

**NANOTECHNOLOGY ENGINEERING TECHNICIAN
(Time-Based)**

APPENDIX A

O*NET-SOC CODE 17-3026.01

This training outline is a minimum standard for Work Processes and Related Instruction. Changes in technology and regulations may result in the need for additional on-the-job or classroom training.

WORK PROCESSES

| | Approximate Hours |
|--|--------------------------|
| A. Workplace Knowledge and Safety | 200 |
| 1. Maintain compliance with all standards of the workplace. | |
| 2. Describe workplace organizational structure. | |
| 3. Understand and follow appropriate workplace policies and procedures, adhering to all local, State, and Federal regulations. | |
| 4. Adhere to Occupational Safety and Health Administration (OSHA) general industry safety standards, including all applicable regulations, policies, and procedures for health, emergency, and environmental compliance. | |
| 5. Demonstrate awareness of emergency procedures. | |
| 6. Accurately follow detailed instructions and procedures. | |
| 7. Able to perform work activities safely and responsibly in compliance with all workplace environment, safety, and health standards and protocols. | |
| B. Quality and Reliability | 1000 |
| 1. Understand corrective or preventative actions to ensure or improve product quality or reliability. | |
| 2. Recognize, develop, implement, or participate in programs to address problems related to production, materials, safety, or quality. | |
| C. Clean Room and Containment Free Manufacturing | 200 |
| 1. Understand and adhere to cleanroom protocols for nanotechnology design and manufacturing, including proper gowning procedures, and equipment and material handling. | |

2. Knowledge of common containment sources and types, which may include human debris, dust, etc.
3. Understand the effects and methods of contamination control in nanotechnology design and manufacturing, such as the importance of wearing required clean room suits, nitrile gloves, facemasks, eyewear, and other personal protective equipment (PPE) to prevent contamination and ensure product quality.
4. Maintain work area according to cleanroom or other processing standards to improve efficiency, safety, and productivity through a clean and orderly environment.

D. Equipment Setup, Operation, and Maintenance

1700

1. Setup, operate, or maintain nanotechnology testing, processing, or production equipment in accordance with appropriate standard procedures, manufacturing practices, hazardous materials restrictions, or health and safety requirements.
2. Identify, report, troubleshoot, or repair nanotechnology processing or testing equipment.
3. Monitor, control, and test semiconductor equipment for manufacturing readiness.
4. Keep concise communication of updates on the status of equipment and area to Lead Technician and/or Engineer.
5. Monitor, sustain, and improve equipment and processes in assigned area while collaborating with production team members and area engineers.
6. Monitor equipment performance and perform preventative and corrective maintenance on assigned tool sets.
7. Apply mechanical, electronic, and computer/software skills to troubleshoot and resolve equipment errors or issues.
8. Recover equipment from process interruptions, complete event documentation, and effectively communicate end of shift pass downs.

E. Prepare, Test, Inspect, Measure, and Assess Results

300

1. Set up and conduct experiments, tests, and analyses, using appropriate techniques and equipment (dependent on automation, technology, and tools per site).
2. Assist nano-scientists or engineers in processing, measuring, or characterizing nano-scale materials or objects according to physical or chemical properties.

3. Utilize measurement tools and techniques such as atomic force microscopy, transmission electron microscopy, scanning electron microscopy, optical microscopy, or particle size analysis.
4. Operate microscopy equipment (e.g., scanning electron microscope) to manipulate nanoscale objects.
5. Inspect or measure thin films using various techniques or analytical tools, such as statistical process control software.
6. Prepare materials for processing, inspection, assessment, or testing.
7. Collaborate with scientists or engineers to design or conduct experiments in developing, building, or testing products, processes, or procedures related to nanotechnology materials, components, structures, devices, or systems.

F. Collect, Analyze, and Report Technical Data

400

1. Collect or compile laboratory test data and perform appropriate analyses.
2. Review data to ensure and verify accuracy and regulatory compliance and investigate or report questionable test results.
3. Interpret test results, compare them to established specifications and control limits, and make recommendations on appropriateness of data for release.
4. Prepare technical reports or documentation such as deviation reports, testing protocols, and trend analyses.
5. Prepare detailed verbal or written presentations for scientists, engineers, project managers, or upper management.
6. Collaborate with nano-scientists or engineers in preparation of capability data, training materials, or other procedural specifications and documentation for transfer of processes to production.

