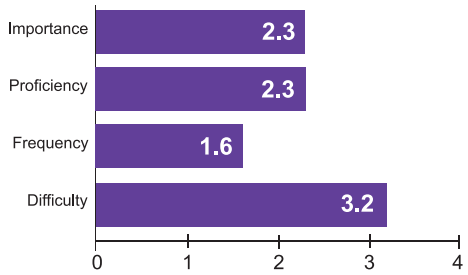
2.5 Condition: Given an analog circuit with schematic and an oscilloscope
Behavior: Analyze analog circuit
Standard: By identifying the frequency, wave shape and amplitude at specified test points

2.6 Condition: Given a list of major functional blocks (microprocessor, input, output and storage)
Behavior: Analyze microprocessor system
Standard: By drawing a block diagram indicating the signal flows between the functional blocks

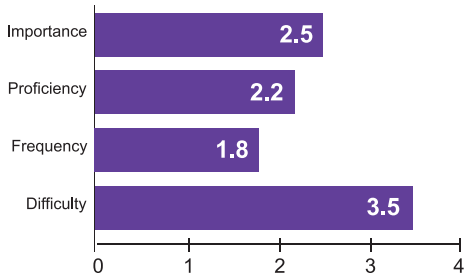
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

2.5



2.6



3 - Operating Equipment

Skill Standard Statement

3.1 Condition: Given an equipment training device, specified parameters and minimal assistance
Behavior: Qualify manufacturing equipment (by adjusting, calibrating and testing)
Standard: According to specifications

3.2 Condition: Given an equipment training device, specified parameters and minimal assistance
Behavior: Operate manufacturing equipment
Standard: According to the specified level of accuracy

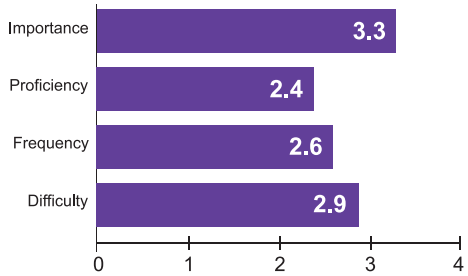
3.3 Condition: Given a set of scenarios of equipment performance
Behavior: Identify equipment inaccuracy
Standard: By classifying each as acceptable or unacceptable

3.4 Condition: Given an equipment training device in and out of control or malfunctioning mode and a troubleshooting procedure
Behavior: Troubleshoot manufacturing equipment
Standard: By identifying most probable failure modes

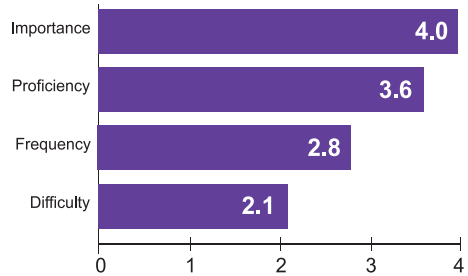
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

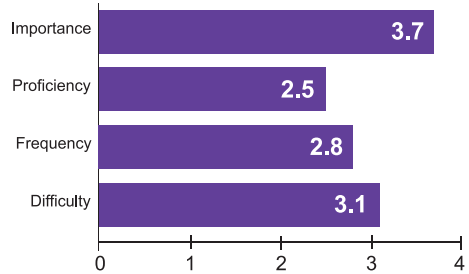
3.1



3.2



3.3



3.4

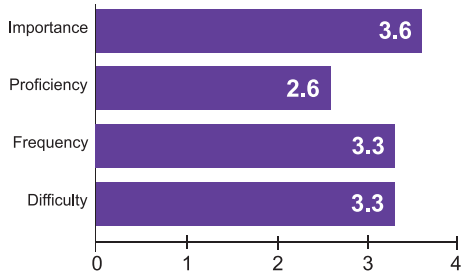


Photo courtesy of Texas Instruments.

Skill Standard Statement

4.1 Condition: Given actual or simulated processing equipment, ergonomic constraints, instructions and minimal supervision
Behavior: Adhere to wafer handling and manufacturing procedures
Standard: In accordance with process recipe (using appropriate wafer transport and handling procedures)

4.2 Condition: Given a list of the major steps in the manufacturing process and a list of purposes of each
Behavior: Recognize the steps in the wafer manufacturing process
Standard: By matching each step to its purpose

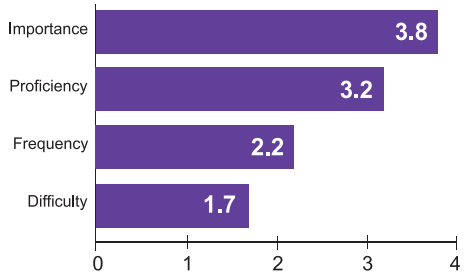
4.3 Condition: Given a list of the major process equipment and a list of functionality
Behavior: Recognize the function of process equipment
Standard: By matching each equipment to its function

4.4 Condition: Given actual or simulated process equipment, measurement tools (e.g., nanospec, resistivity) and procedures
Behavior: Measure process metrics
Standard: To specified accuracy

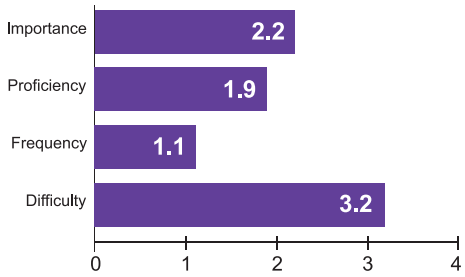
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

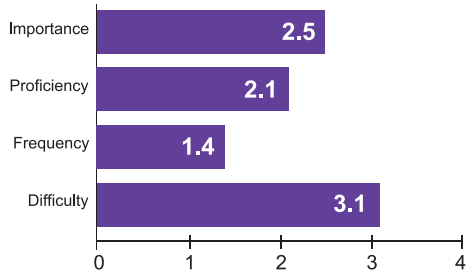
4.1



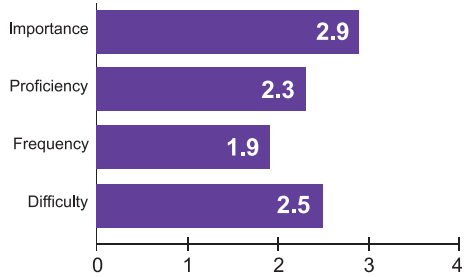
4.2



4.3



4.4



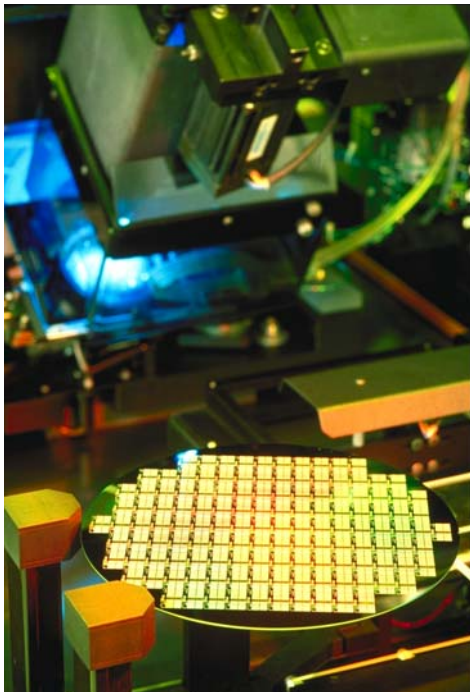


Photo courtesy of Tom Way / IBM Corp.

5 - Troubleshooting and Repairing Electrical/Electronic Systems

Skill Standard Statement

5.1 Condition: Given a set of electrical/electronic performance scenarios
Behavior: Recognize electrical/electronic malfunction indications
Standard: By identifying each as a correct or incorrect function

5.2 Condition: Given electrical/electronic equipment training device, PM procedure, basic hand tools and replacement parts kit
Behavior: Conduct routine preventative maintenance
Standard: According to PM procedures

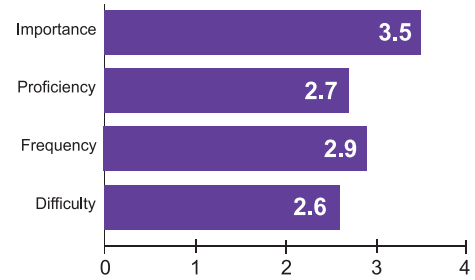
5.3 Condition: Given an equipment training device with an electrical fault, appropriate test equipment, wiring diagrams and schematics
Behavior: Troubleshoot root-cause of electronic failures
Standard: By proven techniques to device level

5.4 Condition: Given line schematic, wiring diagram and a set of conditions
Behavior: Interpret electrical/electronic diagrams
Standard: By determining conditions at specified points

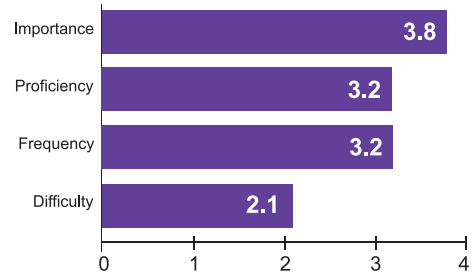
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

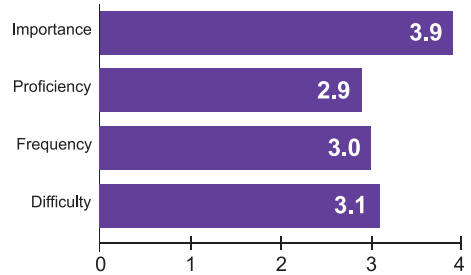
5.1



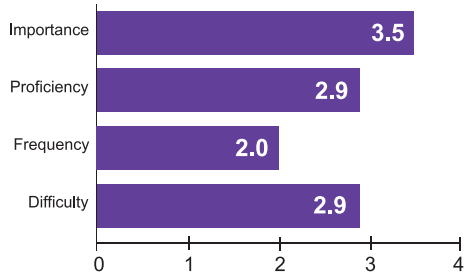
5.2



5.3



5.4



5 - Troubleshooting and Repairing Electrical/Electronic Systems

Skill Standard Statement

5.5 Condition: Given an equipment training device, electronic sensors, motor controllers, connectors, relays, transducers, circuit board components, servo amplifiers, electrical cables, fiber optic cables, necessary tools, wiring diagrams, schematics, appropriate instructions and minimal assistance
Behavior: Replace electrical components
Standard: According to specifications

5.6 Condition: Given an equipment training device, electronic sensors, motor control circuits, cables, connectors, relays, transducers, necessary tools and test equipment, appropriate instructions and minimal assistance
Behavior: Troubleshoot electrical/electronic components and devices, using proven techniques
Standard: According to specification

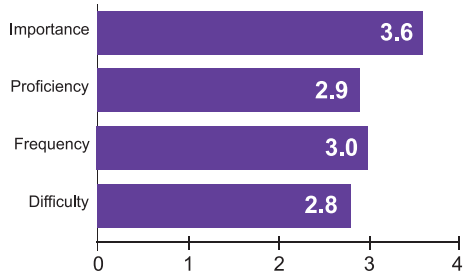
5.7 Condition: Given an equipment training device, electronic sensors, motor control circuits, high voltage and 3-phase power supplies, transducers, servo amplifiers, fiber optic cables, necessary tools and minimal assistance
Behavior: Repair electrical/electronic systems
Standard: According to specification

5.8 Condition: Given a motor controller, a set of parameters and appropriate instructions
Behavior: Program motor controllers
Standard: With correct parameters

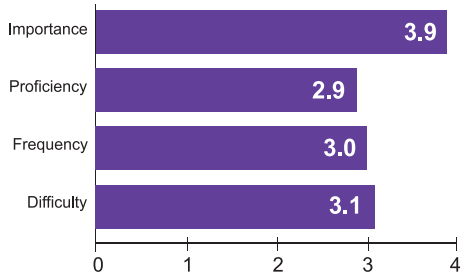
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

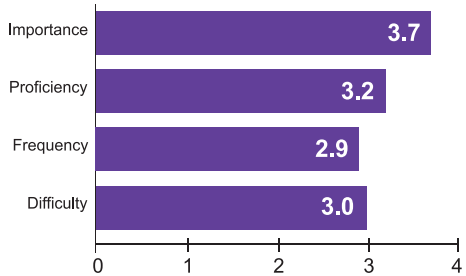
5.5



5.6



5.7



5.8

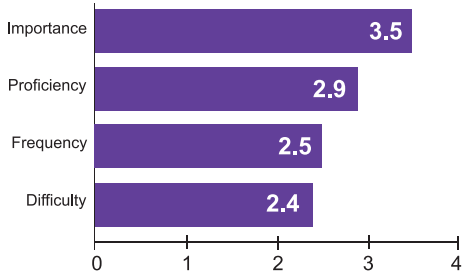


Photo courtesy of Texas Instruments.

