Nanotechnology Technician Skill Standards

TEXAS WORKFORCE INVESTMENT COUNCIL

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Critical Work Function	Key Activity	Key Activity	Key Activity	Key Activity	Key Activity
1. Build Nanotechnology Systems ***(such as probing systems and nanolithography systems)***	1.1 Prepare parts for in-house assembly of system	1.2 Build subsystems for in-house assembly of complete system	1.3 Test subsystem components in house	1.4 Assemble system in house	
2. Install Nanotechnology Systems ***(such as probing systems and nanolithography systems)***	2.1 Prepare parts for on-site assembly of system	2.2 Build subsystems for onsite assembly of complete system	2.3 Test subsystem components on site	2.4 Assemble and install system on site	
3. Maintain and Repair Nanotechnology Equipment ***(such as probing systems and nanolithography systems)***	3.1 Perform preventive maintenance	3.2 Diagnose malfunctions	3.3 Repair malfunctions		
4. Support Nano-scale Product Development ***(such as semiconductor device fabrication or integrating nano-materials into a variety of customer applications)***	4.1 Characterize nano-scale materials	4.2 Perform incoming quality control	4.3 Perform product research	4.4 Design prototypes	4.5 Evaluate prototypes
5. Manufacture Nano-scale Product ***(such as semiconductor device fabrication or integrating nano-materials into a variety of customer applications)***	5.1 Control environment	5.2 Operate manufacturing equipment	5.3 Operate test equipment		

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Occupational Title: Nanotechnology Technician			
Critical Work Function 1. Build Nanotechnology Systems		**Occupational Skills, Knowledge & Conditions**	
Key Activity	**Performance Criteria** *How do we know when the key activity is performed well or performed successfully?*	**Occupational Skills & Knowledge** *What should the technician know and what skills should the technician have in order to do the activity?*	**Conditions** *What tools must the technician use in order to do the activity?*
1.1 Prepare parts for in-house assembly of system	1.1.1 Preparation meets procedural requirements including verification of customer requirements, adequate process planning and review of assembly drawings 1.1.2 Parts appropriate to the system being assembled are selected for use 1.1.3 Materials appropriate to the system being assembled are selected for use	Understanding the importance of variance reporting Mechanical precision to the nano scale Volumetric measurement to the nano scale Crystallography and metallurgy Toughness, strength, and ductility of materials Use of measuring instruments and tools Unit conversion Ability to read mechanical drawings Understanding of industry reference materials Understanding of ISO 9000 Understanding of geometric dimensions and tolerances Knowledge of HAZMAT procedures	Semiconductor manufacturing equipment Computer software (word processing, spreadsheet, database, presentation, email, etc.) Reference handbooks Lab equipment (materials testing, etc.)

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Occupational Title: Nanotechnology Technician			
Critical Work Function 1. Build Nanotechnology Systems		**Occupational Skills, Knowledge & Conditions**	
Key Activity	**Performance Criteria** *How do we know when the key activity is performed well or performed successfully?*	**Occupational Skills & Knowledge** *What should the technician know and what skills should the technician have in order to do the activity?*	**Conditions** *What tools must the technician use in order to do the activity?*
1.2 Build subsystems for in-house assembly of complete system	1.2.1 Subsystems are assembled and integrated according to specifications 1.2.2 Tools appropriate to the system or subsystem being assembled and integrated are selected for use. 1.2.3 Tools are used according to established procedures	Understanding the importance of variance reporting Semiconductor manufacturing processes High precision electrical measurements Crystallography and metallurgy Toughness, strength and ductility of materials Microscopy and spectroscopy Use of measuring instruments and tools Unit conversion Ability to use vacuum systems Ability to gauge repeatability and reproducibility Ability to read mechanical drawings Understanding of industry reference materials Understanding of ISO 9000 Understanding of geometric dimensions and tolerances Knowledge of HAZMAT procedures	Advanced optical microscopes Semiconductor manufacturing equipment Computer software (word processing, spreadsheet, database, presentation, email, etc.) Reference handbooks Oscilloscope Voltmeter Microbalance Instrument interface software Personal protective equipment

