STANDARDS OF APPRENTICESHIP

DEVELOPED BY

CALIFORNIA ADVANCED MANUFACTURING APPRENTICESHIP COLLABORATIVE (CAMAC)

FOR THE OCCUPATIONS OF

Tool Programmer, Numerical
O*Net-SOC Code: 51-4012 RAPIDs Code: 0690

Numerical Control Machine Operator
O*Net-SOC Code: 51-4011.00 RAPIDs Code: 0845R

Machinist
O*Net-SOC Code: 51-4041.00 RAPIDs Code: 0296

Metal Fabricator
O*Net-SOC Code: 51-2041.00 RAPIDs Code: 0325

Welder, Combination
O*Net-SOC Code: 51-4121.02 RAPIDs Code: 0622R

Welding Machine Operator, ARC
O*Net-SOC Code: 51-4122.01 RAPIDs Code: 0945

Machinist (NIMS Certified)
O*Net-SOC Code: 51-4041.00 RAPIDs Code: 0296CB

Mechatronics Technician
O*Net-SOC Code: 49-2094.00 RAPIDs Code: 2014

Welder, ARC
O*Net-SOC Code: 51-4121.06 RAPIDs Code: 0620

Welder-Fitter
O*Net-SOC Code: 51-4121.06 RAPIDs Code: 0627

Machine Operator I
O*Net-SOC Code: 51-4081.01 RAPIDs Code: 0511

DEVELOPED IN COOPERATION WITH THE U.S. DEPARTMENT OF LABOR
OFFICE OF APPRENTICESHIP

APPROVED BY

BY_____
RICHARD DAVIS, CALIFORNIA STATE DIRECTOR
USDOL OFFICE OF APPRENTICESHIP

DATE MAY 10, 2016

SERVING THE INDUSTRY WITH AN OFFICE OF APPRENTICESHIP (OA) APPROVED PROGRAM

EMPLOYER PARTICIPATION AGREEMENT

The foregoing undersigned Employer hereby subscribes to the provisions of and adopts these Apprenticeship Standards formulated by the California Advanced Manufacturing Apprenticeship Collaborative (CAMAC) and approved by the Office of Apprenticeship. The Sponsoring Employer agrees to carry out the intent and purpose of said standards and to abide by the rules and decisions of the California Advanced Manufacturing Apprenticeship Collaborative (CAMAC) ATC established under these Apprenticeship Standards. The Employer affirms they have been furnished a true copy of the Standards and have read and understood them, and do hereby request registration/certification to train Apprentices under the provisions of these Standards, with all attendant rights and benefits thereof, until cancelled voluntarily or revoked by the Employer, California Advanced Manufacturing Apprenticeship Collaborative (CAMAC) or Registration Agency. On-the-job, the Apprentice is hereby guaranteed assignment to a skilled and competent Mentor and is guaranteed that the work assigned to the Apprentice will be rotated so as to ensure training in all phases of work. This form must be signed and returned to CAMAC and the Registration Agency (in turn) for the Employer's apprenticeship program to be registered and become effective.

Sponsoring Employer

Name of Company:_____Federal Tax ID Number_____

Company Representative (Typed) Name_____

Title:_____

Address:_____

City/State/Zip Code:_____

Phone Number:_____Email:_____

Mentor Wage(s) _____

Percent of Minimum Mentor Wage (As Applicable)

1st Level _____% 2nd Level_____% 3rd level_____%
4th Level _____% 5th Level_____% 6th level_____%
7th Level _____% 8th Level_____%

Total Workforce, including non-AM professionals _____

Total Mentor Workers Employed: _____ *Female* _____*Minority*_____

Total Apprentices (to be) Employed in 1st Year _____

Signature _____Date:_____
****

Reviewed and Approved by:

California Advanced Manufacturing Apprenticeship Collaborative ATC (CAMAC)

Signature _____Date:_____

Title:_____

Office of Apprenticeship

Signature _____Date:_____
Richard Davis
Title: **California State Director**_____ Program ID#_____

Appendix A

Appendix A

WORK PROCESS SCHEDULE
TOOL PROGRAMMER, NUMERICAL
O*NET/SOC CODE: 51-4012.00 RAPIDS CODE: 0690

This schedule is attached to and a part of these Standards for the above identified occupation.

1. TERM OF APPRENTICESHIP

The term of the occupation shall be 3 Year with an OJL attainment of 6000 hours supplemented by the required hours of related instruction.

2. RATIO OF APPRENTICES TO MENTORS

One (1) Apprentice may be employed in each department and/or jobsite employing one (1) qualified Mentor.

3. APPRENTICE WAGE SCHEDULE

Apprentices shall be paid a progressively increasing schedule of wages based on a percentage of the current Mentor wage rate.

Note: Sponsoring Employers will show their Mentor wage rate on the Employer Acceptance Agreement

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4. SCHEDULE OF WORK EXPERIENCE (See attached Work Process Schedule)

The Sponsor may modify the work processes to meet local needs prior to submitting these Standards to the appropriate Registration Agency for approval.

5. SCHEDULE OF RELATED INSTRUCTION (See attached Related Instruction Outline)

Appendix A

WORK PROCESS SCHEDULE
TOOL PROGRAMMER, NUMERICAL
O*NET/SOC CODE: 51-4012.00 RAPIDS CODE: 0690

Description: Plans numerical control program to control contour-path machining of metal parts on automatic machine tools: Analyzes drawings, sketches, and design data of part to determine dimension and configuration of cuts, selection of cutting tools, and machine speeds and feed rates, according to knowledge of machine shop processes, part specifications, and machine capabilities. Determines reference points and direction of machine cutting paths. Computes angular and linear dimensions, radii, and curvatures, and outlines sequence of operations required to machine part. Prepares geometric layout on graph paper or using computer-assisted drafting software to show location of reference points and direction of cutting paths, using drafting instruments or computer. Writes instruction sheets and cutter lists to guide setup and operation of machine. Writes program of machine instructions in symbolic language to encode numerical control tape or direct numerical control data base to regulate movement of machine along cutting path. Compares encoded tape or computer printout with original program sheet to assure accuracy of machine instructions. Revises program to eliminate instruction errors or omissions. Observes operation of machined on trial run to prove taped or programmed instructions.

ON-THE-JOB TRAINING:

	APPROXIMATE HOURS
1. Job orientation, familiarization with company policies	150
2. Acquaint the apprentice with the tools of the trade	200
3. Assemble cutting tools	100
4. Loading of programs	100
5. Attaching and positioning of fixtures	250
6. Entering offsets or machine parameters	250
7. Entering and changing machine commands	100
8. Observe machine operation to detect malfunctions	700
9. Work holding and fixturing	100
10. Analyze drawings, sketches, design data	500
11. Drawing, CAD/CAM	1500
12. Writing programs for machine operations	2000
13. Program maintenance	50
TOTALHOURS	**6000**

Safety and safe working practices shall be adhered to throughout the apprenticeship.

Appendix A

RELATED INSTRUCTION
TOOL PROGRAMMER, NUMERICAL
O*NET/SOC CODE: 51-4012.00 RAPIDS CODE: 0690

Related instruction - This instruction may include, but not be limited to:

Note: Due to regional and local code differences and climate conditions, duration of instructional competencies/modules are suggested estimates.

	HOURS
FIRST YEAR	**144**
Manufacturing processes	
Blueprint Reading and Drawing	
Machine Tools (operation of lathe, milling machines, grinders, drill press)	
Materials of industry (familiarity with various materials used in industry)	
Industrial mathematics	
Safety practices and procedures	
SECOND YEAR	**144**
Computer numerically controlled machines (operation and maintenance)	
Machine tool and design drafting	
Computer literacy	
Applied hydraulics, pneumatics, and electricity	
THIRD YEAR	**144**
Trigonometry	
Oral and written communications	
Computer aided drafting	
Microcomputer applications	
	TOTAL HOURS
	432

Recommended Related Instruction Hours - 432 (144 hours per year)

Appendix A

WORK PROCESS
NUMERICAL CONTROL MACHINE OPERATOR
O*NET/SOC CODE: 51-4011.00 RAPIDS CODE: 0845R

This schedule is attached to and a part of these Standards for the above identified occupation.

1. TERM OF APPRENTICESHIP

The term of the occupation shall be 2 Years with an OJL attainment of 4000 hours supplemented by the required hours of related instruction.

2. RATIO OF APPRENTICES TO MENTORS

One (1) Apprentice may be employed in each department and/or jobsite employing one (1) qualified Mentor.

3. APPRENTICE WAGE SCHEDULE

Apprentices shall be paid a progressively increasing schedule of wages based on a percentage of the current Mentor wage rate.

Note: Sponsoring Employers will show their Mentor wage rate on the Employer Acceptance Agreement

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4. SCHEDULE OF WORK EXPERIENCE (See attached Work Process Schedule)

The Sponsor may modify the work processes to meet local needs prior to submitting these Standards to the appropriate Registration Agency for approval.

5. SCHEDULE OF RELATED INSTRUCTION (See attached Related Instruction Outline)

Appendix A

WORK PROCESS
NUMERICAL CONTROL MACHINE OPERATOR
O*NET/SOC CODE: 51-4011.00 RAPIDS CODE: 0845R

DESCRIPTION: Sets up and operates numerical control machine to cut, shape, or form metal work pieces to specifications: Reviews setup sheet and specifications to determine setup procedure, machining sequence, and dimensions of finished workpiece. Attaches fixture to machine bed and positions and secures workpiece in fixture according to setup instructions, using clamps, bolts, handtools, power tools, and measuring instruments, such as rule and calipers. Assembles cutting tools in tool holders and positions tool holders in machine spindles as specified, using handtools, or inserts cutting tools in specified machine magazines. Loads control media, such as disk, tape, or punch card, in machine control console or enter commands to retrieve preprogrammed machine instructions from data base. Manipulates controls and enters commands to index cutting tool to specified set point and to start machine. Observes and listens to machine operation to detect malfunctions, such as worn or damaged cutting tools. Changes cutting tools and location of workpiece during machining process as specified in setup instructions. Measures workpiece for conformance to specifications, using measuring instruments, such as micrometers, dial indicators, and gauges. Notifies supervisor of discrepancies. May adjust machine feed and speed and change cutters to machine parts according to specifications when automatic programming is faulty or machine malfunctions. May machine materials other than metal, such as composites, plastic, and rubber.

ON-THE-JOB TRAINING:

	APPROXIMATE HOURS
1. Lathes	1050
2. Milling Machines	905
3. Grinders	350
4. Shapers	55
5. Bench Work	155
6. Numerical Machines	755
7. Drill Presses	175
8. Jig Borers	163
9. Electrical Discharge Machines	162
10. Power Saw	75
11. Mechanical Time Fuze Machine Operations	80
12. Engraving Machines	75
TOTAL HOURS	**4000**

Appendix A

RELATED INSTRUCTION
NUMERICAL CONTROL MACHINE OPERATOR
O*NET/SOC CODE: 51-4011.00 RAPIDS CODE: 0845R

Related instruction - This instruction may include, but not be limited to:

Note: Due to regional and local code differences and climate conditions, duration of instructional competencies/modules are suggested estimates.

Trade Technology **144**

Introduction in the use of, and operation and adjustment of, various machine tools - drill press, lathe, miller, shaper and grinders. Use of precision measurement tools and industrial safety.

Discussions of surface finish, cutting fluids and lubricants, threads and treading, measuring tools, feeds and speeds, blueprint reading.

Introduction to Numerical Control	**16**
Shop Math and use of Machinery Handbook	**16**
Engineering Drawings	16
Machinability of Materials	**16**
Heat Treating - Welding	**16**
Numerical Control Manual Programming	**16**
Tool and Fixture Design	**16**
Practical Descriptive and Analytic Geometry	**16**
Strength of Materials	**16**

TOTAL HOURS **288**

Appendix A

WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296CB

This schedule is attached to and a part of these Standards for the above identified occupation.

1. TERM OF APPRENTICESHIP

The term of training for a NIMS Certified Machinist will include approximately four years of structured on-the-job learning (OJL), supplemented by the required hours of related instruction, that will lead to successful completion of the required Core Competencies and corresponding NIMS Credentials as stated in the Core Competency Requirements. The term of apprenticeship for all NIMS Certified Machinists will include at minimum 2,000 hours of structured on-the-job learning. Full credit will be given for on-the-job learning evaluated as satisfactory and previous acquisition of the required competencies and corresponding NIMS Credentials.

This is a competency-based apprenticeship program and is not constrained by time. The term of apprenticeship will provide sufficient on-the-job learning (OJL) to enable the apprentice to attain the required competencies for each registered occupation.

2. RATIO OF APPRENTICES TO MENTORS

One (1) Apprentice may be employed in each department and/or jobsite employing one (1) qualified Mentor.

3. APPRENTICE WAGE SCHEDULE

Apprentices shall be paid a progressively increasing schedule of wages based on a percentage of the current Mentor wage rate.

Note: Sponsoring Employers will show their Mentor wage rate on the Employer Acceptance Agreement

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4. SCHEDULE OF WORK EXPERIENCE AND RELATED INSTRUCTION (See attached Work Process and related Instruction Schedule)

The Sponsor may modify the work processes to meet local needs prior to submitting these Standards to the appropriate Registration Agency for approval.