6 - Troubleshooting and Repairing Pneumatic Systems

Skill Standard Statement

6.1 Condition: Given a pneumatic equipment training device, actuators, control valves, pressure switches, cylinders, gauges, filters, basic hand tools, installation instruction and minimal assistance
Behavior: Recognize pneumatic malfunction indications
Standard: By identifying induced flaw

6.2 Condition: Given a pneumatic equipment training device, actuators, control valves, pressure switches, cylinders, gauges, filters, basic hand tools, installation instruction and minimal assistance
Behavior: Conduct preventive maintenance on items including a pressure source, regulators and piping
Standard: According to PM procedure

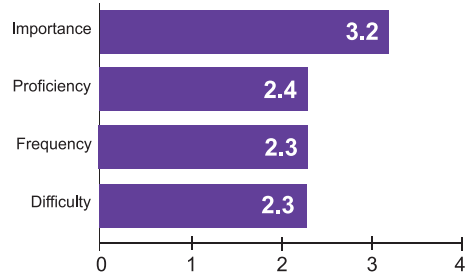
6.3 Condition: Given diagrams
Behavior: Interpret pneumatic system
Standard: By identifying components, flow direction and interconnection

6.4 Condition: Given pneumatic materials
Behavior: Select the correct materials
Standard: According to system requirements

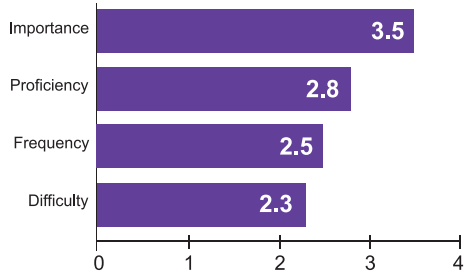
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

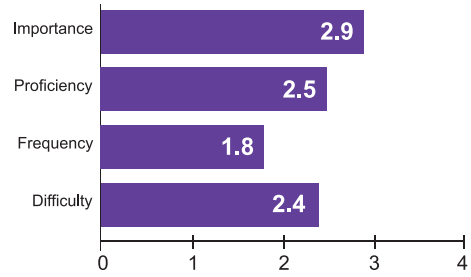
6.1



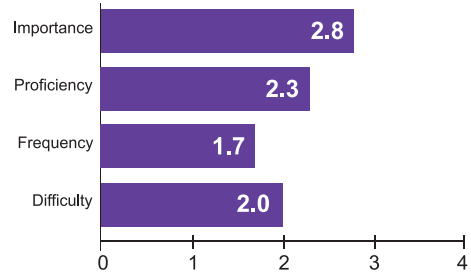
6.2



6.3



6.4



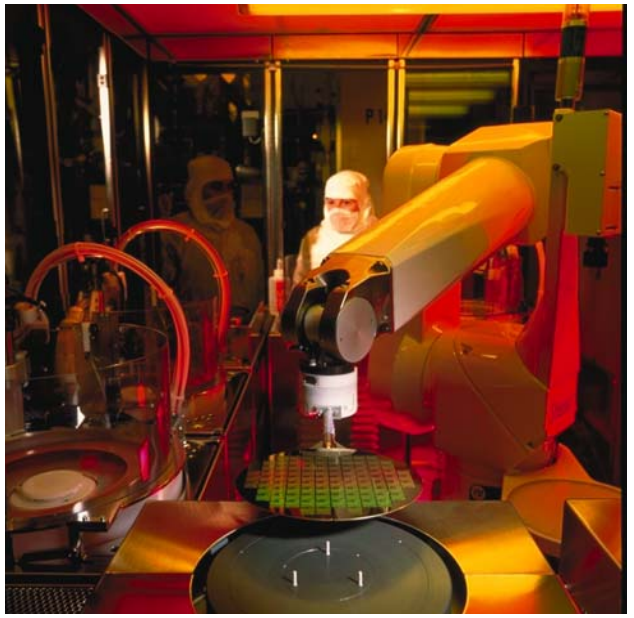


Photo courtesy of Tom Way / IBM Corp.

6 - Troubleshooting and Repairing Pneumatic Systems

Skill Standard Statement

6.5 Condition: Given a pneumatic equipment training device, test equipment and appropriate instruction
Behavior: Perform pneumatic diagnostic tests including measuring air pressure and flow rate
Standard: By verifying system operating specifications

6.6 Condition: Given a pneumatic equipment training device, actuators, control valves, pressure switches, cylinders, gauges, filters, basic hand tools, installation instruction and minimal assistance
Behavior: Install pneumatic components
Standard: According to specifications

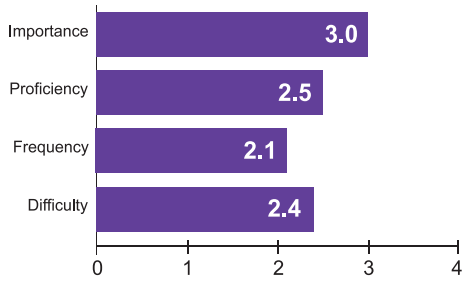
6.7 Condition: Given a pneumatic equipment training device, actuators, control valves, pressure switches, cylinders, gauges, filters, basic hand tools, installation instructions and minimal assistance
Behavior: Maintain pneumatic components
Standard: According to specifications

6.8 Condition: Given a pneumatic equipment training device, actuators, control valves, pressure switches, cylinders, gauges, filters, basic hand tools, installation instruction and minimal assistance
Behavior: Troubleshoot pneumatic components
Standard: According to specifications

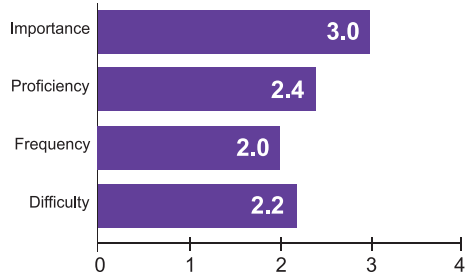
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

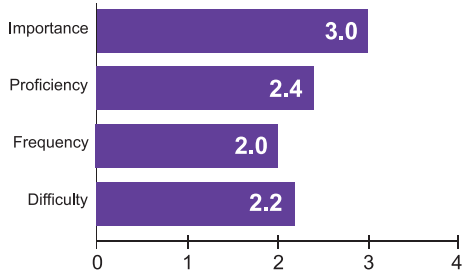
6.5



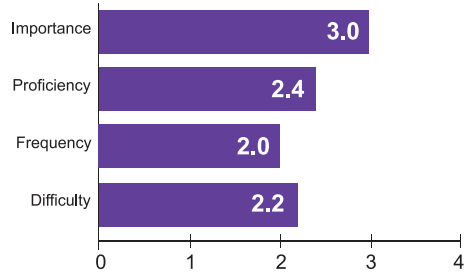
6.6



6.7



6.8



7 - Troubleshooting and Repairing Hydraulic Systems

Skill Standard Statement

7.1 Condition: Given a hydraulic pump, gauge, filter, accumulator, flow control valve, servo valve, directional valve, pressure control valve, preventive maintenance instructions and minimal assistance
Behavior: Conduct preventive maintenance on equipment including hydraulic diagnostic tests
Standard: By identifying induced flaw and recognizing malfunction indications

7.2 Condition: Given a hydraulic pump, gauge, filter, accumulator, flow control valve, servo valve, directional valve and pressure control valve
Behavior: Install hydraulic components
Standard: According to specifications

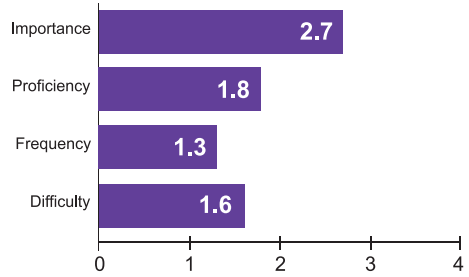
7.3 Condition: Given a hydraulic pump, gauge, filter, accumulator, flow control valve, servo valve, directional valve, pressure control valve, hydraulic pressure and hydraulic servo system
Behavior: Adjust hydraulic components
Standard: According to specifications

7.4 Condition: Given a hydraulic pump, gauge, filter, accumulator, flow control valve, servo valve, directional valve and pressure control valve
Behavior: Troubleshoot hydraulic components
Standard: According to specifications

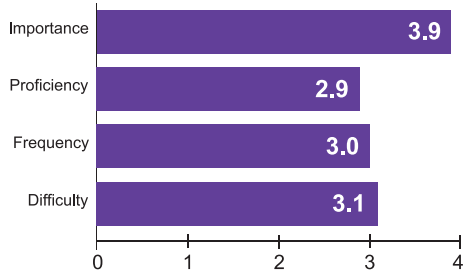
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

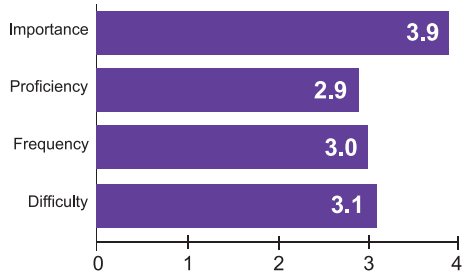
7.1



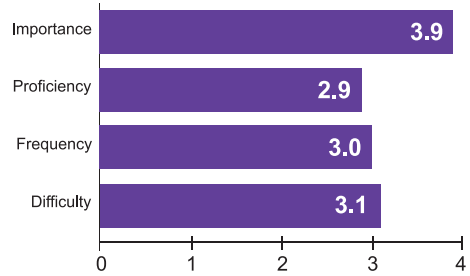
7.2



7.3



7.4



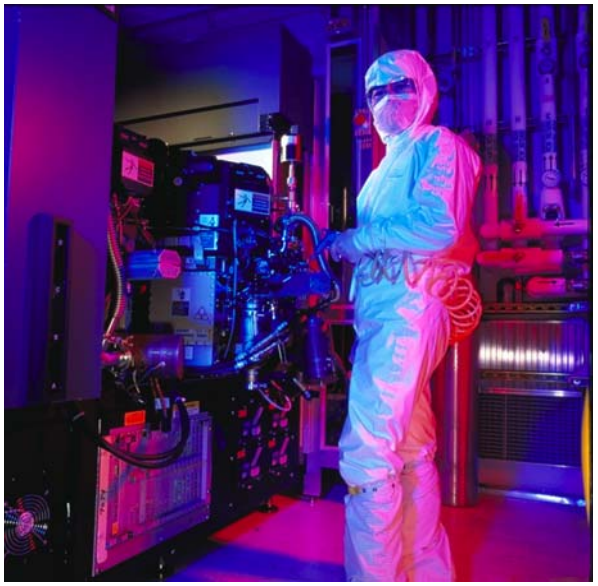


Photo courtesy of Tom Way / IBM Corp.