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Occupational Title: Nanotechnology Technician			
Critical Work Function 1. Build Nanotechnology Systems		**Occupational Skills, Knowledge & Conditions**	
Key Activity	**Performance Criteria** *How do we know when the key activity is performed well or performed successfully?*	**Occupational Skills & Knowledge** *What should the technician know and what skills should the technician have in order to do the activity?*	**Conditions** *What tools must the technician use in order to do the activity?*
1.3 Test subsystem components in house	1.3.1 Tests verify system components are operating properly 1.3.2 Test results are properly documented 1.3.3 Non-conforming product is properly quarantined	Understanding of the importance of variance reporting Volumetric measurement to the nano scale High precision electrical measurements Crystallography and metallurgy Toughness, strength, and ductility of materials Microscopy and spectroscopy Use of measuring instruments and tools Nano scale metrology Unit conversion Ability to use vacuum systems Ability to gauge repeatability and reproducibility Ability to read mechanical drawings Understanding of industry reference materials Understanding of ISO 9000 Understanding of geometric dimensions and tolerances	Advanced optical microscopes Scanning probe microscopes Thin-film measurement equipment: profilometers and ellipsometers to the nano scale Spectrophotometer Laser interferometer Computer software (word processing, spreadsheet, database, presentation, email, etc.) Lab equipment Oscilloscope Voltmeter Microbalance Frequency generator Instrument interface software Personal protective equipment
1.4 Assemble system in house	1.4.1 Testing verifies proper operation of system components, integration of control systems, and the operation of the system interface 1.4.2 Assembled system meets manufacturer performance specifications 1.4.3 Customer acceptance is documented according to company procedure 1.4.4 Post-delivery support is provided according to procedure	Understanding of the importance of variance reporting Unit conversion Ability to read mechanical drawings Understanding of ISO 9000 Understanding of geometric dimensions and tolerances	Computer software (word processing, spreadsheet, database, presentation, email, etc.) Reference handbooks Lab equipment (materials testing, etc.) Instrument interface software Personal protective equipment

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Academic and Employability Knowledge and Skill Matrix for Critical Work Function 1: Build Nanotechnology Systems

On a scale of 1 (lowest) to 5 (highest), identify the level of complexity required in each of these skills for the worker to perform the critical work function. Keep in mind that this scale is not for rating an individual's proficiency. It is intended only for rating the level of complexity required to do the work.

Occupational Title: Nanotechnology Technician																
CWF 1 Build Nanotechnology Systems																
Listening	Speaking	Using Information and Communication Technology	Gathering and analyzing Information	Analyzing and Solving Problems	Making Decisions and Judgments	Organizing and Planning	Using Social Skills	Adaptability	Working in Teams	Leading Others	Building Consensus	Self and Career Development	Writing	Reading	Mathematics	Science
3	3	3	4	4	4	4	3	3	4	4	3	3	2	4	3	3

Statement of Assessment for Critical Work Function 1: Build Nanotechnology Systems

The statements of assessment can do any of several things:

- *Define tools or strategies that industry could use to assess the level of competency a worker has attained in a particular critical work function.*
- *Define for trainers and educators how to assess the level of competency a student has attained relevant to the critical work function.*
- *Define the level of mastery of the critical work function that indicates that a worker or student has achieved an entry-, intermediate-, or advanced level of mastery of a critical work function.*

A. Tests could include:

1) Multiple choice and essay questions that demonstrate an understanding of knowledge being assessed.
2) Preparation and justification of a reasonable solution to a problem scenario.

B. Hands-on exercises or simulations to demonstrate acquisition of knowledge and skills that could:

1) Apply relevant knowledge or skills
2) Focus on the application of knowledge and skills to a new situation
3) Demonstrate an ability to plan, organize, and create a product, service, or an event.
4) Illustrate by individual performance the attained levels of knowledge and skills.
5) Include observation of events, groups, and individuals that focuses on the relevant traits of the skill in question

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Occupational Title: Nanotechnology Technician			
Critical Work Function 2. Install Nanotechnology Systems		**Occupational Skills, Knowledge & Conditions**	
Key Activity	**Performance Criteria** *How do we know when the key activity is performed well or performed successfully?*	**Occupational Skills & Knowledge** *What should the technician know and what skills should the technician have in order to do the activity?*	**Conditions** *What tools must the technician use in order to do the activity?*
2.1 Prepare parts for on-site assembly of system	2.1.1 Preparation meets procedural requirements including verification of customer requirements, adequate process planning and review of assembly drawings 2.1.2 Parts appropriate to the system being assembled are selected for use 2.1.3 Site survey is complete, indicates site is appropriate for installation 2.1.4 Site preparation is complete for installation	Understand the importance of variance reporting Semiconductor manufacturing processes High precision electrical measurements Crystallography and metallurgy Toughness, strength, and ductility of materials Use of measuring instruments and tools Unit conversion Ability to read mechanical drawings Understanding of industry reference materials Understanding of ISO 9000 Understanding of geometric dimensions and tolerances Knowledge of HAZMAT procedures	Computer software (word processing, spreadsheet, database, presentation, email, etc.) Reference handbooks Lab equipment (materials testing, etc.) Instrument interface software Personal protective equipment