Appendix A

WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296CB

NIMS CREDENTIAL: Level I Machining Skills, Measurement, Materials, & Safety

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Core Competency

Identify and Demonstrate Use of Machine Safety and Personal Protective Equipment

NIMS DUTY & PERFORMANCE STANDARD

Duty: Carry out assigned responsibilities while adhering to safe practices in accordance with OSHA requirements and guidelines. Document safety activities as required. Include appropriate personal protective equipment.

Performance Standard: Given written and verbal safety instructions and checklists based on OSHA requirements and guidelines, demonstrate safe workplace practices in material handling, machine operations, handling of tooling, handling and application of coolants, cutting fluids and lubricants. Orally explain the actions taken which directly or indirectly bear upon safe practice in the execution of assigned duties.

PERFORMANCE OBJECTIVES (What an apprentice must know and/or do to perform the work competently.)

Given instruction/demonstration and reading, viewing assignments, the apprentice will:

Identify areas in plant that require hearing devices and safety glasses.

Identify proper clothing required on the job to include shoes, gloves, sleeve, and pant length, jewelry items, hair length, and personal cleanliness.

The apprentice will demonstrate OSHA lifting techniques, proper air gun usage and identification and safe chip handling techniques.

The apprentice will identify all pinch points on primary and supportive machine tools and the proper placements of guards.

The apprentice will demonstrate both emergency and standard shut down of all required equipment.

The apprentice will demonstrate the proper use of hand tools to include hammer, wrenches, screwdrivers, punches and pliers.

Core Competency

Demonstrate Compliance with Lock-out and Tag-out Procedures and OSHA Requirements and Guidelines

NIMS DUTY & PERFORMANCE STANDARD

Appendix A

WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296CB

Duty: Carry out assigned responsibilities while adhering to safe practices in accordance with OSHA requirements and guidelines. Document safety activities as required.

Performance Standard: Given written and verbal safety instructions and checklists based on OSHA requirements and guidelines, demonstrate safe workplace practices in material handling, machine operations, handling of tooling, handling and application of coolants, cutting fluids and lubricants. Orally explain the actions taken which directly or indirectly bear upon safe practice in the execution of assigned responsibilities.

NOTE

Lock-out/tag-out and right-to-know will be accounted for in Industrial Safety and Environmental Protection. Material handling here means handling of shafts and overhead cranes, etc., and personal protection. The apprentice should recognize pinch points, cutting points, and control points.

Core Competency

Machine Operations and Material Handling, Hazardous Materials Handling and Storage, including EPA, Hazmat, and OSHA

NIMS DUTY & PERFORMANCE STANDARD

Duty: Handle and store hazardous materials as assigned while adhering to safe practices in accordance with OSHA and EPA requirements and guidelines. Document safety activities as required.

Performance Standard: Given written and verbal safety instructions detailing the handling and storage of hazardous materials in compliance with OSHA and EPA requirements and guidelines, demonstrate safe workplace practices in the identification, handling, and storage of hazardous materials.

Core Competency

Part Inspection

NIMS DUTY & PERFORMANCE STANDARD

Duty: Develop an inspection plan and inspect simple parts using precision tools and techniques. Prepare reports on the compliance of the parts.

Performance Standard: Given the necessary job process sheets for a part and verbal instructions, identify and select the required measuring instruments and conduct the required inspection procedure(s). Complete required written inspection report and make a

decision to accept or reject component parts. Provide brief verbal explanation of inspection procedures, results, and decisions.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently)

Verify calibrations and sizes of all measuring devices. Take measurements to an accuracy of 1/64 for fractions, .002 for decimals and ½ degree for angles. Read standard orthographic prints and understand types of lines, title block information, revision levels, abbreviations, symbols, and tolerances. Identify surface defects, burrs and any adverse conditions such as flat or torn threads, out of round conditions eccentricity, etc.

Core Competency

Process Control

NIMS DUTY & PERFORMANCE STANDARD

Duty: Follow a sampling plan. Inspect the samples for the required data. Enter the data on appropriate charts. Graph the data. Respond to the warning conditions indicated by the process charts.

Performance Standard: Given the necessary job process sheets for a part, verbal instructions, and the necessary charts and inspection tools, inspect parts according to the sampling plan, collecting the data required for the process control chart. Working with the supplied control and warning limits, place the data, produce new data as needed, graph the data, and take the Stop or Go actions as indicated by the results of producing the process control chart. Provide brief verbal explanation regarding the decision taken.

Core Competency

Process Adjustment—Single Part Production

NIMS DUTY & PERFORMANCE STANDARD

Duty: Analyze the performance of a single-part production process. Formulate process adjustments or improvements where appropriate. Where appropriate, notify supervision of the proposed adjustment and/or improvement. Where authorized, carry out the strategies for process adjustment and/or improvement.

Performance Standard: Given a process plan, part print, inspection process plan, verbal instructions, the necessary tools and equipment, and a part having routine problems being processed, analyze the problem(s), propose a remedy(ies), having been given authorization to implement the process improvement(s), carry it out. Explain the corrective actions and the reasoning used to perform the diagnosis.

Appendix A

WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296CB

Core Competency

Participation in Process Improvement

NIMS DUTY & PERFORMANCE STANDARD

Duty: As a member of a process team, analyze the performance of a production process. With the team formulate process adjustments or improvements where appropriate. Where appropriate, notify supervision of the proposed adjustments and/or improvement. Where authorized, carry out the strategies for process adjustment and/or improvement.

Performance Standard: Given a process plan, part print, inspection process plan, verbal instructions, the necessary tools and equipment, and a routine production process having a problem(s), as a team member, analyze the problem(s), propose a remedy(ies), having been given authorization to implement the process improvement(s), carry it out. Carry out the cause and effect analysis by participating in the development of the appropriate Q.C. methodology with the team, i.e., fishbone diagram. Explain the Q.C. tool, the corrective actions and the reasoning connecting the root cause analysis to the remedial actions taken.

Related Instruction

The knowledge and skills the apprentice will need to pass the ***Level I Machining Skills, Measurement, Materials, and Safety*** credentialing exam are as follows:

Applying the Machinery's Handbook: The apprentice must be able to reference and apply information found in the handbook to solve application problems. Referencing thread percentage, finish symbols, and allowances are some of the skills required.

Basic Mathematics: The exam will assess basic math knowledge of fraction/decimal conversion, addition and subtraction of decimals, and an understanding of percent.

Industrial Safety: The apprentice must become familiar with Hazmat, MSDS, basic personal protective equipment (PPE), and machine tool safety. Student assessment includes identification of a government body that regulates industrial safety – Occupational Safety and Health Administration (OSHA).

Maintenance: Student assessment includes elementary knowledge of referencing and researching maintenance procedures, hand tool maintenance and safety, and simple tool maintenance.

Process Adjustment: The exam presents basic problems of machining processes such as tapping, threading, drilling, milling, reaming, and grinding in which a process adjustment functions as the corrective action. Students must identify a basic goal of process improvement.

Quality Control Procedures: The exam will evaluate knowledge of basic concepts of SPC and sampling plans. Basic knowledge of inspection plans includes rationale, criteria for choosing the correct measuring instrument, and organization. The evaluation includes basic knowledge of inspection setups and measuring instruments.

Appendix A

WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296CB

NIMS CREDENTIAL: Level I Machining Skills, Job Planning, Benchwork, and Layout

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Core Competency

Manual Operations: Layout

NIMS DUTY & PERFORMANCE STANDARD

Duty: Layout the location of hole centers and surfaces within an accuracy of +/-.015 inch.

Performance Standard: Given a surface plate, surface gage, layout height gage, combination set, scriber, layout ink, prick punch, ball peen hammer, process plan, and part print, layout hole locations, radii, and surfaces matching the specifications.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

a. Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge and understanding of blue print reading, and understand orthographic projections in order to perform all machining tasks.

Given a part print, surface plate and all the required layout tools, the apprentice will select proper tools, and use correct procedure, to layout a part including the location of hole centers and surfaces within the accuracy of +/- .015 inch.

Core Competency

Manual Operations: Benchwork

NIMS DUTY & PERFORMANCE STANDARD

Duty: Using aluminum or mild steel, hand drill and hand tap holes. Use hand drills, hand taps, tap wrench, files, scrapers, and coated abrasives to deburr parts. Use arbor presses to perform press fits. Use bench vises and hand tools appropriately.

Performance Standard: Given a process plan, blueprint, access to hand tools, produce a part with two holes prepared for hand tapping, a hole prepared (reamed) for the press fit of a bushing, and a stud for one of the tapped holes. Deburr the part, hand drill and hand tap the holes, press in the bushing, and install the stud.

Appendix A

WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296CB

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

b. Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge and understanding of blue print reading, and understand orthographic projections in order to perform all machining tasks.

Given a part print, surface plate and all the required layout tools, the apprentice will select proper tools, and use correct procedure, to layout a part including the location of hole centers and surfaces within the accuracy of +/- .015 inch.

Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will select the correct tap drills to achieve a minimum of 75% thread in the required tapped holes, and the correct pre-drill hole for reaming operations to achieve tolerances specified on the part print.

Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will calculate cutting speeds required to perform benchwork-machining operations.

Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will calculate dimensions required for a press fit, and use an arbor to perform press fit operations.

Given instruction/demonstration on the procedure used for hand filing, drilling and reaming, the apprentice will perform filing, drilling, and reaming operations within the specified tolerances on the part print.

Given instruction/demonstration on the proper tap selection and the procedure used for hand tapping, the apprentice will perform tapping operations within the specified tolerances on the part print.

Core Competency

Sawing

NIMS DUTY & PERFORMANCE STANDARD

Duty: Set-up and perform sawing to a layout. Choose and mount appropriate blades; weld, break, and re-weld blades as necessary.

Performance Standards: Given a part with a finished layout and access to an appropriate bandsaw and blades, finish saw the part to the layout.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

c. Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge of bandsaw safety procedures, and the identification of bandsaw parts and their function.

Given instruction/demonstration on the proper selection, mounting, set-up, and usage procedure for necessary work-holding devices on the bandsaw, the apprentice will select, mount, set-up, hold, and align work using work holding devices on the bandsaw to perform the required sawing operations.

Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will chose the correct blade for specific sawing operations, and calculate cutting speeds and apply these calculations while performing required sawing operations on the bandsaw.

Given instruction/demonstration, reading assignment and the correct bandsaw blade material to perform a specific sawing operation, the apprentice will properly weld and mount the finished blade on the bandsaw.

Given a bandsaw, process plan, part print, part with finished layout, bandsaw blade, hand tools, bandsaw accessories, instruction/demonstration on the proper set-up and procedures used for sawing, the apprentice will perform the sawing operations on the part to within the layout specified on the part print.

Core Competency

Job Process Planning

NIMS DUTY & PERFORMANCE STANDARD

Duty: Develop a process plan for a part requiring milling, drilling, turning, or grinding. Fill out an operation sheet detailing the process plan and required speeds and feeds.

Performance Standard: Given a print detailing a part requiring milling, drilling, turning, and grinding, verbal instructions, and appropriate references, formulate a set of strategies to manufacture the part and fill out an operation sheet reflecting the chosen strategies including the required speeds and feeds.

Identify all major components and functions of the machine tools, and all major hand tools, measuring tools, tools and fixtures, work materials and provide the rationale for the speeds and feeds selected.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

d. The apprentice will be able to choose the most appropriate location for the origin on the part, and establish a method for defining that location during set-up.

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WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296CB

The apprentice will be able to select appropriate workholding devices for various work pieces.

The apprentice will be able to select appropriate tooling and toolholders for various operations and materials.

The apprentice will be able to calculate speeds and feeds for proper tool-life and surface finish.

Related Instruction

The knowledge and skills you will need to pass the ***Level I Machining Skills, Job Planning, Benchwork, and Layout*** credentialing exam are as follows:

Basic Mathematics: The exam will assess basic math knowledge from whole number computations and algebra to basic geometry. Application of formulas involving tapping, tapers, speeds and feeds, and threading will be evaluated.

Applying the Machinery's Handbook: The apprentice must be able to reference and apply information found in the handbook to solve application problems. Referencing limits, tolerance, and parameters of a material or process are essential skills.

Basic Measurement: The exam will test interpretation of basic measuring instruments, resolution, and applicability of basic measuring tools for given situations. Students must demonstrate knowledge of the differences and similarities of semi-precision and precision measurement.

Basic Machining Theory: The apprentice must understand basic types of tooling materials, applications of tooling and processes for drilling, milling, sawing, turning, and proper procedures using hand tools. A basic understanding of fits and allowances, as well as defining surface finish and machining operation/surface finish relationships is expected.

Layout: The exam will evaluate an understanding of basic and precision layout equipment and procedures. The apprentice should have a basic knowledge of print reading and orthographic projection. Knowledge of the layout of linear, angular, and circular dimensions will be assessed.

NIMS CREDENTIAL: Level I Machining Skills, Drill Press Skills

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Core Competency

Drilling Operations

NIMS DUTY & PERFORMANCE STANDARD

Duty: Set-up and operate machine tools to perform routine drilling operations.

Performance Standard: Given a semi-finished part, process plan, part print, hand precision, and cutting tools, as well as access to a drill press and its accessories, produce a part matching the process plan and the blueprint specifications. The part specified will be in the semi-finished

state having been squared up and the outer surfaces completed with five center-drilled locations. Finishing the part will require the finishing of the five center-drilled locations. Each hole must have at least two secondary operations. The secondary operations will consist of reaming, spot facing, countersinking, counterboring, and counterdrilling. At least one hole must be a blind hole and one a through hole. At least one hole will be power tapped.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

e. Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge of drill press safety procedures, and the identification of drill press, and radial drill press parts and their function.