8 - Troubleshooting and Repairing Mechanical/Electromechanical Systems

Skill Standard Statement

8.1 Condition: Given appropriate instructions, mechanical drive, servo, pump, stepper, clutch and speed reducer
Behavior: Perform mechanical and electromechanical diagnostic tests (which include determining speed, torque, force and power)
Standard: By identifying induced flaw and recognizing malfunction indications

8.2 Condition: Given a mechanical drive, servo, pump, stepper, clutch, speed reducer and PM procedure
Behavior: Perform preventive maintenance checks and adjustments, including linkage and gear trains, setting mechanical stops and end positions of actuators
Standard: According to procedure and specifications

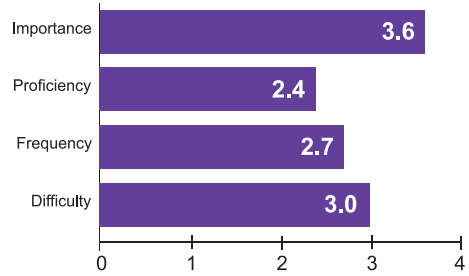
8.3 Condition: Given a mechanical drive, servo, pump, stepper, clutch and speed reducer
Behavior: Install mechanical and electromechanical componenets
Standard: According to specifications

8.4 Condition: Given a mechanical drive, servo, pump stepper, clutch and speed reducer
Behavior: Adjust mechanical and electromechanical components
Standard: According to specifications

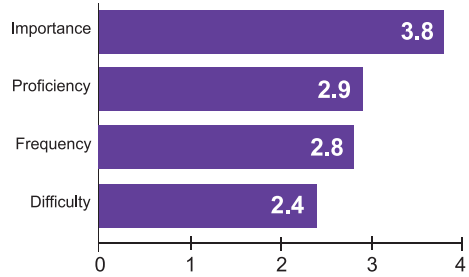
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

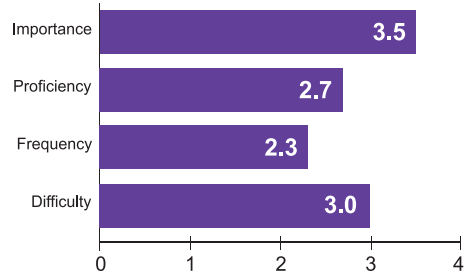
8.1



8.2



8.3



8.4

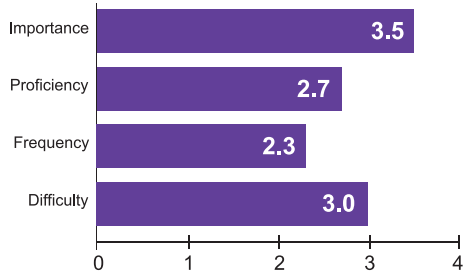


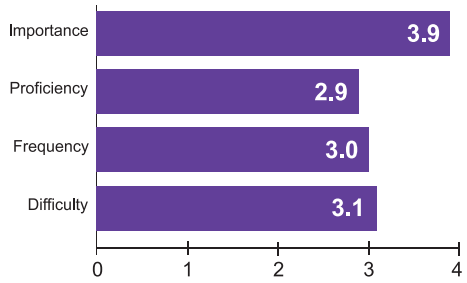
Photo courtesy of Texas Instruments.

Skill Standard Statement

8.5 Condition: Given a mechanical drive, servo, pump, stepper, clutch and speed reducer
Behavior: Troubleshoot mechanical and electromechanical components
Standard: According to specifications

Ranking

8.5



For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

Photo courtesy of SpeedFam-IPEC.

9 - Troubleshooting and Repairing Vacuum Systems

Skill Standard Statement

9.1 Condition: Without access to manuals or text books
Behavior: Explain vacuum fundamentals
Standard: By describing the process of creating a vacuum at low, high and ultrahigh levels with reference to the process used for pumping and the achievable range of vacuum for each level

9.2 Condition: Given one list of vacuum pumps and gauges and another list of descriptions of rough, high and ultrahigh vacuum operational uses
Behavior: Describe the operation of vacuum pumps and gauges
Standard: By correctly matching each device to its description of operation

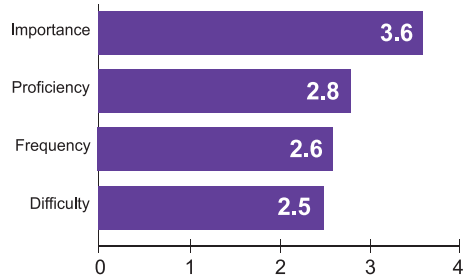
9.3 Condition: Given a vacuum training device, manual and minimal assistance
Behavior: Install vacuum pumps and gauges
Standard: According to specification

9.4 Condition: Given a vacuum training device, PM procedure and minimal assistance
Behavior: Maintain vacuum systems
Standard: By performing maintenance procedure according to specifications

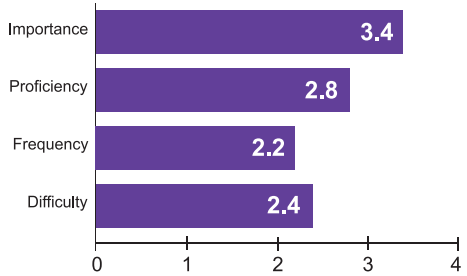
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

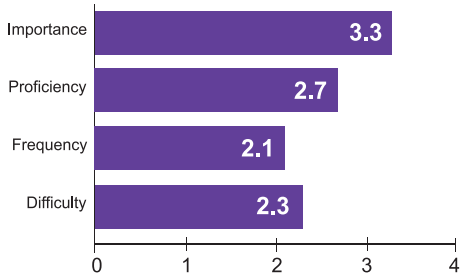
9.1



9.2



9.3



9.4

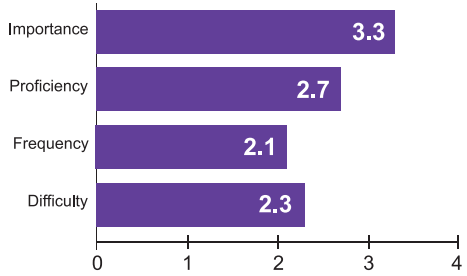


Photo courtesy of Tom Way / IBM Corp.

9 - Troubleshooting and Repairing Vacuum Systems

Skill Standard Statement

9.5 Condition: Given a vacuum training device and list of vacuum components (e.g., valves, fittings, etc.)
Behavior: Identify vacuum components
Standard: By identifying each component and its location on the training device

9.6 Condition: Given a list of materials and their specifications (including vapor pressure) and the specifications required of the vacuum system
Behavior: Identify materials for use in vacuum systems
Standard: By distinguishing appropriate materials used to achieve required specification

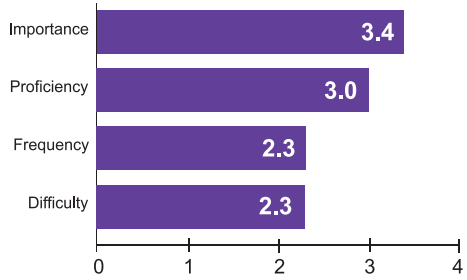
9.7 Condition: Given a vacuum training device, procedures, leak detector, residual gas analyzer and supervision
Behavior: Conduct vacuum diagnosis (using a vacuum diagnostic system)
Standard: According to procedure

9.8 Condition: Given equipment manual
Behavior: Follow specific vacuum safety practices
Standard: By identifying specific safety hazards associated with vacuum systems

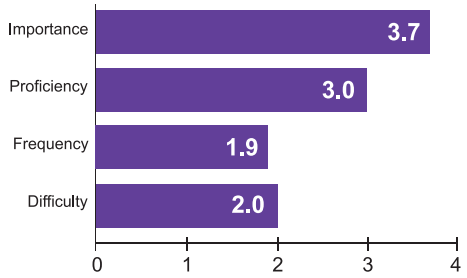
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

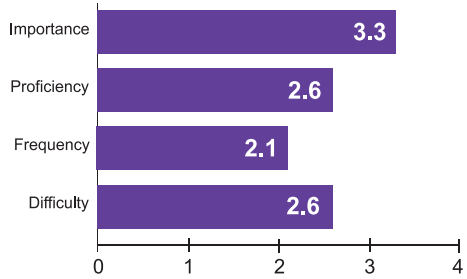
9.5



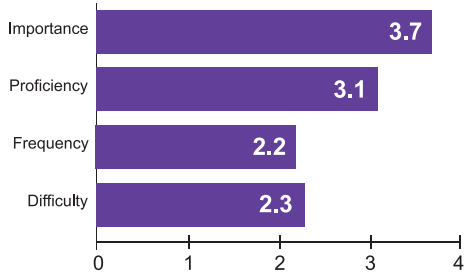
9.6



9.7



9.8



10 - Troubleshooting and Repairing RF Systems

Skill Standard Statement

10.1 Condition: Given a list of RF matches in the semiconductor industry, RF match theory and impedance matching
Behavior: Explain the purpose of each
Standard: According to specifications

10.2 Condition: Given a list of the major subsystems of an RF generator and a list of functionality
Behavior: Recognize the functions of the following RF generator subsystems (oscillators, amplifiers and combiners)
Standard: By matching each subsystem and function

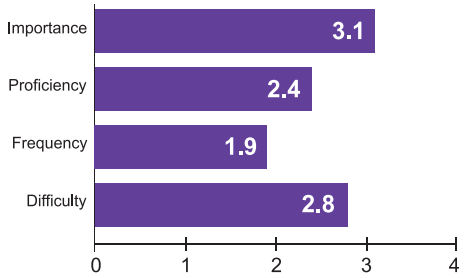
10.3 Condition: Given a list of circuitry used in RF generators
Behavior: Explain the purpose of the following RF generator circuits (buffer, control, driver, output power and automatch)
Standard: According to specification

10.4 Condition: Given a list of RF requirements, coaxial cables, AC ground and DC ground
Behavior: Identify requirements for RF connections and cabling
Standard: According to RF requirements

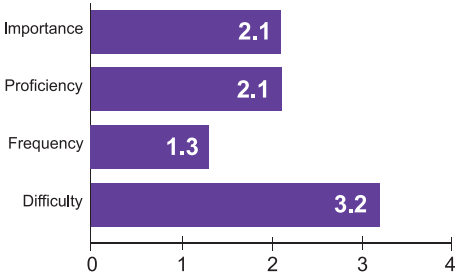
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

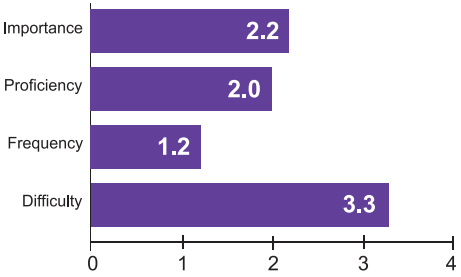
10.1



10.2



10.3



10.4

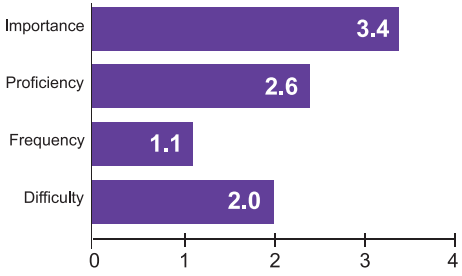


Photo courtesy of SEMATECH.