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Occupational Title: Nanotechnology Technician			
Critical Work Function 2. Install Nanotechnology Systems		**Occupational Skills, Knowledge & Conditions**	
Key Activity	**Performance Criteria** *How do we know when the key activity is performed well or performed successfully?*	**Occupational Skills & Knowledge** *What should the technician know and what skills should the technician have in order to do the activity?*	**Conditions** *What tools must the technician use in order to do the activity?*
2.2 Build subsystems for onsite assembly of complete system	2.2.1 Subsystems are assembled and integrated according to specifications 2.2.2 Tools appropriate to the system or subsystem being assembled and integrated are selected for use. 2.2.3 Tools are used according to established procedures	Understand the importance of variance reporting High precision electrical measurements Use of measuring instruments and tools Unit conversion Ability to gauge repeatability and reproducibility Ability to read mechanical drawings Understanding of industry reference materials Understanding of ISO 9000 Understanding of geometric dimensions and tolerances Knowledge of HAZMAT procedures	Advanced optical microscopes Computer software (word processing, spreadsheet, database, presentation, email, etc.) Reference handbooks Lab equipment Oscilloscope Voltmeter Instrument interface software Personal protective equipment

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Occupational Title: Nanotechnology Technician			
Critical Work Function 2. Install Nanotechnology Systems		**Occupational Skills, Knowledge & Conditions**	
Key Activity	**Performance Criteria** *How do we know when the key activity is performed well or performed successfully?*	**Occupational Skills & Knowledge** *What should the technician know and what skills should the technician have in order to do the activity?*	**Conditions** *What tools must the technician use in order to do the activity?*
2.3 Test subsystem components on site	2.3.1 Tests verify system components are operating properly 2.3.2 Test results are properly documented 2.3.3 Non-conforming product is repaired or replaced	Understanding of statistical process control Understanding the importance of variance reporting Mechanical precision to the nano scale High precision electrical measurements Microscopy and spectroscopy Use of measuring instruments and tools Nano scale metrology Unit conversion Ability to use vacuum systems Ability to gauge repeatability and reproducibility Ability to read mechanical drawings Understanding of industry reference materials Understanding of ISO 9000 Understanding of geometric dimensions and tolerances Knowledge of HAZMAT procedures	Advanced optical microscopes Scanning probe microscopes Thin-film measurement equipment Spectrophotometer Laser interferometer Computer software (word processing, spreadsheet, database, presentation, email, etc.) Reference handbooks Lab equipment Oscilloscope Voltmeter Frequency generator Instrument interface software Personal protective equipment

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Occupational Title: Nanotechnology Technician			
Critical Work Function 2. Install Nanotechnology Systems		**Occupational Skills, Knowledge & Conditions**	
Key Activity	**Performance Criteria** *How do we know when the key activity is performed well or performed successfully?*	**Occupational Skills & Knowledge** *What should the technician know and what skills should the technician have in order to do the activity?*	**Conditions** *What tools must the technician use in order to do the activity?*
2.4 Assemble and install system on site	2.4.1 Testing verifies proper operation of system components, integration of control systems, and the operation of the system interface 2.4.2 Assembled and installed system meets manufacturer specifications 2.4.3 Customer acceptance of the installed system is documented according to company procedure	Understanding the importance of variance reporting Use of measuring instruments and tools Unit conversion Ability to read mechanical drawings Understanding of industry reference materials Understanding of ISO 9000 Understanding of geometric dimensions and tolerances Knowledge of HAZMAT procedures	Computer software (word processing, spreadsheet, database, presentation, email, etc.) Reference handbooks Lab equipment Instrument interface software Personal protective equipment

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Academic and Employability Knowledge and Skill Matrix for Critical Work Function 2: Install Nanotechnology Systems

On a scale of 1 (lowest) to 5 (highest), identify the level of complexity required in each of these skills for the worker to perform the critical work function. Keep in mind that this scale is not for rating an individual's proficiency. It is intended only for rating the level of complexity required to do the work.