Given instruction/demonstration on the proper selection, mounting, set-up, and usage procedure for necessary work-holding devices on the drill press, the apprentice will select, mount, set-up, hold, and align work using work holding devices on the drill press to perform the required drill press operations.

Given instruction/demonstration on the proper selection, mounting, set-up, and usage procedure for necessary tool-holding devices on the drill press, the apprentice will select, mount, set-up, and align tool-holding devices on the drill press to perform the required drill press operations.

Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will calculate cutting speeds and feeds and apply these calculations while performing required machining operations on the drill press.

Given a drill press, process plan, part print, semi-finished part, cutting tools, hand tools, drill press accessories, instruction/demonstration on the proper set-up and procedures used for drilling, tapping, reaming, spot facing, countersinking, and counterboring, the apprentice will perform these secondary operations on the semi-finished part to within the tolerances specified on the part print.

Related Instruction

The knowledge and skills you will need to pass the ***Level I Machining Skills, Drill Press Skills*** credentialing exam are as follows:

Drill Press Components: Proper operation of a drill press depends on knowledge of drill press components and their functions. Identification of the spindle, base, table, column, variable speed control and feed handle are essential for safe and effective use of this machine tool. Other essential components are the table lock, column lock, motor and base.

Process Involvement: An important part of any process improvement is an understanding of the symptoms and causes of some common problems associated with drilling operations. Understanding root causes of drill breakage, excessive wear, enlarged diameters and excessive RPM enable the apprentice to analyze the process and make the correct improvement.

Twist Drill Nomenclature and Sizing: Each twist drill is comprised of many separate features. Identifying the web and understanding web thickness enables apprentice to recognize the

effects of excessive web thickness. Knowing the purpose and location of the margin facilitates proper drill diameter measurement as well as the effect of worn margin near the point of the drill. All general-purpose drills have the same identical point angle. The included point angle of a drill will vary dependent on the application and the material being machined.

Safety Practices: Proper safety procedures insure safe and productive machining. Safety includes safe lifting procedures, hair containment, jewelry removal and loose clothing containment. Drill press safety includes the proper location of the vise, storage of the chuck key and chip removal. Safety awareness should be apparent at all times evident through the correct application of speeds and feeds.

Countersinking, Counterboring, Spotfacing, and Center Drilling: Spotfacing, countersinking and counterboring are drilling procedures used to seat screws and bolts with special head configurations or to seat a fastener or washer evenly on a rough surface. Center drilling is an important procedure for accurate hole location as well as shaft preparation for turning between centers. The specific drilling operations have speeds and feeds that are proportionally slower than drilling with general-purpose twist drills

Layout and Inspection: Choosing the correct measuring instrument is primarily dependent on the tolerance range of the specific dimension. Proper set-up and correct measuring procedures for each measuring device is critical. The apprentice must also know when and where to apply semi-precision and precision layout. Selection and application of proper layout tools and setups is essential in any machining operation.

Tapping: The drill diameter used to create a hole for internal threading will dictate the thread percentage or amount of engagement between two mating threaded components. Most tap drill charts for conventional thread forms are based on 70% – 75% engagement. Pipe taps used for some pneumatic and fluid connects have tap drills based on other parameters. With the proper equipment, tapping can be performed under power if the drill press is capable of reversing the rotation.

Work Holding: The work piece must be held securely to prevent part pullout from the work holding device. The equipment used for work holding parts is dependent upon the shape and size of the part being drilled. Proper location of the vise may prevent the vise from whipping around if the drill gets jammed in the part. Proper selection of work holding devices is critical for safe and accurate application of a drill press.

NIMS CREDENTIALS: Levels I and II Machining Skills, Turning Operations, Turning Between Centers

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Core Competency

Turning Operations: Turning Between Centers, Level I Machining Skills

NIMS DUTY & PERFORMANCE STANDARD

Duty: Set-up and carry out between centers turning operations for straight turning.

Appendix A

WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296CB

Performance Standard: Given raw material, process plan, part print, hand, precision, and cutting tools, as well as access to an appropriate turning machine and its accessories, produce a part matching the process plan and the part print specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least three diameters within +/-.002 inch, one UNC external thread, one UNF external thread, and require an end-for-end swap.

Core Competency

Turning Operations: Turning Between Centers, Level II Machining Skills

NIMS DUTY & PERFORMANCE STANDARD

Duty: Set-up and perform between centers turning for straight and tapered turning by offsetting the tailstock.

Performance Standard: Given raw material, process plan, part print, hand, precision, and cutting tools, as well as access to an appropriate turning machine and its accessories, produce a part matching the process plan and the part print specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least two straight diameters within +/-.001 inch, an appropriate taper at each end of the part, and require a reversal of the part end for end.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

f. Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge of engine lathe safety procedures, and the identification of engine lathe parts and their function.

Given instruction/demonstration by a qualified individual on cutting tool geometry and the proper procedure used for grinding lathe tool bits on the off-hand grinder, the apprentice will perform grinding operations and produce all the required tool bits necessary to perform all required turning operations within the specified tolerances on a part print.

Given instruction/demonstration on cutting tool geometry and inserted tooling, the apprentice will demonstrate the proper insert and tool holder selection, necessary to perform all required turning operations within the specified tolerances on a blueprint.

Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will calculate cutting speeds and feeds and apply these calculations while performing required various turning operations on the engine lathe.

Given instruction/demonstration on the proper selection, mounting, set-up, and usage procedure for the four specified work-holding devices (3-jaw chuck, 4-jaw chuck, face

plate and dog, and draw-in collet chuck), the apprentice will select, mount, set-up, hold, and align work using work holding devices on the engine lathe to perform the required turning operations.

Given instruction/demonstration on the proper set-up and procedures used for drilling and center drilling on the engine lathe, the apprentice will perform drilling and center drilling operations within the tolerances specified on a part print.

Given instruction/demonstration on the proper procedure used for turning, facing, necking, and grooving operations on the engine lathe, the apprentice will perform turning, facing, necking, and grooving operations within the specified tolerances on the part print.

Given instruction/demonstration on the proper procedure used for performing shouldering operations on the engine lathe, the apprentice will perform square, angular, and filleted shouldering operations within the tolerances specified on a part print.

Given instruction/demonstration on the proper set-up procedure used for knurling on the engine lathe, the apprentice will set-up the machine and perform knurling operations within the tolerances specified on the part print.

Given instruction/demonstration on Unified National Thread nomenclature, formulas and the proper set-up procedure used for cutting threads on the engine lathe, the apprentice will cut an external U.N. thread within the tolerances specified on the part print.

Given a blueprint, and instruction/demonstration on taper calculations, and the proper set-up procedure used for cutting internal and external tapers on the engine lathe, the apprentice will cut a taper on the engine lathe using the tailstock set-over method, compound rest, and a taper attachment to within the tolerances specified on a part print.

Related Instruction

The knowledge and skills you will need to pass the ***Turning Operations: Turning Between Centers, Level I Machining Skills*** and ***Turning Operations: Turning Between Centers, Level II Machining Skills*** credentialing exams are as follows:

Process Improvement and Troubleshooting: To improve a process, one must first understand the process. A competent apprentice should be able to identify the root cause if a straight cut between centers measures as a taper. Measuring a taper (when a straight cut is intended) and moving the tailstock the proper amount based on the measurement is another skill needed to effectively and efficiently engage in turning operations. Other skill sets include the proper way to take the first cut on cast iron and hot roll steel, the root cause of lathe center runout, properly turning hard material and the effect of having the lathe tool above or below center.

Turning Safety: Safety knowledge and practice is an important component for lathe operations. The apprentice must know the basic personal protective equipment needed to

operate a lathe safely and effectively. Proper lifting techniques, learning how to find MSDS and HMIS information and some basic personal first aid are essential knowledge for all apprentices. Other safety components involve the safe installation of chucks and collets as well as chip control and chip removal.

Lathe Controls: An understanding of basic lathe control mechanisms enables the apprentice to utilize the lathe in an efficient and productive manner. Knowing how each control works and its function is critical to any safe turning operation. Knowing how to use the feed reverse lever, half nut lever and the proper method to change speeds and feeds is also critical knowledge. Each manufacturer of lathes has unique methods of implementing lathe controls. It is the job of the apprentice to become familiar with each particular set of lathe controls.

Single Point Threading: Single point threading is one of the fundamental skill sets needed to operate a lathe. The apprentice must be familiar with thread angles, helix angles, thread pitch diameter, lead and different families of thread forms. Proper alignment of the threading tool, as well as the proper location of the compound rest are essential setup steps needed to turn threads with a single point tool. An apprentice must be able to calculate the proper infeed to prevent the thread from either being too deep or too shallow.

Tapping, Fits, and Allowances: The turning process is often used to size shafts and holes for certain fits. Knowledge of the definitions of a fit and an allowance is essential prior to machining. The apprentice should have a basic knowledge of the types of fits and be able to reference the *Machinery's Handbook* to determine the size of the each component. Planning the sequence of operations is essential to prevent ruining a fit due to burrs and poor surface finish.

Measurement: The best choice depends on the accuracy and reliability of the measuring instrument. Tolerance as well as the application will also be important factors. An apprentice must also know how to read the measuring instrument properly. An example would be comparing a depth micrometer, outside micrometer and a dial indicator. Thread measurement and surface finish are also important factors when measuring features produced by the turning process.

Process Control: Monitoring the process with process control techniques results in quality parts and customer satisfaction. The first step in any process control endeavor is knowing when the part is accepted or rejected. Basic knowledge of process control techniques such as inspection sheets, Pareto charts, capability studies and X bar/R charts are effective means of process control. The most common method of process control, besides the inspection sheet, is SPC (statistical process control) utilizing the X bar/R chart. The apprentice must understand the definition of range, mean, upper control limit, lower control limit and sample size.

Tooling and Lathe Set-up: Many lathe applications use tooling with carbide inserts. However, some lathe applications use high-speed steel tools that must be ground to the desired shape. The apprentice should know the proper sequence for grinding the surfaces of the lathe tool applying the proper rake angles. Knowledge of the various methods of aligning the lathe centers and the degree of accuracy of each method depends on the tolerance of the work piece dimensions. Proper setups for facing and compound rest fundamentals are other essential skill sets included in this area.

Appendix A

WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296CB

Layout Procedures: Layout is the initial step in any machining process. Understanding the concepts and proper utilization of semi precision and precision layout techniques is important for every apprentice. The apprentice should know the function of a scriber and the types of layout instruments used with surface plates.

NIMS Credentials: Levels I and II Machining Skills, Turning Operations: Chucking

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Core Competency

Turning Operations: Chucking: Level I Machining Skills

NIMS DUTY & PERFORMANCE STANDARDS

Duty: Set-up and carry out chucking operations for turning.

Standard: Given raw material, process plan, part print, hand, precision, and cutting tools, as well as access to an appropriate turning machine and its accessories, produce a part matching the process plan and the print specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least three diameters within +/-.005 inch, two bores within +/-.005 inch, one UNC external thread, and require at least two chuckings or other workholding setup.

Core Competency

Turning Operations: Chucking: Level II Machining Skills

NIMS DUTY & PERFORMANCE STANDARDS

Duty: Set-up and perform tapered boring and turning using a taper attachment.

Standard: Given raw material, process plan, part print, hand, precision, and cutting tools, as well as access to an appropriate turning machine with a taper attachment and its accessories, produce a part matching the process plan and the part print specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least two diameters within +/-.002 inch, one bore within +/-.002 inch, one external and one internal taper, and require at least two chuckings or other workholding set-up.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

g. Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge of engine lathe safety procedures, and the identification of engine lathe parts and their function.

Given instruction/demonstration on cutting tool geometry and the proper procedure used for grinding lathe tool bits on the off-hand grinder by a qualified individual, the

apprentice will perform grinding operations and produce all the required tool bits necessary to perform all required turning, and boring operations within the specified tolerances on a part print.

Given instruction/demonstration on cutting tool geometry and inserted tooling, the apprentice will demonstrate the proper insert and tool holder selection, necessary to perform all required turning, and boring operations within the specified tolerances on a part print.

Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will calculate cutting speeds and feeds and apply these calculations while performing required, various turning operations on the engine lathe.

Given instruction/demonstration on the proper selection, mounting, set-up, and usage procedure for the four specified work-holding devices (3-jaw chuck, 4-jaw chuck, face plate and dog, and draw-in collet chuck), the apprentice will select, mount, set-up, hold, and align work using work holding devices on the engine lathe to perform the required turning operations.

Given instruction/demonstration on the proper set-up and procedures used for drilling and center drilling on the engine lathe, the apprentice will perform drilling and center drilling operations within the tolerances specified on a part print.

Given instruction/demonstration on the proper procedure used for turning, facing, necking, and grooving operations on the engine lathe, the apprentice will perform turning, facing, necking, boring and grooving operations within the specified tolerances on the part print.

Given instruction/demonstration on the proper procedure used for performing shouldering operations on the engine lathe, the apprentice will perform square, angular, and filleted shouldering operations within the tolerances specified on a part print.

Given instruction/demonstration on Unified National Thread nomenclature, formulas and the proper set-up procedure used for cutting threads on the engine lathe, the apprentice will cut an external and internal U.N. thread within the tolerances specified on the part print.

Given a blueprint, and instruction/demonstration on taper calculations, and the proper set-up procedure used for cutting tapers on the engine lathe, the apprentice will cut an external and internal and taper on the engine lathe using the tailstock set-over method, compound rest, and a taper attachment to within the tolerances specified on a part print.