Skill Standard Statement

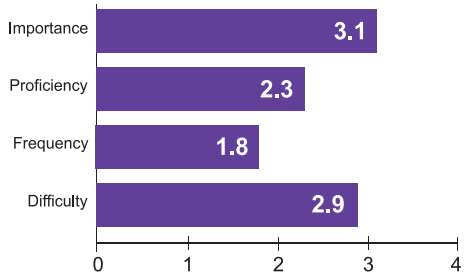
10.5 Condition: Given a list of RF troubleshooting equipment including oscilloscope, spectrum analyzer, frequency counter, power meter, dummy loads and directional coupler

Behavior: Identify RF equipment purpose and proper use

Standard: By matching the lists

Ranking

10.5



For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

Skill Standard Statement

11.1 Condition: Given a block diagram of a liquid heat exchanger
Behavior: Describe the function of a liquid heat exchanger
Standard: By matching operation and purpose for each major component

11.2 Condition: Without references
Behavior: Recall the reason for using DI water in semiconductor manufacturing
Standard: By identifying two major reasons

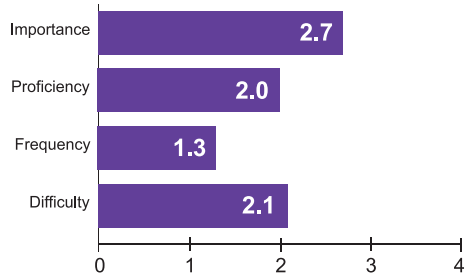
11.3 Condition: Given a list of major components (e.g., bulk storage, pumps, piping, gas interface box, controller, sensors, forelines, mass flow controllers)
Behavior: Identify cause and effects of problems with the gas delivery system
Standard: By matching the operation and purpose of each

11.4 Condition: Given a block diagram of a refrigeration system and a list of equipment functions
Behavior: Recognize the function of a refrigeration system
Standard: By matching the operation and purpose of each major component

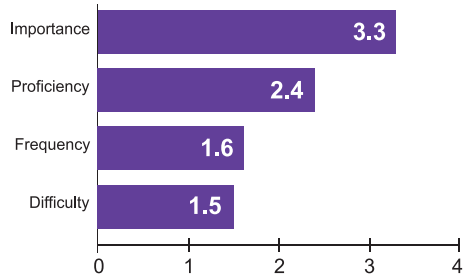
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

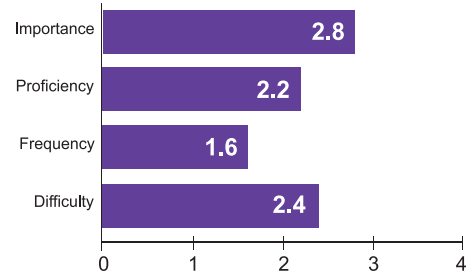
11.1



11.2



11.3



11.4

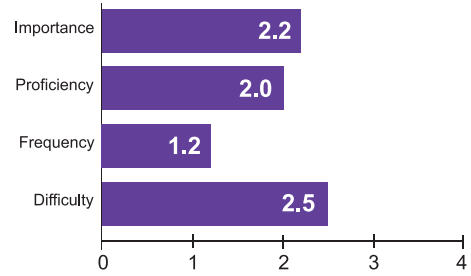
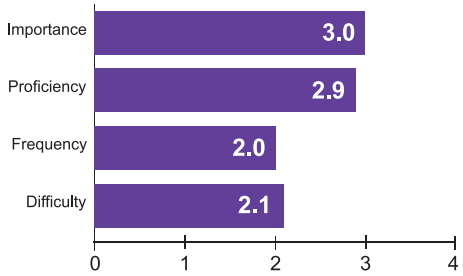


Photo courtesy of Tom Way / IBM Corp.

Skill Standard Statement

11.5 Condition: Given a list of major components (e.g., bulk storage, pumps, piping, valves, sensors, regulators)
Behavior: Identify cause and effects of problems within the liquid delivery system
Standard: By matching the operation and purpose of each

11.5



Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

12 - Performing Preventive and Routine Maintenance

Skill Standard Statement

12.1 Condition: Given a variety of drills and attachments
Behavior: Utilize drills and attachments
Standard: According to manufacturer's operations and safety specifications

12.2 Condition: Given a variety of power drills requiring maintenance and documented maintenance procedures
Behavior: Maintain power drill
Standard: According to manufacturer's maintenance and safety specifications

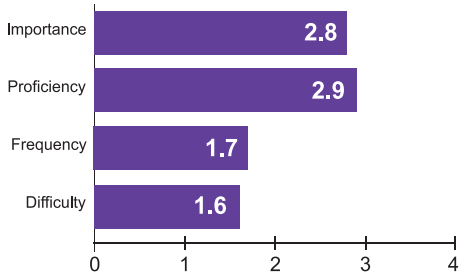
12.3 Condition: Given an equipment training device, a selection of lubricants and a list of equipment lubrication requirements
Behavior: Use appropriate lubricants
Standards: According to specifications

12.4 Condition: Given a maintenance record form, a scenario of performed maintenance and appropriate instructions
Behavior: Fill out maintenance record form including appropriate information
Standard: In the correct format

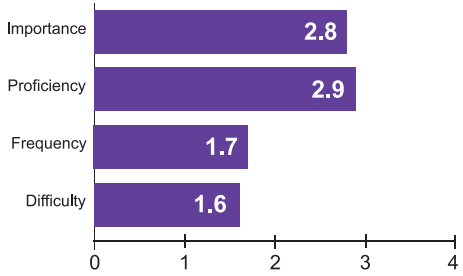
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

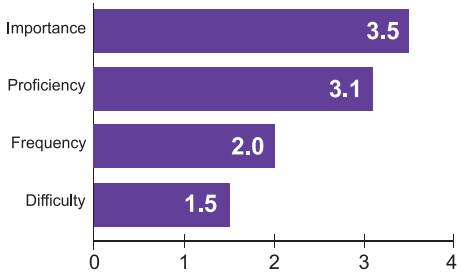
12.1



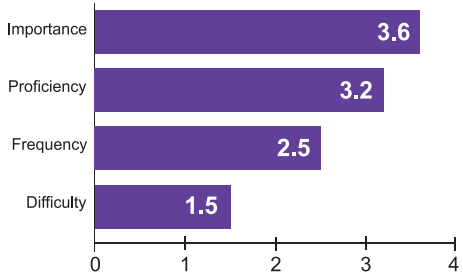
12.2



12.3



12.4



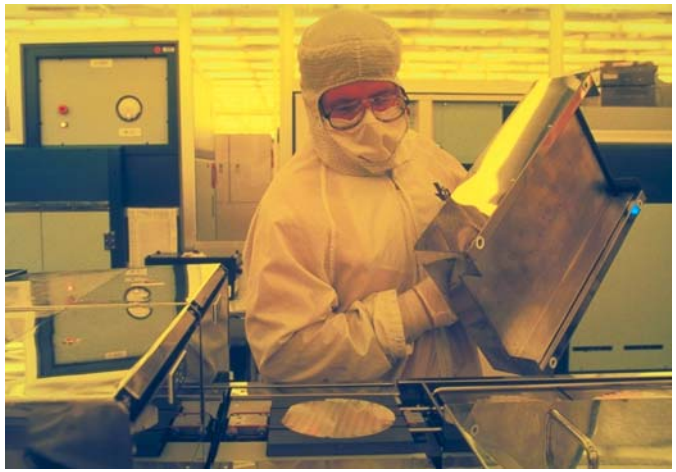


Photo courtesy of Texas Instruments.

Skill Standard Statement

12.5 Condition: Given a service bulletin and an equipment training device
Behavior: Comply with requirements of service bulletin
Standard: According to stated parameters

12.6 Condition: Given appropriate measurement tools and a group of items requiring measurement of depth, length, width, thickness, inside diameter, outside diameter or gap
Behavior: Use mechanical measuring devices to calculate dimensions
Standard: Within specified tolerances

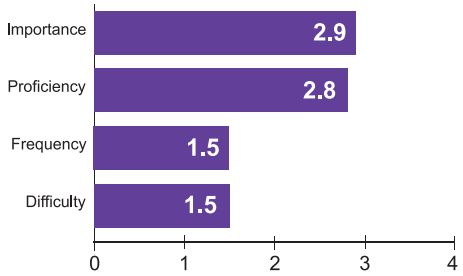
12.7 Condition: Given a set of equipment manufacturer's manuals along with troubleshooting, repairing and operational scenarios
Behavior: Locate reference in manufacturer's manuals
Standard: By correctly identifying reference for each scenario

12.8 Condition: Given a set of mechanical, electrical and electronic drawings and a number of related equipment parts
Behavior: Interpret drawing of parts
Standard: Matching each drawing to appropriate part

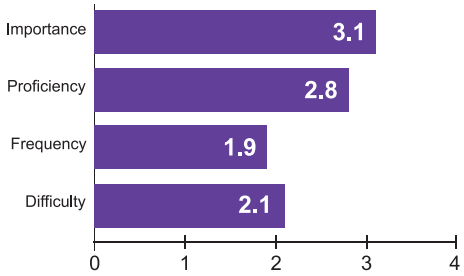
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

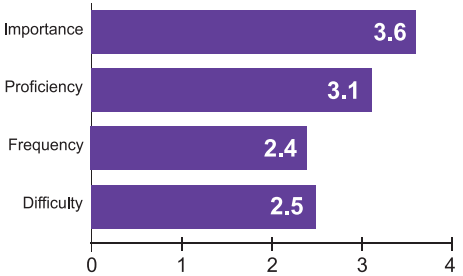
12.5



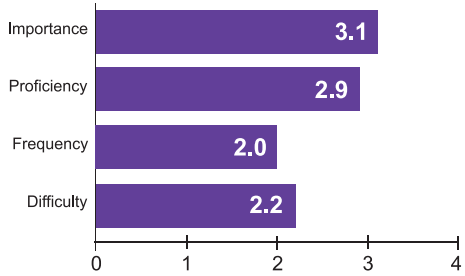
12.6



12.7



12.8



Skill Standard Statement

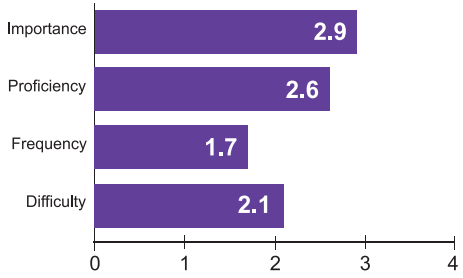
12.9 Condition: Given a set of graphs or charts with references
Behavior: Interpret graphs or charts
Standard: By identifying any required actions

12.10 Condition: Given screwdrivers, wrenches, sockets, hammers, pliers, wire strippers, saws, torque wrenches, vises, files and other special tools
Behavior: Utilize a variety of hand tools correctly
Standard: Applying each tool to an appropriate task

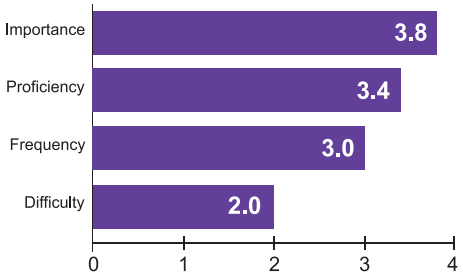
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