G. Develop, Implement, and Monitor Standards for Products, Processes, or Procedures

500

1. Implement production processes, and operate equipment to produce, test, or modify molecular/macromolecular materials, devices, or systems.

2. Assist in the development or modification of industrial experimental or testing techniques, documentation, routines, or procedures of nanoscale use.
3. Evaluate technologies and procedures for improvement opportunities.
4. Assist engineers in developing, standardizing, or testing new products, processes, or procedures.
5. Develop, inform, or implement programs to address problems related to production, materials, safety, or quality.
6. Implement or inform new or enhanced design, methods, or processes for improved testing, or manufacture of nanotechnology materials or products.
7. Monitor operational and testing processes and procedures to ensure adherence to established standards.
8. Monitor equipment during operation to ensure adherence to specifications for characteristics such as pressure, temperature, or flow.

H. Operational Records

200

1. Understand the critical nature of company information security, such as: privacy, protecting confidential information, assets, online courses, and specific procedures.
2. Utilize processes and procedures that protect and maintain security of proprietary information, including but not limited to any identifying information attached to materials and or containers.
3. Maintain accurate record or batch-record documentation.

I. Leadership and Mentoring

50

1. Demonstrate knowledge and practice of employer's mission, policies, practices, and systems.
2. Ensure team complies with regulatory requirements and policies.
3. Provide support and engage in workplace training activities.
4. Adhere to proper methods for equipment and process-based training.
5. Understand how to communicate with supervisors, co-workers, and team members.

6. Learn to work both independently and collaboratively, and how to provide and receive corrective feedback.

Approximate Total Hours 4,550

Apprenticeship work processes are applicable only to training curricula for apprentices in approved programs. Apprenticeship work processes have no impact on classification determinations under Article 8 or 9 of the Labor Law. For guidance regarding classification for purposes of Article 8 or 9 of the Labor Law, please refer to <https://dol.ny.gov/public-work-and-prevailing-wage>.

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APPENDIX B

RELATED INSTRUCTION

Safety and Health

1. General Workplace Safety
2. First Aid & CPR (minimum 6.5 hours)
3. Personal Protective Equipment (PPE)
4. Right-to-Know/Safety Data Sheets (SDS)
5. Sexual Harassment Prevention – must comply with Section 201-g of the Labor Law
6. Occupational Safety and Health Administration (OSHA) 10-Hour General Industry
7. OSHA 30-Hour General Industry (at option of sponsor)

Trade Theory

1. Quantitative Reasoning
 - a. Interpret Linear and Exponential Models
 - b. Quantitative Reasoning Strategies
 - c. Representations of Numbers and Functions
 - d. Graphs and Data
 - e. Multivariable Relationships
2. Introduction to Semiconductor Technology
 - a. Types of Semiconductor Devices
 - b. Proper Safety Equipment Usage and Procedures
 - c. Contamination (and how to prevent it)
 - d. Time and Frequency Scales of Micro/Nanoelectronics
 - e. Wafer Handling Methods
 - f. Semiconductor Fabrication Processes (Etch, Thin Film Decomposition, Polishing, Implant, Lithography, Crystal growth, Diffusion, Annealing, and Packaging)
 - g. Measurement Tools and Methods
 - h. Testing Processes
 - i. Basic Troubleshooting Topics and Methods
3. Advanced Manufacturing
 - a. Manufacturing Practices and Procedures

- b. Basic Electrical Elements
- c. Chemical/Gas Delivery Safety and Chemical Reactions
- d. Mechatronics Systems
- e. Basic Vacuum Technology
- 4. Introduction to Engineering
 - a. Engineering Applications
 - b. Ethical Principles and Standards
 - c. Design Process and Principles
 - d. Engineering Tools and Practices
- 5. Employer Specific Skills

Trade Science

- 1. Principles, Fabrication Methods, and Applications of Nanotechnology
- 2. Nano/Micro Device Fabrication and Testing
- 3. Nanomaterials
- 4. Nanoelectronics
- 5. Nanomechanics
- 6. Nanophotonics
- 7. Nanoionics
- 8. Physics
- 9. Mathematics
- 10. Materials Science
- 11. Thermodynamics
- 12. Surface Science
- 13. Chemistry and Organic Chemistry
- 14. Biology and Molecular Biology
- 15. Semiconductor Physics
- 16. Principles of Energy Storage
- 17. Principles of Engineering and Molecular Engineering

Additional Topics as Required

A minimum of 144 hours of Related Instruction is required for each Apprentice each year.

Appendix B topics are approved by New York State Education Department.