Related Instruction

The knowledge and skills you will need to pass the ***Turning Operations: Chucking, Level I Machining Skills*** and ***Turning Operations: Chucking, Level II Machining Skills*** credentialing exams are as follows:

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WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296CB

Process Improvement and Troubleshooting: To improve a process, one must first understand the process. A competent apprentice should be able to identify the root cause if a straight cut between centers measures as a taper. Measuring a taper (when a straight cut is intended) and moving the tailstock the proper amount based on the measurement is another skill needed to effectively and efficiently engage in turning operations. Other skill sets include the proper way to take the first cut on cast iron and hot roll steel, the root cause of lathe center runout, properly turning hard material and the effect of having the lathe tool above or below center.

Turning Safety: Safety knowledge and practice is an important component for lathe operations. The apprentice must know the basic personal protective equipment needed to effectively operate a lathe safely. Proper lifting techniques, learning how to find MSDS and HMIS information and some basic personal first aid are essential knowledge for all apprentices. Other safety components involve the safe installation of chucks and collets as well as chip control and chip removal.

Lathe Controls: An understanding of basic lathe control mechanisms enables the apprentice to utilize the lathe in an efficient and productive manner. Knowing how each control works and its function is imperative to any safe turning operation. Knowing how to use the feed reverse lever, half nut lever and the proper method to change speeds and feeds is imperative knowledge. Each manufacturer of lathes has unique methods of implementing lathe controls. It is the job of the apprentice to become familiar with each particular set of lathe controls.

Single Point Threading: Single point threading is one of the fundamental skill sets needed to operate a lathe. The apprenticet must be familiar with thread angles, helix angles, thread pitch diameter, lead and different families of thread forms. Proper alignment of the threading tool as well as the proper location of the compound rest are essential set-up steps needed to turn threads with a single point tool. A apprentice must be able to calculate the proper infeed to prevent the thread from either being cut too deep or too shallow.

Tapping, Fits and Allowances: The turning process is often used to size shafts and holes for certain fits. Knowledge of the definitions of a fit and an allowance is essential prior to machining. The apprentice should have a basic knowledge of the types of fits and be able to reference the *Machinery's Handbook* to determine the size of each component. Planning the sequence of operations is essential to prevent ruining a fit due to burrs and poor surface finish.

Measurement: Choosing the proper measuring instrument is an important facet of proper inspection. The best choice is dependent on the accuracy and reliability of the measuring instrument. The tolerance as well as the application will determine the choice. An apprentice must also know how to read the measuring instrument properly. An example would be comparing a depth micrometer, outside micrometer and a dial indicator. Thread measurement and surface finish are also important factors when measuring features produced by the turning process.

Process Control: Monitoring the process with process control techniques results in quality parts and customer satisfaction. The first step in any process control endeavor is knowing when the part is accepted or rejected. Basic knowledge of process control techniques such as inspection sheets, Pareto charts, capability studies and X bar/R charts are effective means of process control. The most common method of process control, besides the inspection sheet, is

SPC (statistical process control) utilizing the X bar/R chart. The apprentice must understand the definition of range, mean, upper control limit, lower control limit and sample size.

Tooling and Lathe Set-up: Many lathe applications use tooling with carbide inserts. However, some lathe applications use high-speed steel tools that must be ground to the desired shape. The apprentice should know the proper sequence for grinding the surfaces of the lathe tool applying the proper rake angles. Knowledge of the various methods of aligning the lathe centers and the degree if accuracy of each method depends on the tolerance of the work piece dimensions. Proper setups for facing and compound rest fundamentals are other essential skill sets included in this area.

Layout Procedures: Layout is the initial step in any machining process. Understanding the concepts and proper utilization of semi-precision and precision layout techniques is important for every apprentice. The apprentice should know the function of a scriber and the types of layout instruments used with surface plates.

NIMS CREDENTIAL: Level I Machining Skills, Milling: Square Up a Block

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Core Competency

Milling: Square Up a Block

NIMS DUTY & PERFORMANCE STANDARD

Duty: Set-up and perform squaring up the six surfaces of a block to within +/-.002 inch and .002 inch over 4.5 inches squareness.

Performance Standard: Given raw material, process plan, part print, hand, precision and cutting tools, as well as access to an appropriate milling machine and its accessories produce a part matching the process plan and the part print specifications. The part will require squaring up from its raw state.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

h. Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge of milling machine safety procedures, and the identification of milling machine parts and their function.

Given instruction/demonstration on cutting tool geometry for High Speed Steel milling cutters, the apprentice will perform proper cutting tool selection necessary to perform all required milling operations within the specified tolerances on a part print.

Given instruction/demonstration on cutting tool geometry and inserted tooling, the apprentice will demonstrate the proper insert and tool holder selection, necessary to perform all required milling operations within the specified tolerances on a blueprint.

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WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
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Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will calculate cutting speeds and feeds and apply these calculations while performing required milling operations on the milling machine.

Given instruction/demonstration on the proper selection, mounting, set-up, usage procedure for work-holding devices, and an understanding of climb and conventional milling, the apprentice will select, mount, set-up, hold, and align work using work holding devices on the milling machine to perform the required milling and squaring operations.

Given instruction/demonstration on the proper set-up and procedures used to perform the squaring up operation, the apprentice will square up six primary surfaces of a raw cut block within the tolerance of ± .002 inch maintaining parallelism and perpendicularity measurement with a TIR of .002 inch over 4.5 inches.

Related Instruction

The knowledge and skills you will need to pass Milling***: Square Up a Block, Level I Machining Skills*** credentialing exam are as follows:

Applying the Machinery's Handbook: The apprentice must be able to reference and to apply information found in the handbook to solve applied problems. Referencing thread percentage, tap drill diameters, speeds, feeds and cutting tool parameters are some of the skills required.

Basic Mathematics: The exam will assess basic math knowledge of fraction/decimal conversion, addition and subtraction of decimals and an understanding of percentage. Processing basic formulas to solve for the given known or another part of the formula is an additional skill required for this module.

Vertical Milling Machine Components: The exam presents questions asking the student to identify components of vertical milling machines. Apprentices must be able to identify essential components, their functions and basic machine adjustments.

Threads and Tapping: Specific areas of knowledge include an understanding of tap drill charts and thread percentage, tapping lubricants, tap drills for pipe threads and taps used for specific operations. The apprentice must be able to troubleshoot basic tapping and threading problems.

Safety Practices: Areas of knowledge includes knowledge of basic safety, cutting tool safety and basic machine maintenance and housekeeping. Apprentices must know some elementary first aid procedures they can perform on themselves.

Milling Operations Set-up: The apprentice must know the procedure for adjusting the mill head to be perpendicular to the table (tramming). Other areas of importance includes center various details or shapes and the proper procedure for utilizing center-finding tools. The importance of layout lines and machining to the lines as well as the application of the sine bar are included.

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WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
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NIMS CREDENTIALS: Levels I and II Machining Skills, Manual Milling Skills

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Core Competency

Manual Milling: Vertical and Horizontal, Level I Machining Skills

NIMS DUTY & PERFORMANCE STANDARD

Duty: Vertical Milling

Set-up and operate vertical milling machines. Perform routine milling, and location of hole centers within +/-.005 inch.

Performance Standard: Vertical Milling

Given raw material, process plan, print, hand, precision, and cutting tools, as well as access to an appropriate vertical milling machine and its accessories, produce a part matching the process plan and the blueprint specifications using appropriate trade techniques and speeds and feeds. The part specified should require squaring up from the raw state, have at least one milled slot, require the location of at least two drilled and reamed holes within +/- .005 inch and have three steps controlled by tolerances of +/-.005 inch.

Core Competency

Manual Milling: Vertical and Horizontal, Level II Machining Skills

NIMS DUTIES & PERFORMANCE STANDARDS

Duty: Vertical Mill - Precision Location of Holes

Set-up and perform boring for location, size, and finish.

Performance Standard: Vertical Mill - Precision Location of Holes

Produce three bores to specification. The holes will be between ¾ inch and 1-1/2 inches and their locations are to be held within +/-.001 inch and hold diameters within +/-.0005 inch. One hole is to be counterbored to a decimal depth holding +/-.002 inch and counterbore diameter within +/-.005 inch.

Duty: Milling Keyseats

Set-up and perform milling keyseats on a shaft.

Performance Standard: Milling Keyseats

Given raw material, process plan, part print, hand, precision, and cutting tools, as well as access to an appropriate milling machine and its accessories, produce a part matching the

process plan and the part print specifications using appropriate trade techniques and speeds and feeds. The part specified will require milling two keyseats whose characteristics match the ANSI B17.1 keys and keyseat standards.

Duty: Milling - Cut a Deep Slot

Set-up and perform the cutting of a deep slot.

Performance Standard: Milling - Cut a Deep Slot

Given raw material, process plan, part print, hand, precision, and cutting tools, as well as access to an appropriate milling machine and its accessories, produce a part matching the process plan and the part print specifications. The part specified will require the milling of three deep slots two parallel to one another, the third at right angles to the first two.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

i. Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge of milling machine safety procedures, and the identification of milling machine parts and their function.

Given instruction/demonstration on cutting tool geometry for High Speed Steel milling cutters, the apprentice will perform proper cutting tool selection necessary to perform all required milling operations within the specified tolerances on a part print.

Given instruction/demonstration on cutting tool geometry and inserted tooling, the apprentice will demonstrate the proper insert and tool holder selection, necessary to perform all required milling operations within the specified tolerances on a blueprint.

Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will calculate cutting speeds and feeds and apply these calculations while performing required milling, drilling, and boring operations on the milling machine.

Given instruction/demonstration on the proper selection, mounting, set-up, usage procedure for work-holding devices, and an understanding of climb and conventional milling, the apprentice will select, mount, set-up, hold, and align work using work holding devices on the milling machine to perform the required milling and squaring operations.

Given required hand and precision tools, instruction/demonstration on the proper set-up and procedures used to perform tramming operations on the vertical milling machine, and the process used to indicate a vise, the apprentice will adjust the milling machine head perpendicular to the table within +/- .001 inch, and indicate a vise maintaining parallelism and perpendicularity measurement of .002 inch over 4.5 inches.

Given instruction/demonstration on the proper set-up and procedures used to perform the squaring up operation, the apprentice will square up six primary surfaces of a raw cut block within the tolerance of ± .002 inch maintaining parallelism and perpendicularity measurement with a TIR of .002 inch over 4.5 inches.

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Given raw material, process plan, print, hand, precision, and cutting tools, as well as access to an appropriate vertical milling machine and its accessories, produce a part matching the process plan and the blueprint specifications using appropriate trade techniques and speeds and feeds. The part specified should require squaring up from the raw state, have at least one milled slot, require the location of at least two drilled and reamed holes within +/- .005 inch and have three steps controlled by tolerances of +/-.005 inch.

Given raw material, process plan, part print, hand, precision, and cutting tools, as well as access to an appropriate milling machine and its accessories, produce three bores to specification. The holes will be between ¾ inch and 1-1/2 inches and their locations are to be held within +/-.001 inch and hold diameters within +/-.0005 inch. One hole is to be counterbored to a decimal depth holding +/-.002 inch and counterbore diameter within +/-.005 inch.

Given raw material, process plan, part print, hand, precision, and cutting tools, as well as access to an appropriate milling machine and its accessories, produce a part matching the process plan and the part print specifications using appropriate trade techniques and speeds and feeds. The part specified would require milling two keyseats whose characteristics match the ANSI B17.1 keys and keyseat standards.

Given raw material, process plan, part print, hand, precision, and cutting tools, as well as access to an appropriate milling machine and its accessories, produce a part matching the process plan and the part print specifications. The part specified will require the milling of three deep slots two parallel to one another, the third at right angles to the first two.

Related Instruction

The knowledge and skills you will need to pass the ***Manual Milling: Vertical and Horizontal, Level I Machining Skills***, and ***Manual Milling: Vertical and Horizontal, Level II Machining Skills*** credentialing exams are as follows:

Applying the Machinery's Handbook: The apprentice must be able to reference and to apply information found in the handbook to solve applied problems. Referencing thread percentage, tap drill diameters, speeds, feeds and cutting tool parameters are some of the skills required.

Basic Mathematics: The exam will assess basic math knowledge of fraction/decimal conversion, addition and subtraction of decimals and an understanding of percentage. Processing basic formulas to solve for the given known or another part of the formula is an additional skill required for this module.

Vertical Milling Machine Components: The exam presents questions asking the student to identify components of vertical milling machines. Apprentices must be able to identify essential components, their functions and basic machine adjustments.

Threads and Tapping: Areas of knowledge include knowledge of basic safety, cutting tool safety and basic machine maintenance and housekeeping. Apprentices must know some elementary first aid procedures they can perform on themselves.

Safety Practices: Areas of knowledge include knowledge of basic safety, cutting tool safety and basic machine maintenance and housekeeping. Apprentices must know some elementary first aid procedures they can perform on themselves.

Milling Operations Setup: The apprentice must know the procedure for adjusting the mill head to be perpendicular to the table (tramming). Other areas of importance include center various details or shapes and the proper procedure for utilizing center-finding tools. The importance of layout lines and machining to the lines as well as the application of the sine bar are included.