Occupational Title: Nanotechnology Technician																
CWF 2 Install Nanotechnology Systems																
Listening	Speaking	Using Information and Communication Technology	Gathering and analyzing Information	Analyzing and Solving Problems	Making Decisions and Judgments	Organizing and Planning	Using Social Skills	Adaptability	Working in Teams	Leading Others	Building Consensus	Self and Career Development	Writing	Reading	Mathematics	Science
4	4	4	3	4	4	4	4	4	4	4	4	3	3	4	4	3

Statement of Assessment for Critical Work Function 2: Install Nanotechnology Systems

The statements of assessment can do any of several things:

- *Define tools or strategies that industry could use to assess the level of competency a worker has attained in a particular critical work function.*
- *Define for trainers and educators how to assess the level of competency a student has attained relevant to the critical work function.*
- *Define the level of mastery of the critical work function that indicates that a worker or student has achieved an entry-, intermediate-, or advanced level of mastery of a critical work function.*

A. Tests could include:

1) Multiple choice and essay questions that demonstrate an understanding of knowledge being assessed.
2) Preparation and justification of a reasonable solution to a problem scenario.

B. Hands-on exercises or simulations to demonstrate acquisition of knowledge and skills that could:

1) Apply relevant knowledge or skills
2) Focus on the application of knowledge and skills to a new situation
3) Demonstrate an ability to plan, organize, and create a product, service, or an event.
4) Illustrate by individual performance the attained levels of knowledge and skills
5) Include observation of events, groups, and individuals that focuses on the relevant traits of the skill in question

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Occupational Title: Nanotechnology Technician			
Critical Work Function 3. Maintain and Repair Nanotechnology Equipment		**Occupational Skills, Knowledge & Conditions**	
Key Activity	**Performance Criteria** *How do we know when the key activity is performed well or performed successfully?*	**Occupational Skills & Knowledge** *What should the technician know and what skills should the technician have in order to do the activity?*	**Conditions** *What tools must the technician use in order to do the activity?*
3.1 Perform preventive maintenance	3.1.1 Maintenance record meets preventive maintenance (PM) program requirements for timeliness and frequency as required by manufacturer specification. 3.1.2 Maintenance record is complete and current	Understanding the importance of variance reporting Semiconductor manufacturing processes Volumetric measurement to the nano scale High precision electrical measurements Crystallography and metallurgy Toughness, strength, and ductility of materials Microscopy and spectroscopy Use of measuring instruments and tools Ability to use vacuum systems Ability to gauge repeatability and reproducibility Ability to read mechanical drawings Understanding of industry reference materials Understanding of ISO 9000 Understanding of geometric dimensions and tolerances Knowledge of HAZMAT procedures	Advanced optical microscopes Scanning probe microscopes Thin-film measurement equipment Computer software (word processing, spreadsheet, database, presentation, email, etc.) Reference handbooks Lab equipment Oscilloscope Voltmeter Microbalance Frequency generator Instrument interface software Personal protective equipment

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Occupational Title: Nanotechnology Technician			
Critical Work Function 3. Maintain and Repair Nanotechnology Equipment		**Occupational Skills, Knowledge & Conditions**	
Key Activity	**Performance Criteria** *How do we know when the key activity is performed well or performed successfully?*	**Occupational Skills & Knowledge** *What should the technician know and what skills should the technician have in order to do the activity?*	**Conditions** *What tools must the technician use in order to do the activity?*
3.2 Diagnose malfunctions	3.2.1 Tests are performed in attempt to duplicate problem with results documented 3.2.2 Anomalies are accurately characterized and documented 3.2.3 Malfunction is identified and recorded	Understanding the importance of variance reporting Mechanical precision to the nano scale High precision electrical measurements Microscopy and spectroscopy Use of measuring instruments and tools Unit conversion Ability to use vacuum systems Ability to gauge repeatability and reproducibility Ability to read mechanical drawings Understanding of industry reference materials Understanding of geometric dimensions and tolerances	Advanced optical microscopes Scanning probe microscopes Thin-film measurement equipment Spectrophotometer Laser interferometer X-ray (fluorescence and diffraction) Computer software (word processing, spreadsheet, database, presentation, email, etc.) Reference handbooks Lab equipment Oscilloscope Voltmeter Microbalance Frequency generator Instrument interface software Personal protective equipment