12.9



12.10



Skill Standard Statement

13.1 Condition: Given a robot coordinate systems training device, appropriate references and minimal assistance
Behavior: Calibrate robot coordinate systems
Standard: According to referenced performance and safety specifications

13.2 Condition: Given basic hand tools, appropriate references, minimal assistance and an automated systems equipment training device containing errors in robotics, end effectors, fixed automations and material transfer systems
Behavior: Troubleshoot automated systems including robots, end effectors, fixed automations and material transfer systems
Standard: According to referenced performance and safety specifications

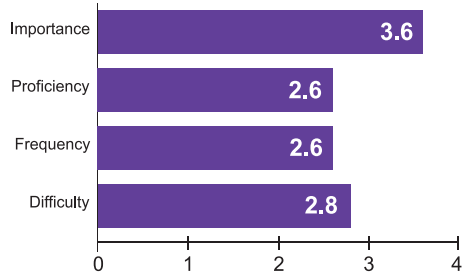
13.3 Condition: Given an automated systems equipment training device containing robotics, end effectors, fixed automations, materials transfer systems, basic hand tools, appropriate references and minimal assistance
Behavior: Install automated systems including robots, end effectors, fixed automations and material transfer systems
Standard: According to referenced performance and safety specification

13.4 Condition: Given an automated systems equipment training device containing robotics, end effectors, fixed automations, material transfer systems, basic hand tools, appropriate references and minimal assistance
Behavior: Maintain automated systems including robots, end effectors, fixed automations and material transfer systems
Standard: According to referenced performance and safety specifications

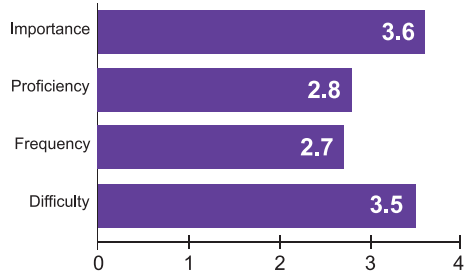
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

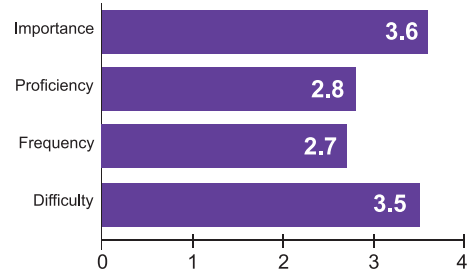
13.1



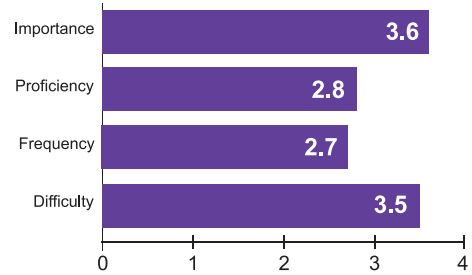
13.2



13.3



13.4



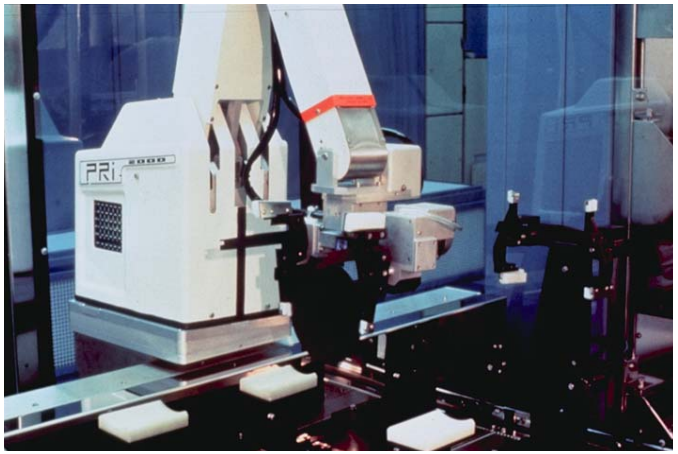


Photo courtesy of SEMATECH.

Skill Standard Statement

13.5 Condition: Given an automated systems equipment training device containing robotics, end effectors fixed automations, and material transfer systems, appropriate references and minimal assistance
Behavior: Program automated systems including robots, end effectors, fixed automations and material transfer systems
Standard: According to referenced specifications

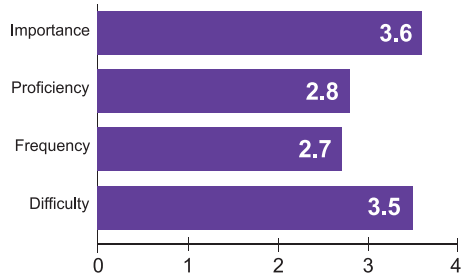
13.6 Condition: Given an automated systems training device, appropriate references and minimal assistance
Behavior: Adjust feedback loops
Standard: According to referenced performance and safety specifications

13.7 Condition: Given a scenario of robot sensing equipment and a choice of requirements
Behavior: Select appropriate robot sensing requirements
Standard: According to robot specifications

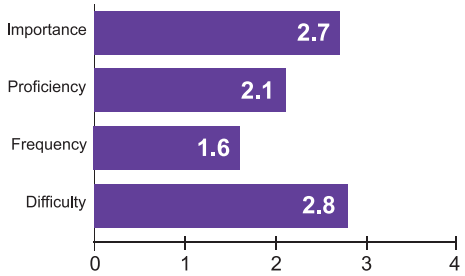
13.8 Condition: Given an automated systems equipment training device containing robotics, end effectors, fixed automations, and material transfer systems, appropriate references and minimal assistance
Behavior: Operate automated systems including robots, end effectors, fixed automations, machine vision systems and material transfer systems
Standard: According to referenced performance and safety precautions

Ranking

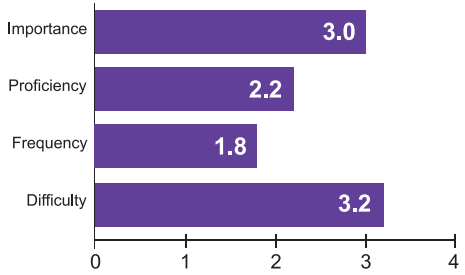
13.5



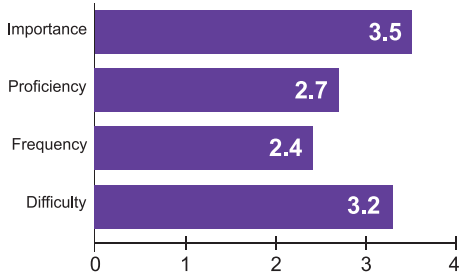
13.6



13.7



13.8



For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

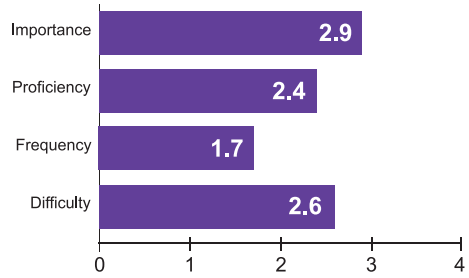
Photo courtesy of SCP Global Technologies.

Skill Standard Statement

13.9 Condition: Given an automated systems training device, appropriate references and minimal assistance
Behavior: Perform zeroing of encoders
Standard: According to referenced performance and safety specifications

Ranking

13.9



For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

Photo courtesy of John Tyler Community College.

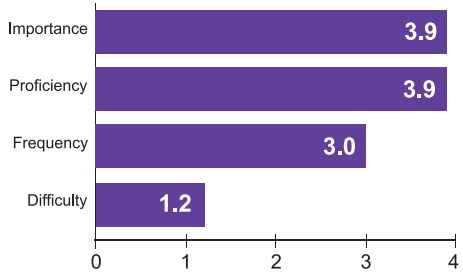
Skill Standard Statement

14.1 Condition: Given a cleanroom environment, materials, protocol guidelines and a set of task-oriented scenarios
Behavior: Conform to cleanroom protocol
Standard: According to specifications

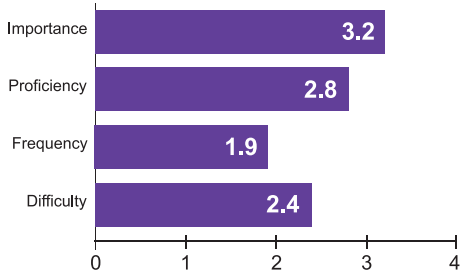
14.2 Condition: Given appropriate instructions and minimal assistance
Behavior: Maintain chemical and gas delivery and disposal systems
Standard: According to appropriate cleanroom and process specifications

Ranking

14.1



14.2



For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

Photo courtesy of SEMATECH.

Skill Standard Statement

15.1 Condition: Given a microcomputer system equipped with software
Behavior: Read and respond to screen commands
Standard: With no errors

15.2 Condition: Given a computer system and data sources
Behavior: Extract data
Standard: Saving specific data to a separate file

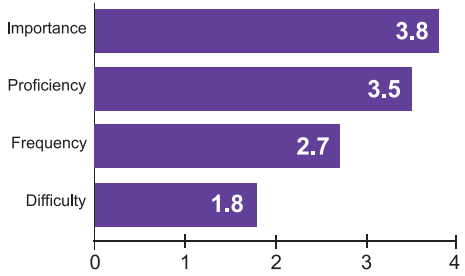
15.3 Condition: Given a computer system equipped with application software
Behavior: Demonstrate a working knowledge of word processing and spreadsheet functions
Standard: By entering, editing, saving and printing data

15.4 Condition: Given a microcomputer system, software, installations manual and minimal assistance
Behavior: Install and set up software
Standard: According to specification

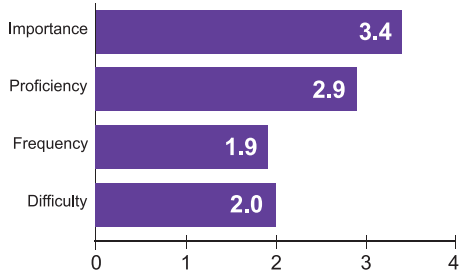
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

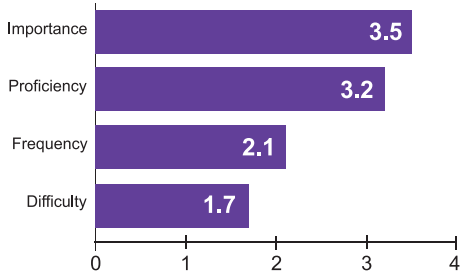
15.1



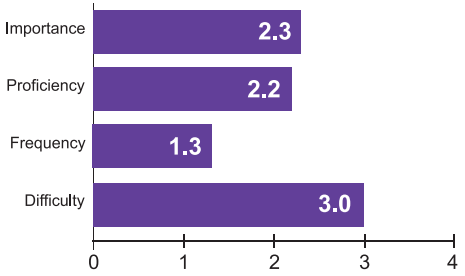
15.2



15.3



15.4



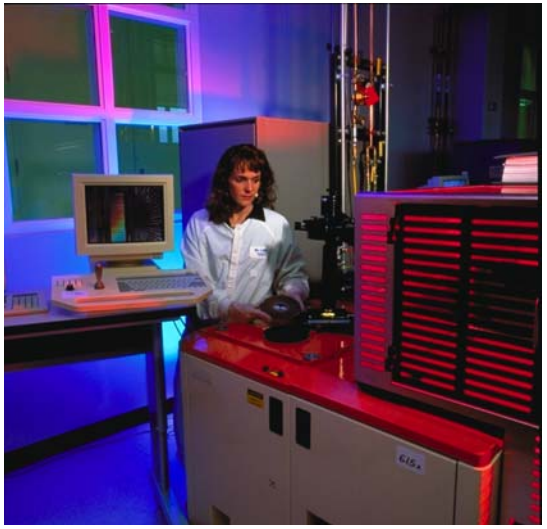


Photo courtesy of Tom Way / IBM Corp.