NIMS Credentials: Levels I and II Machining Skills, Grinding Skills

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Core Competency

Surface Grinding: Grinding Wheel Safety, Level I Machining Skills

NIMS DUTY & PERFORMANCE STANDARD

Duty: Ring test grinding wheels, perform visual safety inspection, mount and dress a grinding wheel in preparation for surface grinding.

Performance Standard: Given a selection of wheels in various conditions determine which are suitable for use, mount one on the spindle, and dress it in preparations for surface grinding. Include the understanding of the grinding wheel code.

PERFORMANCE STANDARD: (What an apprentice must know and/or do to perform the work competently.)

j. Given instruction/demonstration and reading assignments on grinding wheel selection and the standard wheel marking system, the apprentice will determine the proper wheel selection to perform all grinding tasks from information obtained from the part print, and process plan.

Given instruction/demonstration and reading assignments, the apprentice will demonstrate the proper procedure used for visual safety inspection of the grinding wheel, and perform a ring testing, to determine the wheel's soundness prior to mounting.

Given instruction/demonstration and reading assignments, the apprentice will demonstrate the proper procedure used for balancing (where applicable), mounting, and dressing the grinding wheel on the surface grinder to perform required grinding operations.

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Related Instruction

The knowledge and skills you will need concerning Grinding Wheel Safety to pass the ***Level I Machining Skills Surface Grinding*** credentialing exam are as follows:

Grinding Safety: Basic shop practices should be applied in grinding operations. Proper housekeeping and cleanup procedures are critical in safe grinding applications. Proper dress and lifting techniques are also important. Grinding wheel safety is the first step in any grinding procedure. The grinding wheel should be checked for cracks and fractures. Proper installation and wheel dressing are also important factors.

Measurement: Grinding is often considered a finishing operation after milling or rough turning. Grinding operations are usually applied in situations where high accuracy is desired. The apprentice must be able to read a micrometer or vernier micrometer (capable of measuring to .0001 inches). Proper application of dial indicators and height gages is important in measuring ground surfaces of different heights. Comprehension of surface finish specifications and measuring tool selection are essential inspection skills necessary to ensure quality.

Grinding Wheel Dressing: In order to achieve satisfactory surface finishes and to safely use a grinding wheel, the apprentice must understand and apply proper grinding wheel dressing techniques. Knowledge of the types of grinding wheels that can and cannot be dressed with a diamond dresser is essential for safe machining. Understanding the process of wheel trueing and wheel dressing and the effects of a poorly dressed grinding wheel provide the apprentice with basic troubleshooting knowledge for assessing the root cause of some grinding problems.

Types of Abrasives: Proper identification and application knowledge of the types of abrasives used in grinding operations provides an apprentice with the proper foundation for determining which type of abrasive is the most effective for a given grinding application. The apprentice should know the most common grinding abrasive as well as the hardest natural abrasive.

Pedestal Grinders: The pedestal grinder is a free-standing grinding machine used for roughing, snagging castings and sharpening high-speed lathe tool bits amongst other applications. Guard location and wheel dressing techniques differ for a pedestal grinder when compared to a surface grinder. The type of grinding wheel installed on the pedestal grinder is dependent on the application and the type of material being ground.

Work Holding: To intelligently discuss grinding problems, grinding machine problems and setups, the apprentice must be familiar with the names of the grinding machine components. The spindle nut on the grinder must be turned in the correct direction to either install or remove the grinding wheel from the spindle. Most machines will have a left-handed thread to self-tighten from the inertia of the grinding wheel. However, some older machines have the direction the nut must be rotated to tighten the same as wheel rotation.

Grinding Machine Components: To intelligently discuss grinding problems, grinding machine problems and setups, the apprentice must be familiar with the names of the grinding machine components. The spindle nut on the grinder must be turned in the correct direction to either install or remove the grinding wheel from the spindle. Most machines will have a left-handed thread to self-tighten from the inertia of the grinding wheel. However, some older machines have the direction the nut must be rotated to tighten the same as wheel rotation.

Appendix A

WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296CB

Grinding Carbide and Carbide Tooling: Carbide can be ground by two types of grinding wheel material. The best abrasive for machining carbide is diamond. However, due to expense, some carbide grinding applications will use a green silicon carbide wheel. The silicon carbide wheel is inferior to diamond. Diamond wheels, if properly trued and dressed, will yield surface finishes that surpass surface finishes produced by silicon carbide grinding wheels.

Core Competency

Surface Grinding: Horizontal Spindle, Reciprocating Table, Level I Machining Skills

NIMS DUTY & PERFORMANCE STANDARD

Duty: Set-up and operate manual surface grinders. Perform routine surface grinding, location of surfaces, and squaring of surfaces. Perform wheel dressing.

Performance Standard: Given a block squared up on a mill, a process plan, part print, hand and precision tools, and choice of a grinding wheel, as well as access to a surface grinder and its accessories, dress the wheel, produce a part matching the process plan and the part print specifications using appropriate trade techniques. The part specified will be in the semi-finished state having been squared up. Finishing the part will require the precision finishing of the six faces of the block to tolerances common to precision grinding for squareness, size, and surface finish characteristics.

Core Competency

Surface Grinding: Horizontal Spindle, Reciprocating Table, Level II Machining Skills

NIMS DUTIES & PERFORMANCE STANDARDS

Duty: Finish Flats to +/-.0005

Grind a block's six faces to finished dimensions having tolerances of +/-.0005 inch and squareness of .0005 inch over 4 inches, and 32 microinch surface finish. Dress the wheel as necessary.

Performance Standard: Finish Flats to +/-.0005

Given a block squared up on a mill, hardened to 55 to 60 RC, a process plan, part print, hand and precision tools, and choice of a grinding wheels, as well as access to a surface grinder and its accessories, dress the wheel, produce a part matching the process plan and the part print specifications using appropriate trade techniques. The part specified will be in the semi-finished state having been squared up. Finishing the part will require the precision finishing of the six faces of the block to tolerances common to precision grinding for squareness, size, and surface finish characteristics.

Appendix A

WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296CB

Duty: Finish Flats at Simple Angles and Grind Contour Radii

Set-up and perform the finish surface grinding of flat surfaces at simple angles with respect to one another. Dress the wheel as necessary.

Performance Standard: Finish Flats at Simple Angles and Grind Contour Radii

Given a block roughed out on a mill, a process plan, part print, hand and precision tools, and choice of a grinding wheels, as well as access to a surface grinder and its accessories, dress the wheel, grind the specified radii and angled surfaces to a finish matching the process plan and the part print specifications using appropriate trade techniques. The part specified will be in the semi-finished state having been roughed out. Finishing the part will require the precision finishing of the specified surfaces of the block to tolerances common to precision grinding for squareness, size, and surface finish characteristics.

Duty: Grinding Wheel Preparation and Balancing

Set up and perform the preparation and balancing of a grinding wheel 14 inches diameter or greater. Place the wheel into service.

Performance Standard: Grinding Wheel Preparation and Balancing

Given a wheel and appropriate equipment prepare the wheel to go into service. Mount the wheel. Produce a surface finish of 32 micro-inches or better on a cylinder or flat surface of CRS.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

k. Given instruction/demonstration and reading assignments on grinding wheel selection and the standard wheel marking system, the apprentice will determine the proper wheel selection to perform all grinding tasks from information obtained from the part print, and process plan.

Given instruction/demonstration and reading assignments the apprentice will demonstrate the proper procedure used for visual safety inspection of the grinding wheel, and perform a ring testing, to determine the wheels soundness prior to mounting.

Given instruction/demonstration and reading assignments the apprentice will demonstrate the proper procedure used for balancing a wheel (14 inches or greater), mounting, and dressing the grinding wheel on the surface grinder to perform required grinding operations.

Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge of surface grinder safety procedures, and the identification of surface grinder parts, and their function.

Given instruction/demonstration on the proper selection, mounting, set-up, and usage procedure for necessary work-holding devices on the surface grinder, the apprentice will select, mount, set-up, hold, and align work using work holding devices on the surface grinder to perform the required grinding operations.

Appendix A

WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296CB

Given instruction/demonstration a block squared up on a mill, hardened to 55 to 60 RC, a process plan, part print, precision tools, choice of grinding wheels and access to a surface grinder and its accessories, choose the appropriate wheel, dress a wheel, produce a part matching the process plan and the part print specifications using the appropriate techniques. Grind a block's six faces to finished dimensions having a tolerance of ± .0005 inches and a perpendicularity TIR of .0005 inches over 4 inches holding a surface finish of 32 microinches or better.

Given instruction/demonstration a block squared up on a surface grinder, a process plan, part print, precision measuring tools, a choice of grinding wheels and access to a surface grinder and its accessories, set a radius dresser, dress the wheel, grind the specified radii, angled surfaces and slot to a finish matching the process plan and print specifications using appropriate grinding techniques. Use the appropriate work holding devices to grind all surfaces, angles and contours.

Given instruction/demonstration, the apprentice will dress and grind an internal or external radius tangent to an angle other than 90° or 0° holding tolerances correlated to the NIMS credentialing print for Machining – Level II Surface Grinding.

Related Instruction

The knowledge and skills you will need to pass the ***Surface Grinding: Horizontal Spindle, Reciprocating Table, Level I and Level II Machining Skills*** credentialing exams are as follows:

Grinding Safety: Basic shop practices should be applied in grinding operations. Proper housekeeping and cleanup procedures are imperative in safe grinding applications. Proper dress and lifting techniques are also important. Grinding wheel safety is the first step in any grinding procedure. The grinding wheel should be checked for cracks and fractures. Proper installation and wheel dressing are also important factors.

Measurement: Grinding is often considered a finishing operation after milling or rough turning. Grinding operations are usually applied in situations where high accuracy is desired. The apprentice must be able to read a micrometer or vernier micrometer (capable of measuring to .0001 inches). Proper application of dial indicators and height gages is important in measuring ground surfaces of different heights. Comprehension of surface finish specifications and measuring tool selection are essential inspection skills necessary to ensure quality.

Grinding Wheel Dressing: In order to achieve satisfactory surface finishes and to safely use a grinding wheel, the apprentice must understand and apply proper grinding wheel dressing techniques. Knowledge of the types of grinding wheels that can and cannot be dressed with a diamond dresser is essential for safe machining. Understanding the process of wheel trueing and wheel dressing and the effects of a poorly dressed grinding wheel provide the apprentice with basic troubleshooting knowledge for assessing the root cause of some grinding problems.

Types of Abrasives: Proper identification and application knowledge of the types of abrasives used in grinding operations provides a apprentice with the proper foundation for determining which type of abrasive is the most effective for a given grinding application. The apprentice should know the most common grinding abrasive as well as the hardest natural abrasive.

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WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296CB

Pedestal Grinder: The pedestal grinder is a free standing grinding machine used for roughing, snagging castings and sharpening high-speed lathe tool bits amongst other applications. Guard location and wheel dressing techniques differ for a pedestal grinder when compared to a surface grinder. The type of grinding wheel installed on the pedestal grinder is dependent on the application and the type of material being ground.

Work Holding: Proper work holding and piece part set-up is important in any grinding operation. The apprentice must know how to hold both ferrous and non-ferrous materials. The set-up for grinding angles and radii must be solid and accurate. The apprentice must know the purpose, theory and proper set-up of magnetic parallels when grinding ferrous materials.

Grinding Machine Components: To intelligently discuss grinding problems, grinding machine problem s and setups, the apprentice must be familiar with the names of the grinding machine components. The spindle nut on the grinder must be turned in the correct direction to either install or remove the grinding wheel from the spindle. Most machines will have a left-handed thread to self-tighten from the inertia of the grinding wheel. However, some older machines have the direction the nut must be rotated to tighten the same as wheel rotation.

Grinding Carbide and Carbide Tooling: Carbide can be ground by two types of grinding wheel material. The best abrasive for machining carbide is diamond. However, due to expense, some carbide grinding applications will use a green silicon carbide wheel. The silicon carbide wheel is inferior to diamond. Diamond wheels, if properly trued and dressed, will yield surface finishes that surpass surface finishes produced by silicon carbide grinding wheels.

NIMS CREDENTIAL: Level I CNC Milling and / or CNC Turning

Core Competency

CNC Programming - Milling

NIMS DUTY & PERFORMANCE STANDARD

Duty: Using the principles of Cartesian coordinates develop a program for the manufacture of a simple part.

Performance Standard: Given a computer and a basic CNC software program, and a blueprint for part comparison, apply the principles of three dimensional coordinate planes in the development of a simple program for the production of the part on a CNC milling machine.

PERFORMANCE OBJECTIVES (What an apprentice must know and/or do to perform the work competently.)

I. The apprentice will be able to describe the functions and use of basic G and M codes.

The apprentice will be able to identify coordinates on a blueprint with respect to an origin.

The apprentice will be able to implement linear interpolation into a program to cut straight lines between two points.

The apprentice will be able to implement circular interpolation into a program to cut true arcs and circles, using I & J (arc vector), and R (radium value) methods.

The apprentice will be able to write a program using the appropriate format for a particular machine control, and work from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc. that will be used.

CNC Programming - Turning

NIMS DUTY & PERFORMANCE STANDARD

Duty: Using the principles of Cartesian coordinates develop a program for the manufacture of a simple part.

Performance Standard: Given a computer and a basic CNC software program, and a blueprint for part comparison: apply the principles of two-dimensional coordinate planes in the development of a simple program for the production of the part on a CNC lathe or CNC turning center.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

m. The apprentice will be able to describe the functions and use of basic G and M codes.

The apprentice will be able to identify coordinates on a blue print with respect to an origin.