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Occupational Title: Nanotechnology Technician			
Critical Work Function 3. Maintain and Repair Nanotechnology Equipment		**Occupational Skills, Knowledge & Conditions**	
Key Activity	**Performance Criteria** *How do we know when the key activity is performed well or performed successfully?*	**Occupational Skills & Knowledge** *What should the technician know and what skills should the technician have in order to do the activity?*	**Conditions** *What tools must the technician use in order to do the activity?*
3.3 Repair malfunctions	3.3.1 Appropriate tools are selected for the repair 3.3.2 Repairs are resolved per manufacturer specification 3.3.3 Service report is prepared for customer according to policy 3.3.4 Maintenance record is complete and current	Understanding the importance of variance reporting Mechanical precision to the nano scale Volumetric measurement to the nano scale High precision electrical measurements Crystallography and metallurgy Toughness, strength, and ductility of materials Microscopy and spectroscopy Use of measuring instruments and tools Nano scale metrology Unit conversion Ability to use vacuum systems Ability to gauge repeatability and reproducibility Ability to read mechanical drawings Understanding of ISO 9000 Understanding of geometric dimensions and tolerances Knowledge of HAZMAT procedures	Computer software (word processing, spreadsheet, database, presentation, email, etc.) Reference handbooks Lab equipment Oscilloscope Voltmeter Instrument interface software Personal protective equipment

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Academic and Employability Knowledge and Skill Matrix for Critical Work Function 3: Maintain and Repair Nanotechnology Equipment

On a scale of 1 (lowest) to 5 (highest), identify the level of complexity required in each of these skills for the worker to perform the critical work function. Keep in mind that this scale is not for rating an individual's proficiency. It is intended only for rating the level of complexity required to do the work.

Occupational Title: Nanotechnology Technician																
CWF 3 Maintain and Repair Nanotechnology Equipment																
Listening	Speaking	Using Information and Communication Technology	Gathering and analyzing Information	Analyzing and Solving Problems	Making Decisions and Judgments	Organizing and Planning	Using Social Skills	Adaptability	Working in Teams	Leading Others	Building Consensus	Self and Career Development	Writing	Reading	Mathematics	Science
3	3	3	4	5	4	4	4	4	4	4	4	3	3	4	4	4

Statement of Assessment for Critical Work Function 3: Maintain and Repair Nanotechnology Equipment

The statements of assessment can do any of several things:

- *Define tools or strategies that industry could use to assess the level of competency a worker has attained in a particular critical work function.*
- *Define for trainers and educators how to assess the level of competency a student has attained relevant to the critical work function.*
- *Define the level of mastery of the critical work function that indicates that a worker or student has achieved an entry-, intermediate-, or advanced level of mastery of a critical work function.*

A. Tests could include:

1) Multiple choice and essay questions that demonstrate an understanding of knowledge being assessed.
2) Preparation and justification of a reasonable solution to a problem scenario.

B. Hands-on exercises or simulations to demonstrate acquisition of knowledge and skills that could:

1) Apply relevant knowledge or skills
2) Focus on the application of knowledge and skills to a new situation
3) Demonstrate an ability to plan, organize, and create a product, service, or an event.
4) Illustrate by individual performance the attained levels of knowledge and skills
5) Include observation of events, groups, and individuals that focuses on the relevant traits of the skill in question

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Occupational Title: Nanotechnology Technician			
Critical Work Function 4. Support Nano-scale Product Development		**Occupational Skills, Knowledge & Conditions**	
Key Activity	**Performance Criteria** *How do we know when the key activity is performed well or performed successfully?*	**Occupational Skills & Knowledge** *What should the technician know and what skills should the technician have in order to do the activity?*	**Conditions** *What tools must the technician use in order to do the activity?*
4.1 Characterize nano-scale materials	4.1.1 Sample is appropriately prepared for processing 4.1.2 Sample data is collected, analyzed, and results are documented as required by procedure 4.1.3 Statistical process control is developed as required 4.1.4 Data anomalies are characterized and accurately documented 4.1.5 Analysis findings are reported and documented according to procedure	Understanding of statistical process control Understanding the importance of variance reporting Mechanical precision to the nano scale Volumetric measurement to the nano scale High precision electrical measurements Crystallography and metallurgy Toughness, strength, and ductility of materials Microscopy and spectroscopy Familiarity with quantum effects Use of measuring instruments and tools Nano scale metrology Unit conversion Ability to use vacuum systems Ability to gauge repeatability and reproducibility Understanding of industry reference materials Understanding of ISO 9000 Understanding of geometric dimensions and tolerances Knowledge of HAZMAT procedures	Advanced optical microscopes Scanning probe microscopes Semiconductor manufacturing equipment Thin-film measurement equipment Spectrophotometer Laser interferometer X-ray (fluorescence and diffraction) Computer software (word processing, spreadsheet, database, presentation, email, etc.) Reference handbooks Lab equipment Voltmeter Microbalance Instrument interface software Personal protective equipment