16 - Adhering to Basic Safety Practices

Skill Standard Statement

16.1 Condition: Given actual or simulated wafer fab manufacturing equipment, manufacturing scenarios in electrical, chemical, RF, high voltage and gas environments and minimal assistance
Behavior: Follow basic safety practices
Standard: According to appropriate procedures

16.2 Condition: Given wafer fab manufacturing scenarios, OSHA standards and no assistance
Behavior: Apply appropriate OSHA standards
Standard: According to regulations

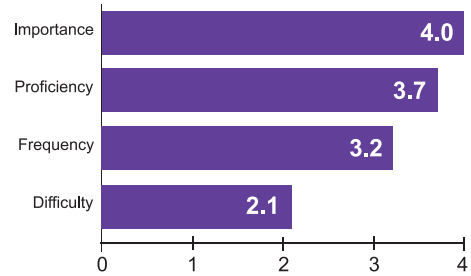
16.3 Condition: Given an equipment training device
Behavior: Demonstrate emergency shutdown procedures
Standard: According to guidelines

16.4 Condition: Without references or assistance
Behavior: Explain the purposes of the emergency response team
Standard: According to specifications

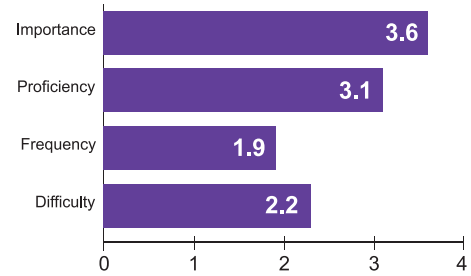
16 - Adhering to Basic Safety Practices

Ranking

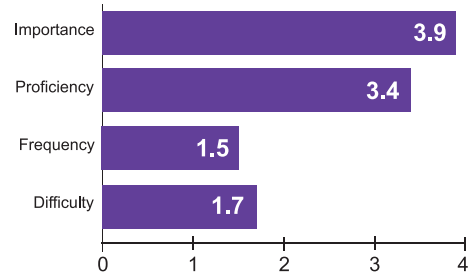
16.1



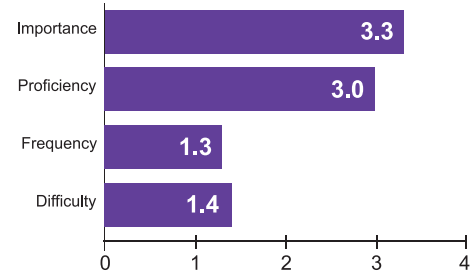
16.2



16.3



16.4



For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

Photo courtesy of Texas Instruments.

17 - Applying Scientific Fundamentals

Skill Standard Statement

17.1 Condition: Given a list of balanced chemical reactions and a list of descriptions of processes that may include the name of the chemical (but not the formula)
Behavior: Demonstrate knowledge of basic chemical reactions applied to semiconductor processes
Standard: By correctly matching the reaction to the process

17.2 Condition: Given a list of chemicals found in a fab, descriptions of various chemical processes conducted in the fab and MSDS's
Behavior: Explain fundamental behavior of acids, bases and solvents
Standard: Recommending an appropriate acid, base or solvent for use in each process (e.g., BOE, solvent for EBR)

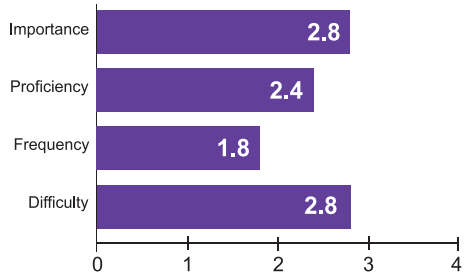
17.3 Condition: Given a schematic of photolithography equipment such as a stepper
Behavior: Apply the principles of optics
Standard: By describing the rationale for the choice of light source, identify the region of the spectrum, illustrate how optical elements transfer the image and define the features that control the resolution of the system

17.4 Condition: Given a semiconductor process (etching, sputtering or CVD)
Behavior: Apply the principles of plasma physics
Standard: By writing a description of the chemical interactions that take place during the process

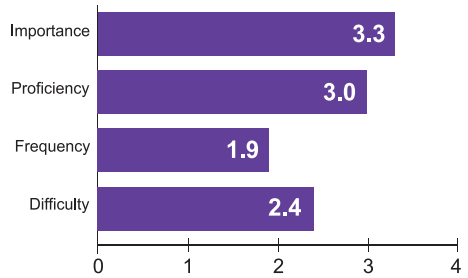
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

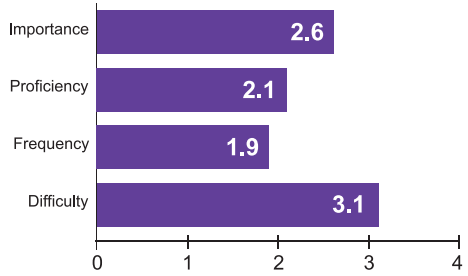
17.1



17.2



17.3



17.4

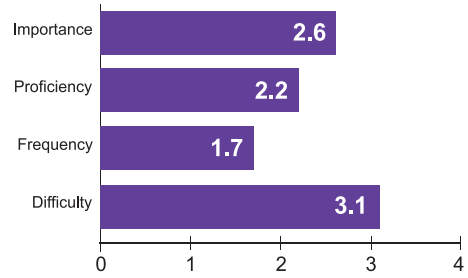


Photo courtesy of SEMATECH.

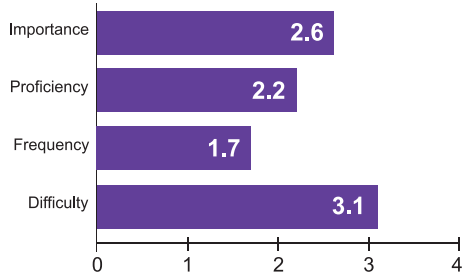
Skill Standard Statement

17.5 Condition: Given a transducer, sensor or measurement device used in semiconductor process equipment

Behavior: Apply the principles of physics to the operation of transducers, sensors and other measurement devices

Standard: By writing a description (including diagrams and drawings) of the operation, troubleshooting and maintenance of the device

17.5



Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

18 - Performing Mathematical Computations

Skill Standard Statement

18.1 Condition: Given a set of measurements, including scientific notation and mathematical operators
Behavior: Calculate including units of measure
Standard: Expressing results in English and metric units

18.2 Condition: Given etch rate and acid concentration table and desired material thickness
Behavior: Perform calculations common to processing chemicals
Standard: Devising recipe for material removal

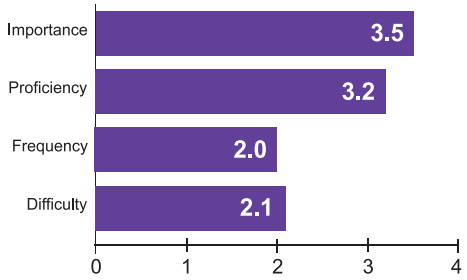
18.3 Condition: Given examples
Behavior: Perform calculations common to physics, chemistry and electronics
Standard: Without error

18.4 Condition: Given matching lists of statistical methods and descriptions of statistical calculations
Behavior: Identify fundamental statistical methods (STD, mean, median, mode, etc.)
Standard: By matching method and description

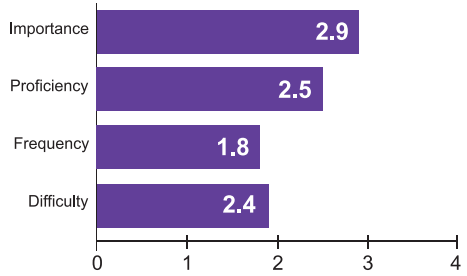
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

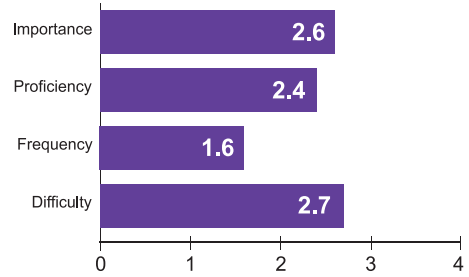
18.1



18.2



18.3



18.4

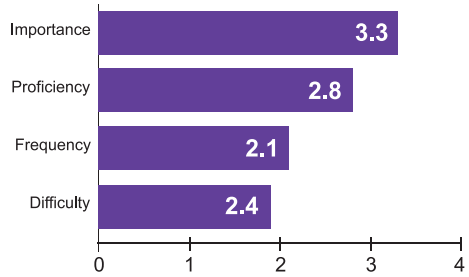


Photo courtesy of SpeedFam-IPEC.

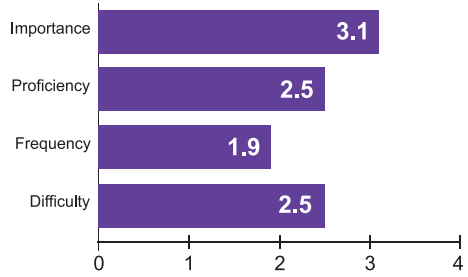
Skill Standard Statement

18.5 Condition: Given examples of the 7 QC tools (Pareto, fishbone cause-analysis diagram, control chart, force-field diagram, trend chart, flow diagram and histogram)

Behavior: Explain the purpose and function of SPC and related charts/reports

Standard: By matching each data set to QC tool data type and to correct tool

18.5 Ranking



For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

19 - Recognizing Workplace Fundamental Principles

Skill Standard Statement

19.1 Condition: Without references
Behavior: Describe importance of value added and non-value added processes
Standard: Without error

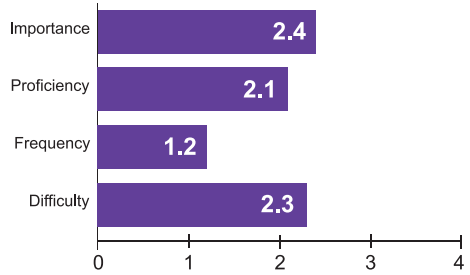
19.2 Condition: Given an employee benefits packet
Behavior: Describe the cost and value of employee benefits
Standard: According to current cost data and text referenced in the packet

19.3 Condition: Given case studies and assigned learning materials
Behavior: Describe the value of ethical behavior to the individual and the employer in each case study
Standard: Based on assigned learning material

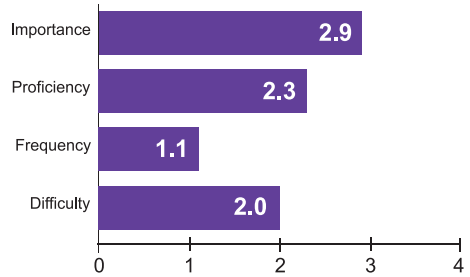
19.4 Condition: Given a list of business practices
Behavior: Recognize ethical and non-ethical business practices
Standard: By categorizing ethical and non-ethical behaviors appropriately based on assigned learning material