The apprentice will be able to implement linear interpolation into a program to cut straight lines between two points.

The apprentice will be able to implement circular interpolation into a program to cut true arcs and circles, using I & J (arc vector) and R (radius value) methods.

The apprentice will be able to write a program using the appropriate format for a particular machine control, and work from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc. that will be used.

Core Competency

CNC: Write a Simple CNC Milling Program and Review Tool Path

NIMS DUTY & PERFORMANCE STANDARD

Appendix A

WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296CB

Duty: Using a computer and editor software, write simple CNC programs using M and G codes from the Machinery's Handbook. Simple programs are single plane, cutter centerline, linear and circular interpolation, single cutter, with no canned cycles as specified on the print.

Performance Standard: Given a part print with the tool path shown, and computer with editor software, write a program, including speeds and feeds, to drive an end mill through a continuous path around three sides of a part requiring the development of a linear interpolation tool path as well as circular interpolation. Store the program on computer media.

PERFORMANCE OBJECTIVES (What an apprentice must know and/or do to perform the work competently.)

n. The apprentice will be able to describe the functions and use of basic G and M codes.

The apprentice will be able to identify coordinates on a blueprint with respect to an origin.

The apprentice will be able to calculate and implement speeds and feeds for proper tool life and surface finish.

The apprentice will be able to implement linear interpolation into a program to cut straight lines between two points.

The apprentice will be able to implement circular interpolation into a program to cut straight lines between two points.

The apprentice will be able to write a program using the appropriate format for a particular machine control, and work form a process plan to get guidance for sequences, steps, procedures, machining parameters, etc. that will be used.

CNC: Write a Simple CNC Turning Program and Review Tool Path

NIMS DUTY & PERFORMANCE STANDARD

Duty: Using a computer and editor software write simple CNC programs using M and G codes from the Machinery's Handbook. Simple programs are single plane, cutter centerline, linear and circular interpolation, single cutter, with no canned cycles as specified on the print.

Performance Standard: Given a part print with the tool path shown, and the computer with editor software; write a program including speeds and feeds, to drive a cutting tool through a continuous path following the geometry of a part requiring the development of a linear interpolation tool path as well as circular interpolation. Store the program on computer media.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

o. The apprentice will be able to describe the functions and use of basic G and M codes.

The apprentice will be able to identify coordinates on a blueprint with respect to an origin.

The apprentice will be able to calculate and implement speeds and feeds for proper tool life and surface finish.

The apprentice will be able to implement linear interpolation into a program to cut straight lines between two points.

The apprentice will be able to implement circular interpolation into a program to cut true arcs and circles, using the I & J (arc vector), and R (radius value) methods.

The apprentice will be able to write a program using the appropriate format for a particular machine control, and work from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc. that will be used.

Core Competency

CNC: Operate a CNC Milling Machine

NIMS DUTY & PERFORMANCE STANDARD

Duty: Operate a CNC Milling Machine

Performance Standard: Given a CNC mill, create a qualified CNC program, setup and operate the mill, change tool values as necessary, replace and qualify tooling as necessary.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

p. The apprentice will be able to describe the functions and use of basic G and M codes.

The apprentice will be able to identify coordinates on a blueprint with respect to an origin.

The apprentice will be able to calculate and implement speeds and feeds for proper tool life and surface finish.

The apprentice will be able to write a program using the appropriate format for a particular machine control, and work from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc. that will be used.

The apprentice will be able to install and qualify the required tooling for the program.

The apprentice will be able to mount, locate and set the origin of the work piece on a CNC milling machine.

The apprentice will be able to load a program, create a DNC-link, or enter a program via control keyboard into a CNC milling machine control.

The apprentice will be able to safely execute a program for its first run (debugging).

CNC: Operate a CNC Lathe

NIMS DUTY & PERFORMANCE STANDARD

Duty: Operate a CNC Lathe

Performance Standard: Given a CNC lathe create a qualified CNC program, setup and operate the lathe, change tool values as necessary, replace and qualify tooling as necessary.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

q. The apprentice will be able to describe the functions and use of basic G and M codes.

The apprentice will be able to identify coordinates on a blueprint with respect to an origin.

The apprentice will be able to calculate and implement speeds and feeds for proper tool life and surface finish.

The apprentice will be able to calculate and implement speeds and feeds for proper tool life and surface finish.

The apprentice will be able to write a program using the appropriate format for a particular machine control, and work from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc. that will be used.

The apprentice will be able to install and qualify the required tooling for the program.

The apprentice will be able to mount, locate, and set the origin of the workpiece on a CNC lathe.

The apprentice will be able to load a program, create a DNC-link, or enter a program via control keyboard into a CNC lathe control.

The apprentice will be able to safely execute a program for its first run (debugging).

CORE COMPETENCIES ALIGNED WITH ALL MACHINING CREDENTIALS

Core Competency

General Housekeeping and Maintenance

NIMS DUTY & PERFORMANCE STANDARD

Appendix A

WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296CB

Duty: Keep the duty station clean and safe for work. Keep the tools, workbenches, and manual equipment clean, maintained, and safe for work.

Performance Standard: Given maintenance, cleaning, and housekeeping checklists, as well as verbal instructions, clean, maintain, and respond appropriately to safety hazards on all benchwork tools and conventional and CNC machine tools. Maintain the cleanliness of the general work area.

Core Competency

Preventative Maintenance - Machine Tools

NIMS DUTY & PERFORMANCE STANDARD

Duty: Inspect and assess the general condition of an assigned machine tool. Make routine adjustments as necessary and as authorized. Reports problems to supervision that is beyond the scope of authority. Carry out daily, weekly, and/ or monthly routine upkeep chores cited on checklists for a given machine tool.

Performance Standard: Given the preventive maintenance procedures and schedules for a given machine tool, as well as sufficient instruction and experience to recognize maintenance problems, carry out routine maintenance, report problems which are beyond the scope of authority, fill out the history forms for tracking maintenance.

Core Competency

Tooling Maintenance

NIMS DUTY & PERFORMANCE STANDARD

Duty: Inspect and assess the condition of tooling. Refurbish tooling where appropriate. Refer tooling for repair or regrind where appropriate.

Performance Standard: Given samples of tooling in various conditions, diagnose the tooling, take the correct steps to put the tooling back in service. The sample tooling should include turning, milling, and drilling tools. These tools should be both insert tooling as well as conventional tooling. The apprentice must demonstrate the offhand grinding of a drill between the diameter of .125 inch and 1.000 inch. The offhand regrinding of a turning tool and the correct rotation and replacement of inserts in an insert style milling cutter body must be demonstrated. The apprentice must demonstrate the ability to recognize when a cutter should be referred to a tool and cutter grinder.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

Appendix A

WORK PROCESSES AND RELATED INSTRUCTION
MACHINIST (NIMS Certified)
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296CB

General Housekeeping and Maintenance

Given maintenance, cleaning and housekeeping checklist as well as verbal instructions, clean, maintain and respond appropriately to safety hazards on all bench work tools and conventional and CNC machine tools. Maintain the cleanliness of the general work area.

Preventative Maintenance - Machine Tools

Given a specific machine tool, the learner will locate, check and fill all applicable lubrication reservoirs, check for proper oil pressure and check that all lubrication points are functioning properly. Check the general condition of the equipment and make routine adjustments as stated in the maintenance schedule.

Tooling Maintenance

r. Diagnose tooling in various conditions and take the correct steps to put the tooling back in service.

Perform cutter-sharpening operations.

Understand insert identification nomenclature and index or change inserts.

Appendix A

Work Process:
MACHINIST
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296

This schedule is attached to and a part of these Standards for the above identified occupation.

1. TERM OF APPRENTICESHIP

The term of the occupation shall be 4 Year with an OJL attainment of 8000 hours supplemented by the required hours of related instruction.

2. RATIO OF APPRENTICES TO MENTORS

One (1) Apprentice may be employed in each department and/or jobsite employing one (1) qualified Mentor.

3. APPRENTICE WAGE SCHEDULE

Apprentices shall be paid a progressively increasing schedule of wages based on a percentage of the current Mentor wage rate.

Note: Sponsoring Employers will show their Mentor wage rate on the Employer Acceptance Agreement

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4. SCHEDULE OF WORK EXPERIENCE (See attached Work Process Schedule)

The Sponsor may modify the work processes to meet local needs prior to submitting these Standards to the appropriate Registration Agency for approval.

5. SCHEDULE OF RELATED INSTRUCTION (See attached Related Instruction Outline)

Appendix A

Work Process:
MACHINIST
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296

Description: Sets up and operates conventional, special-purpose, and numerical control (NC) machines and machining centers to fabricate metallic and nonmetallic parts, and fits and assembles machined parts into complete units, applying knowledge of machine shop theory and procedures, shop mathematics, machinability of materials, and layout techniques: Studies blueprints, sketches, drawings, manuals, specifications, or sample part to determine dimensions and tolerances of finished workpiece, sequence of operations, and setup requirements. Measures, marks, and scribes dimensions and reference points on material or workpiece as guides for subsequent machining. Selects, aligns, and secures holding fixtures, cutting tools, attachments, accessories, and materials on machines, such as mills, lathes, jig borers, grinders, and shapers. Calculates and sets controls to regulate machining factors, such as speed, feed, coolant flow, and depth and angle of cut, or enters commands to retrieve, input, or edit computerized machine control media. Starts and observes machine operation to detect malfunctions or out-of-tolerance machining, and adjusts machine controls or control media as required. Verifies conformance of finished workpiece to specifications, using precision measuring instruments. Sets up and operates machine on trial run to verify accuracy of machine settings or programmed control data. Fits and assembles parts into complete assembly, using jigs, fixtures, surface plate, surface table, handtools, and power tools. Verifies dimensions and alignment of assembly, using measuring instruments, such as micrometers, height gauges, and gauge blocks. May install machined replacement parts in mechanisms, machines, and equipment, and test operation of unit to ensure functionality and performance. May operate welding equipment to cut or weld parts. May develop specifications from general description and draw sketch of part or product to be fabricated. May confer with engineers, production personnel, programmers, or others to resolve machining or assembly problems.

ON-THE-JOB TRAINING:

	APPROXIMATE HOURS
A. TOOL CRIB	**500**
1. Learning names of raw materials and names and use of tools, jigs, fixtures and gauges.	
B. DRILLS	**500**
1. Power and radial drilling, tapping, ream-lapping, counterboring and countersinking, grinding drills, lubricants, cutting, speeds and feeds, safety.	
C. LATHE - ENGINE	**1500**
1. Chucking, use of face plate, mandrel, steady rest and follow rest, centering, straight turning, facing taper, turning with taper attachment, offset tail stock and compound, drilling, reaming.	

Appendix A

Work Process:
MACHINIST
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296

D. MILLING MACHINE **1000**

1. Plain, vertical and universal. Selection of cutters, methods of holding work, vise, clamps, dividing head, circular table - plain or slab, milling, sawing, boring, fly cutter milling, vertical head, keyway cutting, slotting, spline milling, rack cutting, cutter milling, gear cutting, gang milling, form milling, speeds and feed, lubricants, safety.

E. SHAPER AND PLANER **500**

1. Methods of holding work, vise, clamps, dividing head, surface and angle cutting, keyway cutting, squaring, dovetailing, speeds and feeds, grinding tools, safety.

F. SURFACE GRINDER **300**

1. Safety, selection of grinding wheels, speeds and feeds, mounting wheels, magnetic chuck, dressing wheels, plain or surface grinding, angle grinding, squaring.

G. UNIVERSAL GRINDER **500**

1. Safety, mounting wheels, speeds and feeds, dressing wheels, straight, taper, angle face, form and hole grinding.

H. CUTTER GRINDER **600**

1. Safety, mounting wheels, setting up indexing attachments, clearance angles for various types of cutters and reamers, setting up for these angles, grinding plain, spiral and end mills, reamers, form cutters.

I. HEAT TREATMENT **100**

1. Kinds of steel, S.A.E. classification, how to harden, draw, case and pack harden and anneal, use of pyrometer and color chart, hardness tests, quenching baths, and safety.

J. BENCH WORK **500**

1. Filing, scraping, chipping, layout and assembly, use of gauge blocks and dial indicator, vernier height gauge, lapping, tapping and threading, lubricants, inspection, safety.

K. GENERAL MACHINERY REPAIR **2000**

1. Inspection and adjusting, removing and replacing broken and worn parts of machine tools, scraping bearings and ways and rebuilding machines, welding.

L. TOTAL HOURS **8000**

Appendix A

RELATED INSTRUCTION OUTLINE
MACHINIST
O*NET/SOC CODE: 51-4041.00 RAPIDS CODE: 0296

Related instruction - This instruction may include, but not be limited to:

Note: Due to regional and local code differences and climate conditions, duration of instructional competencies/modules are suggested estimates.

Safety
Mathematics
Basic Blueprint Reading and Sketching
Tools and Equipment
Engine Lathes
Drives
Air Conditioning and Air Compressors
Drill Press
Radial Drill Press
Shaper
Planer
Farrel Wheel Borer
Grinding Technology
Magnaflux Unit
Wheel Press
Wheel Lathe
Bench Layouts
V Block and Clamp
Jack Screw
Journal Bearings

TOTAL HOURS 576

Appendix A

WORKPROCESS
Mechatronics Technician
O*NET-SOC CODE: 49-2094.00 RAPIDS CODE: 2014

This schedule is attached to and a part of these Standards for the above identified occupation.