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Occupational Title: Nanotechnology Technician			
Critical Work Function 4. Support Nano-scale Product Development		**Occupational Skills, Knowledge & Conditions**	
Key Activity	**Performance Criteria** *How do we know when the key activity is performed well or performed successfully?*	**Occupational Skills & Knowledge** *What should the technician know and what skills should the technician have in order to do the activity?*	**Conditions** *What tools must the technician use in order to do the activity?*
4.2 Perform incoming quality control	4.2.1 Supplier approval is verified with proper documentation 4.2.2 Document audit is conducted and verifies that material meets specifications 4.2.3 Sampling verifies material meets specifications	Understanding of statistical process control Understanding the importance of variance reporting Mechanical precision to the nano scale Volumetric measurement to the nano scale High precision electrical measurements Crystallography and metallurgy Toughness strength and ductility of materials Microscopy and spectroscopy Use of measuring instruments and tools Nano scale metrology Unit conversion Ability to gauge repeatability and reproducibility Understanding of industry reference materials Understanding of ISO 9000 Understanding of geometric dimensions and tolerances Knowledge of HAZMAT procedures	Advanced optical microscopes Scanning probe microscopes Thin-film measurement equipment Spectrophotometer X-ray Computer software (word processing, spreadsheet, database, presentation, email, etc.) Reference handbooks Lab equipment Oscilloscope Voltmeter Microbalance Personal protective equipment

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Occupational Title: Nanotechnology Technician			
Critical Work Function 4. Support Nano-scale Product Development		**Occupational Skills, Knowledge & Conditions**	
Key Activity	**Performance Criteria** *How do we know when the key activity is performed well or performed successfully?*	**Occupational Skills & Knowledge** *What should the technician know and what skills should the technician have in order to do the activity?*	**Conditions** *What tools must the technician use in order to do the activity?*
4.3 Perform product research	4.3.1 Product under development meets customer needs or specifications 4.3.2 Research results appropriately documented from start of research to finish, including full analysis of failures 4.3.3 Proper use of design of experiments	Semiconductor manufacturing processes Crystallography and metallurgy Toughness, strength, and ductility of materials Familiarity with quantum effects Unit conversion Understanding of industry reference materials Understanding of geometric dimensions and tolerances Knowledge of HAZMAT procedures	Advanced optical microscopes Scanning probe microscopes Thin-film measurement equipment Spectrophotometer X-ray Computer software (word processing, spreadsheet, database, presentation, email, etc.) Reference handbooks Lab equipment Microbalance Instrument interface software Personal protective equipment

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Occupational Title: Nanotechnology Technician			
Critical Work Function 4. Support Nano-scale Product Development		**Occupational Skills, Knowledge & Conditions**	
Key Activity	**Performance Criteria** *How do we know when the key activity is performed well or performed successfully?*	**Occupational Skills & Knowledge** *What should the technician know and what skills should the technician have in order to do the activity?*	**Conditions** *What tools must the technician use in order to do the activity?*
4.4 Design prototypes	4.4.1 Customer requirements are clarified and documented, as appropriate 4.4.2 Prototype performs to expectation and specification	Understanding of design of experiments Understanding the importance of variance reporting Semiconductor manufacturing processes Mechanical precision to the nano scale Volumetric measurement to the nano scale High precision electrical measurements Crystallography and metallurgy Toughness, strength, and ductility of materials Microscopy and spectroscopy Familiarity with quantum effects Use of measuring instruments and tools Nano scale metrology Unit conversion Ability to use vacuum systems Ability to gauge repeatability and reproducibility Ability to read mechanical drawings Understanding of industry reference materials Understanding of ISO 9000 Understanding of geometric tolerances Knowledge of HAZMAT procedures	Computer software (word processing, spreadsheet, database, presentation, email, etc.) Reference handbooks Instrument interface software