Ranking

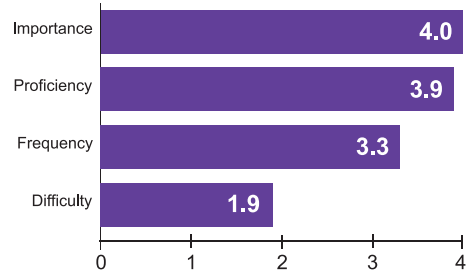
19.1



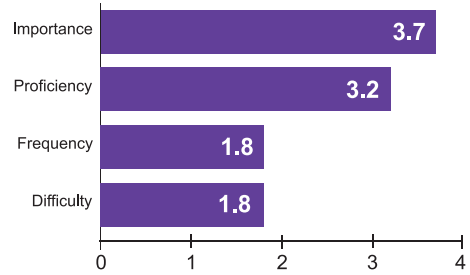
19.2



19.3



19.4



For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

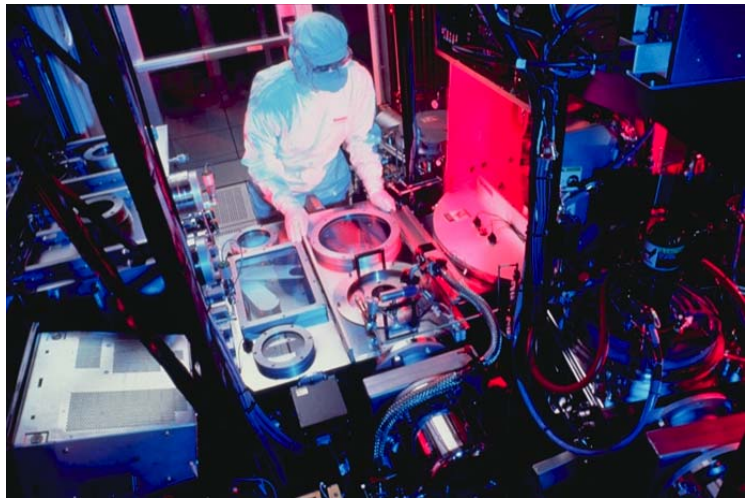


Photo courtesy of SEMATECH.

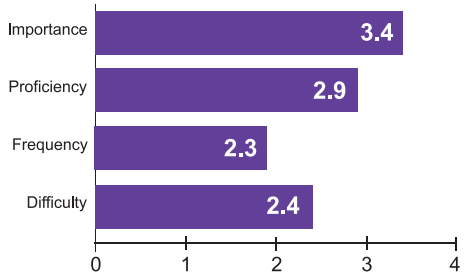
19 - Recognizing Workplace Fundamental Principles

Skill Standard Statement

19.5 Condition: Given a model of a goal containing the required elements (quantity, quality and time)
Behavior: Establish a goal (personal or occupation related)
Standard: By writing a goal that exhibits all required elements represented in the model

Ranking

19.5



For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

20 - Using Information Skills

Skill Standard Statement

20.1 Condition: Given a scenario with a series of steps in a procedure (to include gathering malfunction information, recording data and communicating equipment information for shift pass down) and an equipment training device

Behavior: Read and interpret technical materials

Standard: By completing the procedure according to specification

20.2 Condition: Given an equipment training device with an existing set of instructions and a new step to be added (e.g., a field service bulletin)

Behavior: Maintain documentation

Standard: By correctly placing the new instruction step

20.3 Condition: Given an equipment training device and task completion specification

Behavior: Provide instruction

Standard: Enabling a peer to successfully complete the task

20.4 Condition: Given a project outline including several tasks, stated prerequisites and appropriate instructions

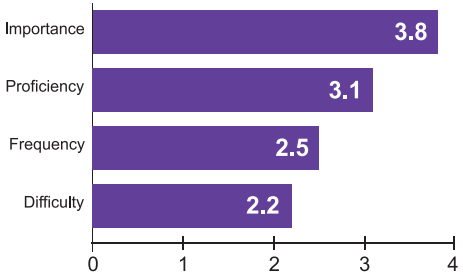
Behavior: Schedule tasks

Standard: In correct sequence

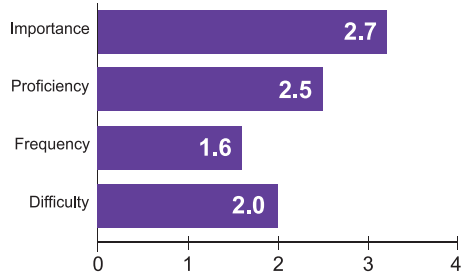
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

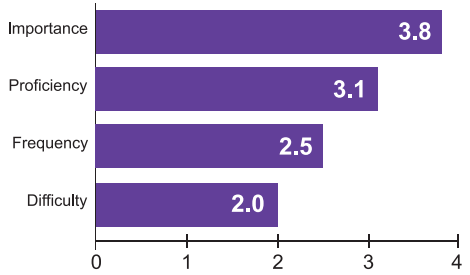
20.1



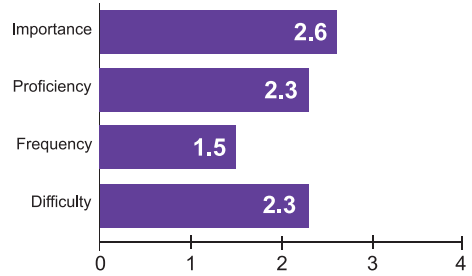
20.2



20.3



20.4



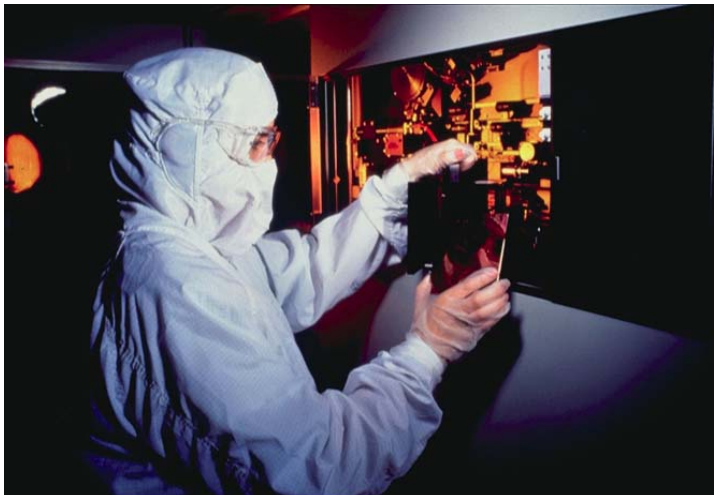
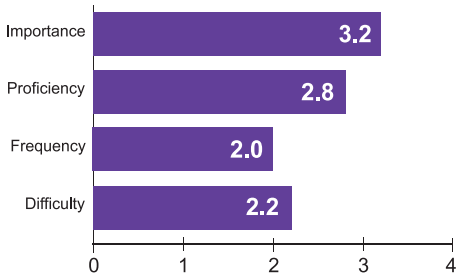


Photo courtesy of SEMATECH.

Skill Standard Statement

20.5 Condition: Given reports of machine performance parameters and instructions
Behavior: Organize information
Standard: Compiling a data table

20.5



Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

21 - Employing Interpersonal Skills

Skill Standard Statement

21.1 Condition: Given a typical work site scenario and a partner
Behavior: Demonstrate productive interpersonal relationships
Standard: By role playing appropriate behavior including accurate assessment of client/customer needs, conflict resolutions and leadership skills based on assigned learning material

21.2 Condition: Given specs for a complex, team-oriented project (e.g., an automated material transfer system), appropriate equipment and tools, a list of team members and minimal assistance
Behavior: Exhibit teamwork skills
Standard: By demonstrating appropriate teamwork skills including respect for diversity, acceptance of constructive feedback, contributions to brainstorming and participating in team self-direction in setting, programming and troubleshooting the system according to specifications

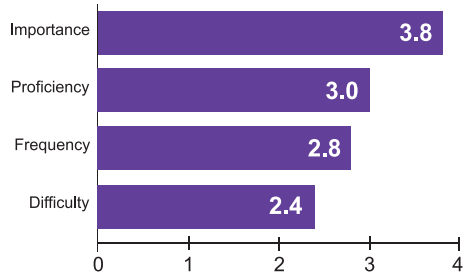
21.3 Condition: Given a scenario of significantly changing work situations
Behavior: Contribute to change
Standard: By describing constructive actions employees could take

21.4 Condition: Given a list of common company policies and procedures and a scenario depicting conflicts between policy and common practice
Behavior: Follow operational procedures
Standard: By role playing appropriate actions and explaining importance of company policies and procedures

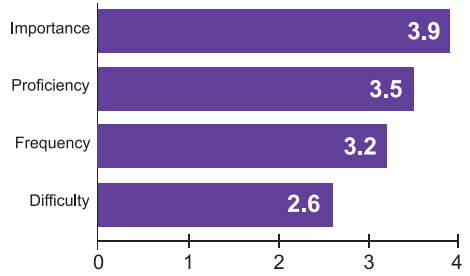
Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

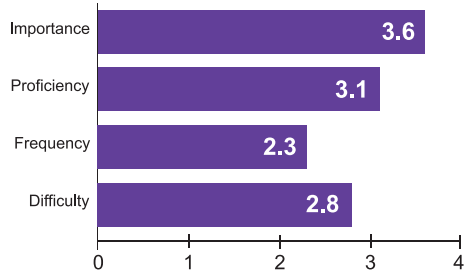
21.1



21.2



21.3



21.4

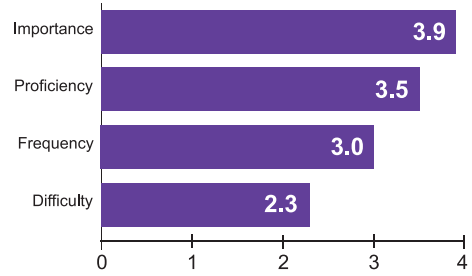
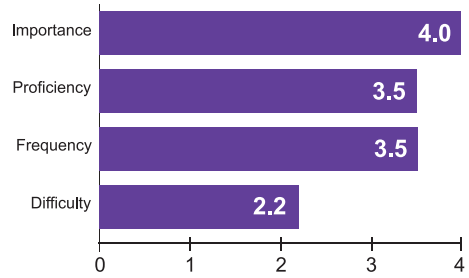


Photo courtesy of FOCAL Semiconductors.