1. TERM OF APPRENTICESHIP

The term of the occupation shall be 4 Year with an OJL attainment of 8000 hours supplemented by the required hours of related instruction.

2. RATIO OF APPRENTICES TO MENTORS

One (1) Apprentice may be employed in each department and/or jobsite employing one (1) qualified Mentor.

3. APPRENTICE WAGE SCHEDULE

Apprentices shall be paid a progressively increasing schedule of based on a percentage of the current Mentor wage rate.

Note: Sponsoring Employers will show their Mentor wage rate on the Employer Acceptance Agreement

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4. SCHEDULE OF WORK EXPERIENCE (See attached Work Process Schedule)

The Sponsor may modify the work processes to meet local needs prior to submitting these Standards to the appropriate Registration Agency for approval.

5. SCHEDULE OF RELATED INSTRUCTION (See attached Related Instruction Outline)

Appendix A

WORKPROCESS
Mechatronics Technician
O*NET-SOC CODE: 49-2094.00 RAPIDS CODE: 2014

	Hours
Safety	**250**
Preventive Maintenance	**1500**

Perform preventive maintenance on the various production and warehouse systems.
Develop and upgrade preventative maintenance procedures for components, equipment, parts and systems.
Perform preventative maintenance and calibration of equipment and systems.

Documentation	**50**

Maintain system logs and manuals to document testing and operation of equipment.
Procure parts and maintain inventory and related documentation.
Provide user applications and engineering support and recommendations for new and existing equipment with regard to installation, upgrades and enhancement.

Design /Build	**1500**

Build prototypes from rough sketches or plans.
Design basic circuitry and draft sketches for clarification of details and design documentation under engineers' directions, using drafting instruments and computer aided design equipment.
Read blueprints, wiring diagrams, schematic drawings, and engineering instructions for assembling electronics units, applying knowledge of electronic theory and components.
Assemble electrical and electronic systems and prototypes according to engineering data and knowledge of electrical principles, using hand tools and measuring instruments.
Install and maintain electrical control systems and solid state equipment.

Troubleshooting/Repair	**3200**

Appendix A

WORKPROCESS
Mechatronics Technician
O*NET-SOC CODE: 49-2094.00 RAPIDS CODE: 2014

Adjust and replace defective or improperly functioning circuitry and electronics components, using hand tools and soldering iron.
Assemble, test, and maintain circuitry or electronic components according to engineering instructions, technical manuals, and knowledge of electronics, using hand and power tools.
Identify and resolve equipment malfunctions, working with manufacturers and field representatives as necessary to procure replacement parts.
Test electronics units, using standard test equipment, analyze results to evaluate performance and determine need for adjustment.
Analyze and interpret test information to resolve design-related problems.
Modify electrical prototypes, parts, assemblies, and systems to correct functional deviations.

Communication/Collaboration **1500**

Maintain working knowledge of state-of-the-art tools, software, etc., through reading and/or attending conferences, workshops or other training.
Provide support and education, working with operators to identify needs, determine sources of problems and to provide information on function of processes.
Evaluate engineering proposals, shop drawings and design comments for sound electrical engineering practice and conformance with established safety and design criteria, and recommend approval or disapproval.
Provide technical assistance and resolution when electrical or engineering problems are encountered.
Review existing electrical engineering criteria to identify necessary revisions, deletions or amendments to outdated material.

Total 8000

Appendix A

RELATED INSTRUCTION OUTLINE
Mechatronics Technician
O*NET-SOC CODE: 49-2094.00 RAPIDS CODE: 2014

Related instruction - This instruction may include, but not be limited to:

Note: Due to regional and local code differences and climate conditions, duration of instructional competencies/modules are suggested estimates.

Communications Courses (Expository Writing and Into to Communications)	**96**
Mathematics (Algebra/Trigonometry I and II)	**96**
Safety (Industrial Safety/PPE/First Aid)	**48**
Technical Content (Application Software, DC/AC Circuit Analysis, Electronic Devices, Electrical Machines I and II, Digital Electronics, Intro to Automation, Robot Programming, Programmable Logic Controllers, Diagrams and Schematics, Intro to Automation, Linear IC Applications) Safety is a part of all Instructions	**336 (minimum)**
Total	**576**

Appendix A

WORK PROCESS SCHEDULE
METAL FABRICATOR
O*NET-SOC CODE: 51-2041.00 RAPID CODE: 0325

This schedule is attached to and a part of these Apprenticeship Standards for the above identified occupation.

1. TERM OF APPRENTICESHIP

The term of the occupation shall be three (3) or four (4) years with an OJL attainment of up to 2,000 hours per year for a total of 6,000 – 8,000 hours supplemented by the required hours of related instruction.

2. RATIO OF APPRENTICES TO MENTORS

One (1) Apprentice may be employed in each department and/or jobsite employing one (1) qualified Mentor.

3. APPRENTICE WAGE SCHEDULE

Apprentices shall be paid a progressively increasing schedule of based on a percentage of the current Mentor wage rate.

Note: Sponsoring Employers will show their Mentor wage rate on the Employer Acceptance Agreement

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4. SCHEDULE OF WORK EXPERIENCE (See attached Work Process Schedule)

The Sponsor may modify the work processes to meet local needs prior to submitting these Standards to the appropriate Registration Agency for approval.

5. SCHEDULE OF RELATED INSTRUCTION (See attached Related Instruction Outline)

Appendix A

WORK PROCESS SCHEDULE
METAL FABRICATOR
O*NET-SOC CODE: 51-2041.00 RAPID CODE: 0325

Job Processes (within courses)	Job Training Hours - 3 Year Program (6,000 hours)	Job Training Hours - 4 Year Program (8,000 hours)
Shielded Metal Arc Welding (SMAW) • Set-up SMAW equipment • Evaluate the quality of a SMAW weld • Run a stringer bead • Perform a butt joint (square) in the four basic positions • Perform a butt/groove weld in the four basic positions (flat, vertical, horizontal, overhead) • Perform a lap weld in the four basic positions (flat, vertical, horizontal, overhead) • Perform a t-joint/fillet in the four basic positions (flat, vertical, horizontal, overhead) • Perform a corner joint in the four basic positions (flat, vertical, horizontal, overhead) • Perform an edge joint in the four basic positions (flat, vertical, horizontal, overhead)	375	500
Gas Tungsten Arc Welding (GTAW) • Set-up GTAW equipment • Evaluate the quality of a GTAW weld • Perform a butt/groove weld in the four basic positions (flat, vertical, horizontal, overhead) • Perform a lap weld in the four basic positions (flat, vertical, horizontal, overhead) • Perform a t-joint in the four basic positions (flat, vertical, horizontal, overhead) • Perform a corner joint in the four basic positions (flat, vertical, horizontal, overhead) • Perform an edge joint in the four basic positions (flat, vertical, horizontal, overhead)	750	1,000
OxyFuel Cutting and Welding (OFC/W) • Set-up OFC equipment • Perform oxyfuel cutting • Perform oxyfuel welding • Perform oxyfuel brazing	390	520
Gas Metal Arc Welding (GMAW) • Set-up GMAW equipment • Perform a butt/groove weld in the appropriate position for short arc and/or pulse spray • Perform a lap weld in the appropriate position for	1,500	2,000

Appendix A

WORK PROCESS SCHEDULE
METAL FABRICATOR
O*NET-SOC CODE: 51-2041.00 RAPID CODE: 0325

Job Processes (within courses)	Job Training Hours - 3 Year Program (6,000 hours)	Job Training Hours - 4 Year Program (8,000 hours)
short arc and/or pulse spray • Perform a t-joint in the appropriate position for short arc and/or pulse spray • Perform a butt/groove weld in the flat or horizontal position using globular or spray method • Perform a lap weld in the flat or horizontal position using globular or spray method • Perform a t-joint weld in the flat or horizontal position using globular or spray method		
Rigging • Identify types of fiber rope • Demonstrate coiling and uncoiling techniques • Whip the end of a line • Inspect fiber rope • Splice fiber rope • Demonstrate the ability to tie various types of knots with fiber rope • Reeve rope falls • Identify types of wire ropes • Inspect wire ropes • Attach end fittings to wire rope • Identify rigging hardware • Demonstrate the use of a single choker hitch • Demonstrate the use of a double wrap choker hitch • Demonstrate the use of a single basket hitch • Demonstrate the use of a double wrap basket hitch • Inspect and use chains • Use an overhead crane • Use a jack • Use a roller • Use a pulling device • Operate a fork lift • Demonstrate crane signals	188	250
Tools and Equipment Set-up and use the following: • Hand tools • Measuring devices • Precision measuring instruments • Shears • Punch press	1,125	1,500

Appendix A

WORK PROCESS SCHEDULE
METAL FABRICATOR
O*NET-SOC CODE: 51-2041.00 RAPID CODE: 0325

Job Processes (within courses)	Job Training Hours - 3 Year Program (6,000 hours)	Job Training Hours - 4 Year Program (8,000 hours)
• Drill press • Grinders • Bending brakes • Saws • Beam drilling line • Beam punch line • Plate drilling machine • Plate cutting machine • Brakes • Rolls • Ironworker		
Fabrication and Assembly • Position, align, fit, and weld parts to form complete units or subunits, following blueprints and layout specifications, and using jigs, welding torches, and hand tools • Verify conformance of work pieces to specifications, using squares, rulers, and measuring tapes • Tack-weld fitted parts together • Layout and examine metal stock or work pieces to be processed to ensure that specifications are met • Align and fit parts according to specifications, using jacks, turnbuckles, wedges, drift pins, pry bars, and hammers • Locate and mark work piece bending and cutting lines, allowing for stock thickness, machine and welding shrinkage, and other component specifications • Position or tighten braces, jacks, clamps, ropes, or bolt straps, or bolt parts in position for welding or riveting • Study engineering drawings and blueprints to determine materials requirements and task sequences • Move parts into position, manually or with hoists or cranes	1,672	2,230
Total Hours	**6,000**	**8,000**

Appendix A

RELATED INSTRUCTION OUTLINE
METAL FABRICATOR
O*NET-SOC CODE: 51-2041.00 RAPIDS CODE: 0325

Related instruction - This instruction may include, but not be limited to:

Note: Due to regional and local code differences and climate conditions, duration of instructional competencies/modules are suggested estimates.

Course	Hours Required	
	Classroom	**Shop**
Training and Fabrication for Shop Ironworkers	30	50
Introduction to Blueprint Reading	20	0
Mathematics for Ironworkers	30	0
10-Hour OSHA Training	10	0
Scaffold Erector/Dismantler Training for Ironworkers	12	4
First Aid/CPR	8	0
Welding (OxyFuel, SMAW, GTAW, GMAW)	30	100
Rigging and Cranes	40	40
Structural Steel Erection 1	30	20
Fork Lift	6	2
Layout Instruments for Ironworkers	10	10
Supervisor Training for Shop Ironworkers	24	0
Total Classroom and Shop Hours	**250**	**226**
Total Hours	**476**	
*Knowledge of Architectural Metal Panel Cladding Systems **(TSI Employees Only)**	20	20
Total Classroom and Shop Hours	270	246
Total Hours	**516**	

Appendix A

WORK PROCESS SCHEDULE
WELDER-ARC
O*NET/SOC CODE: 51-4121.02 RAPIDS CODE: 0620

This schedule is attached to and a part of these Standards for the above identified occupation.

1. TERM OF APPRENTICESHIP

The term of the occupation shall be 4 Year with an OJL attainment of 8000 hours supplemented by the required hours of related instruction.

2. RATIO OF APPRENTICES TO MENTORS

One (1) Apprentice may be employed in each department and/or jobsite employing one (1) qualified Mentor.

3. APPRENTICE WAGE SCHEDULE

Apprentices shall be paid a progressively increasing schedule of wages based on a percentage of the current Mentor wage rate.

Note: Sponsoring Employers will show their Mentor wage rate on the Employer Acceptance Agreement

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4. SCHEDULE OF WORK EXPERIENCE (See attached Work Process Schedule)

The Sponsor may modify the work processes to meet local needs prior to submitting these Standards to the appropriate Registration Agency for approval.

5. SCHEDULE OF RELATED INSTRUCTION (See attached Related Instruction Outline)

Appendix A

WORK PROCESS SCHEDULE
WELDER-ARC
O*NET/SOC CODE: 51-4121.02 RAPIDS CODE: 0620

Description: Welds together metal components of products, such as pipelines, automobiles, boilers, ships, aircraft, and mobile homes, as specified by layout, blueprints, diagram, work order, welding procedures, or oral instructions, using electric arc-welding equipment: Obtains specified electrode and inserts electrode into portable holder or threads consumable electrode wire through portable welding gun. Connects cables from welding unit to obtain amperage, voltage, slope, and pulse. Starts power supply to produce electric current. Strikes (forms) arc which generates heat to melt and deposit metal from electrode to workpiece and join edges of workpiece. Manually guides electrode or gun along weld line, maintaining length of arc and speed of movement to form specified depth of fusion and bead, as judged from color of metal, sound of weld, and size of molten puddle. Welds in flat, horizontal, vertical, or overhead positions. Examines weld for bead size and other specifications. May manually apply filler rod to supply weld metal. May clean or degrease weld joint or workpiece, using wire brush, portable grinder, or chemical bath. May repair broken or cracked parts and fill holes. May prepare broken parts for welding by grooving or scarfing surfaces. May chip off excess weld, slag, and spatter, using hand scraper or power chipper. May preheat workpiece, using hand torch or heating furnace. May position and clamp work pieces together or assemble them in jig or fixture. May tack assemblies together. May cut metal plates or structural shapes. May operate other machine shop equipment to prepare components for welding. Important variations include types of metals welded, sub processes used, trade name of equipment used, work site (in-plant, job shop, construction site, shipyard), method of application (manual, semiautomatic), high-production or custom, level of ambidexterity required, type of joints welded (seam, spot, butt). May be required to pass employer performance tests or standard tests to meet certification standards of governmental agencies or professional and technical associations.