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Occupational Title: Nanotechnology Technician			
Critical Work Function 4. Support Nano-scale Product Development		**Occupational Skills, Knowledge & Conditions**	
Key Activity	**Performance Criteria** *How do we know when the key activity is performed well or performed successfully?*	**Occupational Skills & Knowledge** *What should the technician know and what skills should the technician have in order to do the activity?*	**Conditions** *What tools must the technician use in order to do the activity?*
4.5 Evaluate prototypes	4.5.1 Evaluation findings are reported and documented according to procedure 4.5.2 Appropriate analytical equipment is selected for the task 4.5.3 Prototype performs to expectation and specification	Understanding of design of experiments Understanding the importance of variance reporting Semiconductor manufacturing processes Mechanical precision to the nano scale High precision electrical measurements Crystallography and metallurgy Toughness, strength, and ductility of materials Microscopy and spectroscopy Familiarity with quantum effects Use of measuring instruments and tools Nano scale metrology Unit conversion Ability to use vacuum systems Ability to gauge repeatability and reproducibility Ability to read mechanical drawings Understanding of industry reference materials Understanding of ISO 9000 Understanding of geometric dimensions and tolerances Knowledge of HAZMAT procedures	Advanced optical microscopes Scanning probe microscopes Thin-film measurement equipment Spectrophotometer Laser interferometer X-ray Computer software (word processing, spreadsheet, database, presentation, email, etc.) Lab equipment Oscilloscope Voltmeter Microbalance Frequency generator Instrument interface software Personal protective equipment

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Academic and Employability Knowledge and Skill Matrix for Critical Work Function 4: Support Nano-scale Product Development

On a scale of 1 (lowest) to 5 (highest), identify the level of complexity required in each of these skills for the worker to perform the critical work function. Keep in mind that this scale is not for rating an individual's proficiency. It is intended only for rating the level of complexity required to do the work.

Occupational Title: Nanotechnology Technician																
CWF 4 Support Nano-scale Product Development																
Listening	Speaking	Using Information and Communication Technology	Gathering and analyzing Information	Analyzing and Solving Problems	Making Decisions and Judgments	Organizing and Planning	Using Social Skills	Adaptability	Working in Teams	Leading Others	Building Consensus	Self and Career Development	Writing	Reading	Mathematics	Science
4	4	3	4	5	4	3	3	4	4	4	4	3	4	4	4	5

Statement of Assessment for Critical Work Function 4: Support Nano-scale Product Development

The statements of assessment can do any of several things:

- *Define tools or strategies that industry could use to assess the level of competency a worker has attained in a particular critical work function.*
- *Define for trainers and educators how to assess the level of competency a student has attained relevant to the critical work function.*
- *Define the level of mastery of the critical work function that indicates that a worker or student has achieved an entry-, intermediate-, or advanced level of mastery of a critical work function.*

A. Tests could include:

1) Multiple choice and essay questions that demonstrate an understanding of knowledge being assessed.
2) Preparation and justification of a reasonable solution to a problem scenario.

B. Hands-on exercises or simulations to demonstrate acquisition of knowledge and skills that could:

1) Apply relevant knowledge or skills
2) Focus on the application of knowledge and skills to a new situation
3) Demonstrate an ability to plan, organize, and create a product, service, or an event.
4) Illustrate by individual performance the attained levels of knowledge and skills
5) Include observation of events, groups, and individuals that focuses on the relevant traits of the skill in question

Occupational Title: Nanotechnology Technician			
Critical Work Function 5. Manufacture Nano-scale Product		**Occupational Skills, Knowledge & Conditions**	
Key Activity	**Performance Criteria** *How do we know when the key activity is performed well or performed successfully?*	**Occupational Skills & Knowledge** *What should the technician know and what skills should the technician have in order to do the activity?*	**Conditions** *What tools must the technician use in order to do the activity?*
5.1 Control environment	5.1.1 Charts or data show that environmental conditions are monitored and controlled to stay within specifications and tolerances for qualities such as temperature, vibration, airborne contaminants, and electromagnetic discharge, quality or condition of source power 5.1.2 Final product passes quality control tests	Understanding of statistical process control Understanding the importance of variance reporting Use of measuring instruments and tools Unit conversion Understanding of industry reference materials Understanding of ISO 9000 Knowledge of HAZMAT procedures	Computer software (word processing, spreadsheet, database, presentation, email, etc.) Reference handbooks Lab equipment Oscilloscope Voltmeter Instrument interface software Personal protective equipment
5.2 Operate manufacturing equipment	5.2.1 Appropriate process flow is identified and followed according to procedure 5.2.2 Components appropriate to the process are put to use 5.2.3 Processes such as material deposition or pattern transfers are executed within specification 5.2.4 Device or product is assembled using the specified components and packaged according to specification 5.2.5 Manufactured devices test out within performance specifications, and within expected failure percentages 5.2.6 Statistical process control is used appropriately, data is updated in a timely manner, charts are continuously reviewed, and control actions are documented	Understanding of statistical process control Understanding the importance of variance reporting Semiconductor manufacturing processes Mechanical precision to the nano scale High precision electrical measurements Crystallography and metallurgy Microscopy and spectroscopy Use of measuring instruments and tools Ability to use vacuum systems Ability to gauge repeatability and reproducibility Ability to read mechanical drawings Understanding of ISO 9000 Understanding of geometric dimensions and tolerances Knowledge of HAZMAT procedures	Semiconductor manufacturing equipment Computer software (word processing, spreadsheet, database, presentation, email, etc.) Reference handbooks Lab equipment Instrument interface software Personal protective equipment