Skill Standard Statement

21.5 Condition: Given a group generated DO/DON'T List of responsible behavior or equivalent
Behavior: Exhibit responsibility
Standard: By complying with the DO/DON'T List

21.5



Ranking

For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

22 - Displaying Appropriate Personal Qualities

Skill Standard Statement

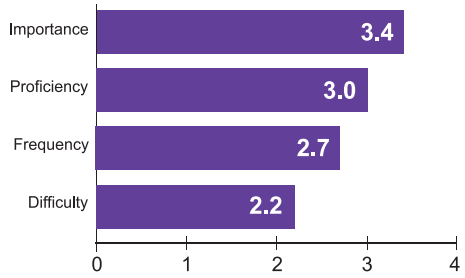
22.1 Condition: Given scenarios in which one's self-esteem is challenged
Behavior: Demonstrate appropriate self-esteem
Standard: By selecting the appropriate responses

22.2 Condition: Given policy, a set of scenarios concerning harassment, discrimination, etc.
Behavior: Demonstrate appropriate social skills
Standard: By complying with policies

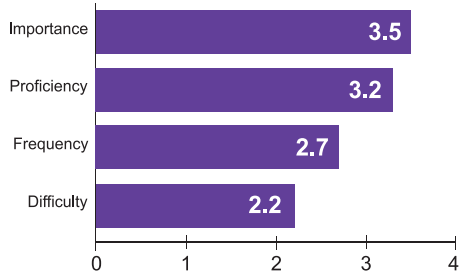
22.3 Condition: Given a scenario in which you have a challenging amount of work to accomplish in a minimal amount of time
Behavior: Display self-management skills
Standard: By describing strategies to accomplish all assigned work

Ranking

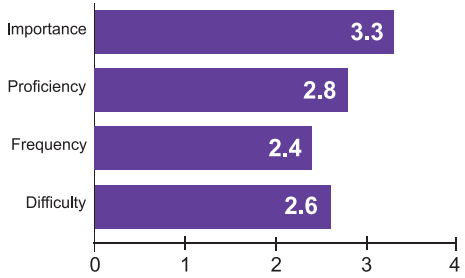
22.1



22.2



22.3



For the first 6 months on the job:
Importance - how important is it to know or do
Proficiency - how well must it be done
Frequency - how frequently is the task done or the knowledge applied
Difficulty - how difficult is it to learn or do

Photo courtesy of FOCAL Semiconductors.

Appendix A - Performance Criteria Ranking

Ranking

The PCAL (Performance Criteria Analysis List) process uses a ranking scale based upon four factors. For every performance criteria statement (PCS) in the list, a score was assigned as follows for each factor:

IMPORTANCE **(How important is it for entry level employees to know or do the PCS?)**

4	=	Highest	Much higher priority than other PCSs on the list. CRUCIAL and highest priority. Inadequate knowledge or performance of PCS would adversely impact quality or safety of products/services.
3	=	High	Somewhat higher priority than other PCSs on the list. Inadequate knowledge or performance of PCS might adversely impact quality or safety of products/services to some degree.
2	=	Low	Somewhat lower priority than other PCSs on the list. Inadequate performance of PCS may not directly impact quality or safety of products/services.
1	=	Lowest	Much lower priority than other PCSs on the list. Inadequate performance of PCS would not have a direct impact on quality or safety of products/services, but must be performed.

PROFICIENCY **(How good is good enough for entry level employees to know or do the PCS?)**

4	=	Highest	Can recall and apply complex facts and principles and resolve problems. Can evaluate conditions and make proper decisions using complex facts and principles. Can do all elements of PCS quickly and accurately with no supervision.
3	=	High	Can recall and apply many facts and principles to different situations. Can analyze facts and principles and draw some appropriate conclusions. Can do all elements of PCS. Only needs spot checks of work.
2	=	Low	Can recall some facts and principles. Can state general principles about the subject. Can do many elements of the PCS but requires help on the hardest parts.
1	=	Lowest	Can recognize only simple facts and terms. Can do only simple parts of PCS and must be closely supervised.

FREQUENCY **(How frequently are entry level employees expected to know or do the PCS?)**

4 = Highest Spends much more time doing this than most other PCSs on the list.
3 = High Spends a little more time doing this than other PCSs on the list.
2 = Low Spends somewhat less time doing this than other PCSs on the list.
1 = Lowest Spends much less time doing this than other PCSs on the list.

DIFFICULTY **(How difficult is it for entry level employees to know or do the PCS?)**

4 = Highest Much more difficult to learn and perform than other PCSs on list.
3 = High Somewhat more difficult to learn and perform than other PCSs on list.
2 = Low Somewhat easier to learn and perform than other PCSs on list.
1 = Lowest Much easier to learn and perform than other PCSs on the list.

A sample shown below illustrates the rating scale.

Skill	Imp	Pro	Fre	Dif
Identify and communicate trends of machine performance	3.5	2.5	2.7	3.2

The values are based on a scale of 0-4, with 4 being the highest rank. The numbers shown are an average of all respondents (41 possible). Similar data exist for the entire list of skills.

Appendix A - Performance Criteria Ranking

Emphasis Rating (ER)

The emphasis rating shown below, combines the importance, proficiency, frequency and difficulty rankings to give a weighted, overall rating. This was used to prioritize and determine which skills were eventually considered most important to be included in the final list.

$$ER = \frac{1}{8}\left[\frac{\left(\frac{\#\text{ of responses}}{41}\right)}{.25} + (\text{Imp} \times 3) + \text{Pro} + \text{Fre} + (\text{Dif} \times 2)\right]$$

The first term in brackets weights the number of responses compared to the 41 total respondents. Not all respondents replied to every skill in the list if their expertise was outside of the area for example. Thus a skill that is performed by all gives a higher ER.

Both Importance and Difficulty are weighted given multiplying factors of three and two respectively to reflect their emphasis. The term 1/8 normalizes the maximum ER value to 4.0. In the skill example above, there were 41 responses to give an ER as shown below:

$$ER = \frac{1}{8}\left[\frac{\left(\frac{41}{41}\right)}{.25} + (3.5 \times 3) + 2.5 + 2.7 + (3.2 \times 2)\right]$$

$$= 3.3$$

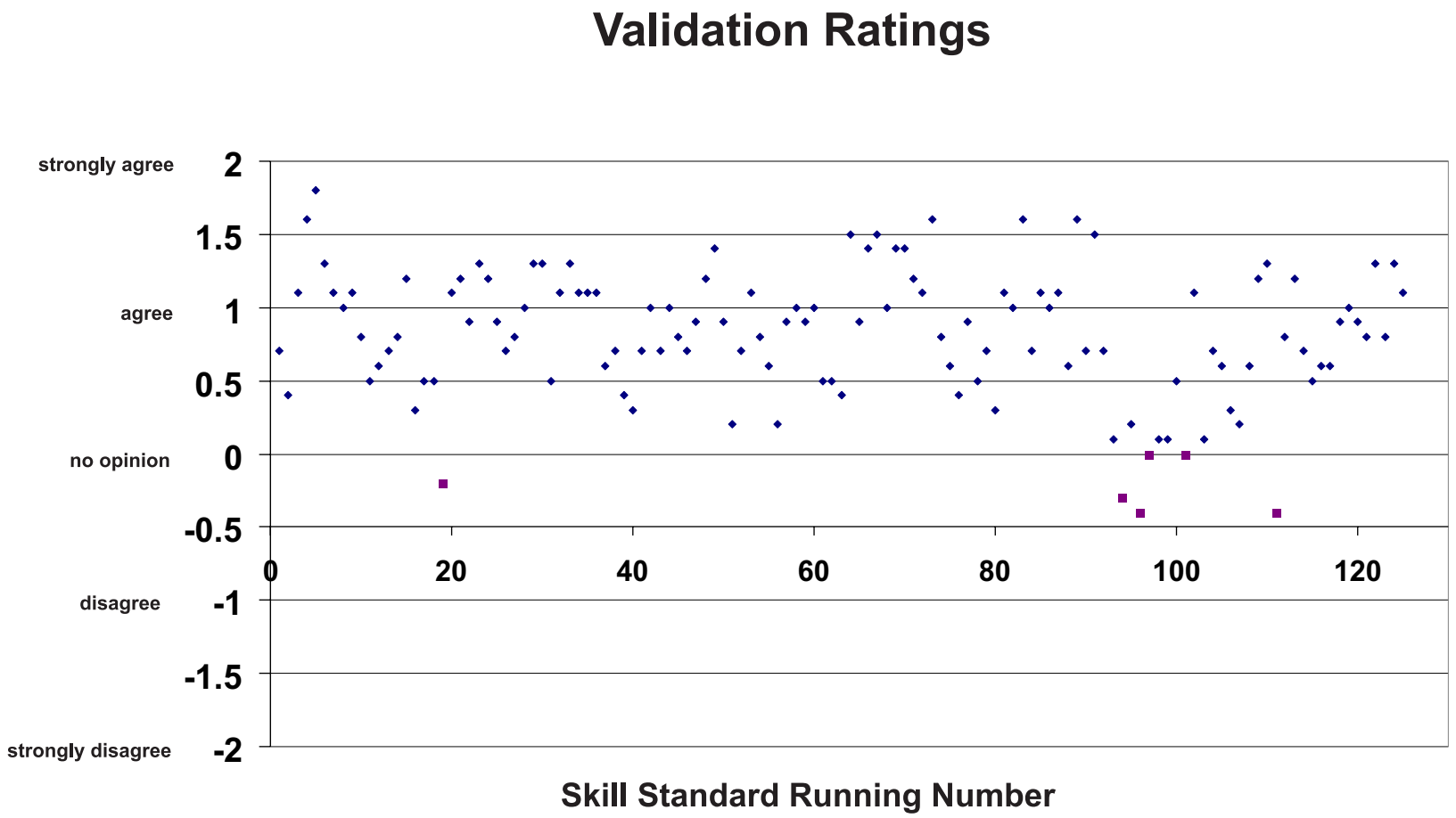
In the process of creating the skill standards, those skills with ER's of less than 2.0 were not considered.

Appendix A - Performance Criteria Ranking

Appendix B - Validation Data

Validation Data

The skill standards as stated were reviewed for agreement by industry subject matter experts. Using a Likert Scale (-2 = strongly disagree, -1 = disagree, 0 = no opinion, +1 = agree, +2 = strongly agree). The average rating for all the statements is shown on the graph at right. The skill standard statements (six in total) that had a rating ≤ 0 were not included in the final list.


Validation Ratings
strongly agree
agree
no opinion
disagree
strongly disagree
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
20
40
60
80
100
120
Skill Standard Running Number

Appendix C - Glossary and Acronyms

According to Specification
: A defined specification which will vary depending on the learning and training environment. May be manufacturers' specifications or specifications identified in learning materials.

BOE
: Buffered Oxide Etch

Control Chart
: Used in Statistical Process Control; contains upper and lower control limits, mean, a series of data points and description of parameter being tracked.

CVD
: Chemical Vapor Deposition

DI
: De-Ionized

EBR
: Edge Bead Removal

Equipment Training Device
: Equipment consisting of sufficient components and devices (real or simulated) to enable the learner to demonstrate the skill or knowledge required.

ESD
: Electro-Static Discharge

Flow Chart
: A diagram illustrating a process or procedure which often contains inputs, action steps, decision points and outputs.

Maintenance Record Form
: A form (soft copy or hard copy) for recording actions, readings and comments used to document maintenance tasks.

MSDS
: Material Safety Data Sheet

OSHA
: U.S. government agency “Occupational Safety and Health Administration.”Proven Techniques
Techniques that have become accepted standards in the industry and classroom learning environments.

QC
: Quality Control

RF
: Radio Frequency

Scenario
: A plausible situation designed to enable proof of compliance with a standard.

SPC
: Statistical Process Control

Appendix D - About the Sponsors

Maricopa Advanced Technology Education Center (MATEC)

Established in 1996, the Maricopa Advanced Technology Education Center (MATEC) is a National Science Foundation (NSF) funded National Center of Excellence. MATEC is intended to be a permanent center for education and workforce development in the semiconductor industry. MATEC provides the key elements that lead to lifelong learning and success for participants who plan to enter and work in the semiconductor industry.

Technician Performance Improvement Council (TPIC)

The TPIC, formerly known as the Technician Training Council, acts as a catalyst to influence the application of effective learning models that support strategic development of semiconductor process and equipment technician training. Council members include technician training professionals from SEMATECH and SEMI/SEMATECH member companies. Much of the council's work is accomplished through task forces which take on projects of relevance to the industry as a whole. Task force results are presented to the general membership and if appropriate are published as technical documents for dissemination.