NANOTECHNOLOGY TECHNICIAN SKILL STANDARDS

Occupational Title: Nanotechnology Technician			
Critical Work Function 5. Manufacture Nano-scale Product		**Occupational Skills, Knowledge & Conditions**	
Key Activity	**Performance Criteria** *How do we know when the key activity is performed well or performed successfully?*	**Occupational Skills & Knowledge** *What should the technician know and what skills should the technician have in order to do the activity?*	**Conditions** *What tools must the technician use in order to do the activity?*
5.3 Operate test equipment	5.3.1 Tests are conducted according to established procedure 5.3.2 Excessive test failures are identified and reported according to procedure 5.3.3 Test equipment is calibrated according to schedule and records are current 5.3.4 Analysis of test results are effectively communicated to ensure manufacturing process parameters are maintained	Knowledge of statistical process control Understanding the importance of variance reporting Volumetric measurement to the nano scale High precision electrical measurements Microscopy and spectroscopy Use of measuring instruments and tools Unit conversion Ability to use vacuum systems Ability to gauge repeatability and reproducibility Understanding of industry reference materials Understanding of ISO 9000 Understanding of HAZMAT procedures	Advanced optical microscopes Scanning probe microscopes Thin-film measurement equipment Spectrophotometer Laser interferometer X-ray Computer software (word processing, spreadsheet, database, presentation, email, etc.) Reference handbooks Lab equipment Oscilloscope Voltmeter Microbalance Instrument interface software Personal protective equipment

Academic and Employability Knowledge and Skill Matrix for Critical Work Function 5: Manufacture Nano-scale Product

On a scale of 1 (lowest) to 5 (highest), identify the level of complexity required in each of these skills for the worker to perform the critical work function. Keep in mind that this scale is not for rating an individual's proficiency. It is intended only for rating the level of complexity required to do the work.

Occupational Title: Nanotechnology Technician																
CWF 5 Manufacture Nano-scale Product																
Listening	Speaking	Using Information and Communication Technology	Gathering and analyzing Information	Analyzing and Solving Problems	Making Decisions and Judgments	Organizing and Planning	Using Social Skills	Adaptability	Working in Teams	Leading Others	Building Consensus	Self and Career Development	Writing	Reading	Mathematics	Science
3	3	3	3	3	3	3	3	3	4	3	3	3	2	3	3	3

Statement of Assessment for Critical Work Function 5: Manufacture Nano-scale Product

The statements of assessment can do any of several things:

- *Define tools or strategies that industry could use to assess the level of competency a worker has attained in a particular critical work function.*
- *Define for trainers and educators how to assess the level of competency a student has attained relevant to the critical work function.*
- *Define the level of mastery of the critical work function that indicates that a worker or student has achieved an entry-, intermediate-, or advanced level of mastery of a critical work function.*

A. Tests could include:

1) Multiple choice and essay questions that demonstrate an understanding of knowledge being assessed.
2) Preparation and justification of a reasonable solution to a problem scenario.

B. Hands-on exercises or simulations to demonstrate acquisition of knowledge and skills that could:

1) Apply relevant knowledge or skills
2) Focus on the application of knowledge and skills to a new situation
3) Demonstrate an ability to plan, organize, and create a product, service, or an event.
4) Illustrate by individual performance the attained levels of knowledge and skills
5) Include observation of events, groups, and individuals that focuses on the relevant traits of the skill in question