ON-THE-JOB TRAINING:

APPROXIMATE HOURS

A. 1300
1. Blueprint reading and sketching
2. Use and handling of oxyacetylene gas
3. Operate torch, simple cutting and lancing
4. Safety

B. 1350
1. Prepare jobs
2. Machine setting and arc conditions
3. Adjust torch and gauges for proper flame conditions such as neutral, reducing and oxidizing flame, rubber arc, short force full arc, tiny, concentrated, depositing and digging arc
4. Simple welding (arc, acetylene)
5. Safety

Appendix A

WORK PROCESS SCHEDULE
WELDER-ARC
O*NET/SOC CODE: 51-4121.02 RAPIDS CODE: 0620

APPROXIMATE HOURS

C. 1350
1. Downhand welding
2. Vertical, horizontal, overhead
3. Pipe welding - all positions
4. Bead, deep groove, lap joint, butt joint corner and fillet welding with bare and coated mild steel rod arc and acetylene
5. Safety

D. 1350
1. Special practices
2. Arc cutting, carbon electrode
3. Carbon arc test welding
4. Cast iron, medium carbon and high carbon
5. Automatic submerged arc welding
6. Safety

E. 1350
1. Hard surfacing (arc, acetylene)
2. Tool steel (hot and cold working)
3. Low alloys (arc and acetylene)
4. High alloys (arc and acetylene)
5. Martensitic, ferritic, austenitic
6. Safety

F..... 1300
1. Non-ferrous alloys
2. All types of welding at hand (arc and acetylene)
3. Safety

TOTAL HOURS **8000**

Appendix A

RELATED INSTRUCTION
WELDER-ARC
O*NET/SOC CODE: 51-4121.02 RAPIDS CODE: 0620

Related instruction - This instruction may include, but not be limited to:

Note: Due to regional and local code differences and climate conditions, duration of instructional competencies/modules are suggested estimates.

	Hours
Mathematics for Welding Technicians	54
Introduction to Welding	90
Introduction to Welding Technology	90
Welding Inspection	36
Shielding Metal Arc 1 Welding (Stick)	90
Shielding Metal Arc 2 Welding (Stick)	90
Advanced Pipe Welding in Shielded Metal Arc	90
Gas Tungsten Arc Welding	90
Gas Tungsten Arc Welding (Pipe)	90
Gas Arc Welding: Semi Automatic Processes	90
Gas arc Welding: Ferrous and non-Ferrous Metals	72
Flux Core Arc Welding	90
Symbol Reading, Layout and Fabrication	90
TOTAL HOURS	**1062**

Appendix A

WORK PROCESS SCHEDULE
WELDER, COMBINATION
O*NET-SOC CODE: 51-4121.02 RAPIDS CODE: 0622R

This schedule is attached to and a part of these Standards for the above identified occupation.

1. TERM OF APPRENTICESHIP

The term of the occupation shall be 4 Year with an OJL attainment of 7328 hours supplemented by the required hours of related instruction.

2. RATIO OF APPRENTICES TO MENTORS

One (1) Apprentice may be employed in each department and/or jobsite employing one (1) qualified Mentor.

3. APPRENTICE WAGE SCHEDULE

Apprentices shall be paid a progressively increasing schedule of wages based on a percentage of the current Mentor wage rate.

Note: Sponsoring Employers will show their Mentor wage rate on the Employer Acceptance Agreement

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4. SCHEDULE OF WORK EXPERIENCE (See attached Work Process Schedule)

The Sponsor may modify the work processes to meet local needs prior to submitting these Standards to the appropriate Registration Agency for approval.

5. SCHEDULE OF RELATED INSTRUCTION (See attached Related Instruction Outline)

Appendix A

WORK PROCESS SCHEDULE
WELDER, COMBINATION
O*NET-SOC CODE: 51-4121.02 RAPIDS CODE: 0622R

Curricula modules are based on industry standardized applications of current construction practices. Modules are knowledge and skill based including a system for assessment. The assessment will include task objectives, procedures, review materials, and competency-based performance tests.

WELDER WORK PROCESS SCHEDULE	**HOURS**

This instruction and experience shall include the following operations, but not necessarily in the listed sequence. Time spent on specific operations need not be continuous.

1. General Trade 2000
   a. Demonstrate proper safety precautions and procedures
   b. Electrode identification
   c. Interpretation of blueprints and specifications
   d. Proper use of welding tools and equipment

2. Cutting Process 1164
   Oxyfuel Cutting

3.Welding Process 3000
   a Use of low hydrogen electrodes
   b. Fast freeze electrodes
   c. Pipe welding
   d. SMAW pipe welding
   e. GTAW pipe welding

4.Related Welding Activities 1164
   a. Welded joints
   b. Power joints
   c. Weld testing
   d. Polarities & Arc Blow
   e. Codes and Qualification

TOTAL HOURS **7328**

Appendix A

RELATED INSTRUCTION
WELDER, COMBINATION
O*NET-SOC CODE: 51-4121.02 RAPIDS CODE: 0622R

Related instruction - This instruction may include, but not be limited to:

Note: Due to regional and local code differences and climate conditions, duration of instructional competencies/modules are suggested estimates.

WELDER RELATED CLASSROOM INSTRUCTION

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Modules	Hours
Basic Safety	15
Introduction to Construction Math	15
Introduction to Hand Tools	10
Introduction to Power Tools	5
Introduction to Blueprints	7.5
Basic Rigging	20
Welding Safety	2.5
Oxyfuel Cutting	17.5
Base Metal Preparation	12.5
Weld Quality	10
SMAW - Equipment and Setup	5
SMAW - Electrodes and Selection	2.5
SMAW - Beads and Fillet Welds	120
SMAW - Groove Welds with Backing	10
Joint Fit-Up and Alignment	5
SMAW - Open V-Groove Welds	120
SMAW - Open-Root Pipe Welds	100
Welding Symbols	5
Reading Welding Detail Drawings	12.5
Stainless Steel Groove Welds	80
Air Carbon Arc Cutting and Gouging	12.5
Plasma Arc Cutting	7.5
GMAW and FCAW - Equipment and Filler Metals	10
GMAW and FCAW - Plate	80
GTAW - Equipment and Filler Metals	10
GTAW - Plate	40
GTAW - Aluminum Plate	50
TOTAL HOURS	**785**

*DOL apprenticeship program standards recommend 144 hours related instruction per level and/or year.

Appendix A

RELATED INSTRUCTION:
WELDER-FITTER
O*NET CODE: 51-4121.03 RAPIDS CODE: 0627

This schedule is attached to and a part of these Standards for the above identified occupation.

1. TERM OF APPRENTICESHIP

The term of the occupation shall be 4 Years with an OJL attainment of 8000 hours supplemented by the required hours of related instruction.

2. RATIO OF APPRENTICES TO MENTORS

One (1) Apprentice may be employed in each department and/or jobsite employing one (1) qualified Mentor.

3. APPRENTICE WAGE SCHEDULE

Apprentices shall be paid a progressively increasing schedule of wages based on a percentage of the current Mentor wage rate.

Note: Sponsoring Employers will show their Mentor wage rate on the Employer Acceptance Agreement

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4. SCHEDULE OF WORK EXPERIENCE (See attached Work Process Schedule)

The Sponsor may modify the work processes to meet local needs prior to submitting these Standards to the appropriate Registration Agency for approval.

5. SCHEDULE OF RELATED INSTRUCTION (See attached Related Instruction Outline)

Appendix A

RELATED INSTRUCTION:
WELDER-FITTER
O*NET CODE: 51-4121.03 RAPIDS CODE: 0627

Description: Lays out, fits, and welds fabricated, cast, and forged components to assemble structural forms, such as machinery frames, tanks, pressure vessels, furnace shells, and building and bridge parts, according to blueprints and knowledge of welding and metallurgy: Selects equipment and plans layout, assembly, and welding, applying knowledge of geometry, physical properties of metal machining weld shrinkage, and welding techniques. Lay out, positions, aligns, and fits components together. Bolt, clamp, and tack-weld part to secure in position for welding. Sets up equipment and welds parts, using arc, gas-shielded arc, submerged arc, or gas welding equipment. May assemble parts by bolting and riveting. May repair products by dismantling, straightening, reshaping, and reassembling parts, using cutting torch, straightening press, and hand tools. May specialize in using one welding process. May specialize in fitting and welding components of metal tools, dies, and fixtures.

ON-THE-JOB TRAINING:

	APPROXIMATE HOURS
A. Shop Information	100
1. Safety procedures	
2. Stocking and storage procedures	
3. Tool and equipment maintenance	
4. Job ticket information	
B. Rigging	500
1. Safety procedures	
2. Use of ropes, cables, chains	
3. Cranes, derricks, jacks	
4. Cable splicing	
5. Field rigging	
6. Moving, loading, lashing	
C. Maintenance of Equipment	500
1. Care and use of tools	
2. Dismantling	
3. Field rigging	
4. Moving field equipment	
D. Layout and Fabrication	1900
1. Cutting	
2. Bending	
3. Assembling	
4. Tacking and welding	
E. Welding	5000
1. Acetylene	
2. Electric arc welding	
3. Cutting and burning	
4. Mug & Tag	
TOTAL HOURS	**8000**

Appendix A

RELATED INSTRUCTION:
WELDER-FITTER

O*NET CODE: 51-4121.03 RAPIDS CODE: 0627

Related instruction - This instruction may include, but not be limited to:

Note: Due to regional and local code differences and climate conditions, duration of instructional competencies/modules are suggested estimates.

A. Blueprint Reading

B. Mathematics

C. Welding

D. Sheetmetal

E. Safety and First Aid

TOTAL HOURS 1152

Appendix A

WORK PROCESS SCHEDULE
WELDING-MACHINE OPERATOR, ARC
O*NET/SOC CODE: 51-4122.01 RAPIDS CODE: 0945

This schedule is attached to and a part of these Standards for the above identified occupation.

1. TERM OF APPRENTICESHIP

The term of the occupation shall be 3 Year with an OJL attainment of 6000 hours supplemented by the required hours of related instruction.

2. RATIO OF APPRENTICES TO MENTORS

One (1) Apprentice may be employed in each department and/or jobsite employing one (1) qualified Mentor.

3. APPRENTICE WAGE SCHEDULE

Apprentices shall be paid a progressively increasing schedule of wages based on a percentage of the current Mentor wage rate.

Note: Sponsoring Employers will show their Mentor wage rate on the Employer Acceptance Agreement

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4. SCHEDULE OF WORK EXPERIENCE (See attached Work Process Schedule)

The Sponsor may modify the work processes to meet local needs prior to submitting these Standards to the appropriate Registration Agency for approval.

5. SCHEDULE OF RELATED INSTRUCTION (See attached Related Instruction Outline)

Appendix A

WORK PROCESS SCHEDULE
WELDING-MACHINE OPERATOR, ARC
O*NET/SOC CODE: 51-4122.01 RAPIDS CODE: 0945

Description: Sets up and operates arc welding machine that welds together parts of fabricated metal products, as specified by blueprints, layouts, welding procedures, and operating charts: Welds flat, cylindrical, or irregular parts that may be clamped, tack-welded, or otherwise positioned. May position weld line parallel to carriage. Turns cranks or pushes buttons to align electrode on welding head over weld joint to weld linear joints, or adjust length of radial arm to position electrode over weld joint when welding radial joints. Clamps cylindrical work pieces onto turning rolls under stationary head to weld circular joints. Threads specified electrode wire from reel through feed rolls and welding head. Turns welding head to set specified angle of electrode. May fill hopper with specified flux and direct nozzle or gravity feed over weld line, or adjust shielding gas or gas mixture flow rate. Turns knobs to set current, voltage, and slope, and synchronize feed of wire and flux with speed of welding action. May set limit switch which automatically stops machine at end of weld. Starts machine and observes meters and gauges, or observes welding action for compliance with procedures. Visually examines welds for adherence to specifications. May grind welded surfaces for penetrant test. Adjusts machine setup to vary size, location, and penetration of bead. May install track template to weld irregularly shaped seams. May make trial run before welding and record setup and operating data. May layout, fit, and tack work pieces together. May preheat workpiece, using hand torch or heating furnace. May reweld defective joints, using hand-welding equipment. May remove surplus slag, flux, and spatter, using brush, portable grinder, and hand scraper. May operate machine equipped with two or more heads.

ON-THE-JOB TRAINING:

	APPROXIMATE HOURS
A. Gas Welding (Heli-Arc)	**2100**
1. Set-up and operation of equipment	
2. Selection of proper rods and fluxes	
3. Welding of hub equipment - (molds, trimmers, etc)	
4. Weld repair of press forming equipment (molds, rings, plungers, etc.)	
5. Pre-heat and post-heat of glass forming equipment	
B. Stud Welding	**240**
1. Set-up and operation of electric-arc stud welder	
2. Set-up and operation of capacitor discharge stud welder	
3. Locating stud position by use of templates and drawings	
C. Oxygen, Acetylene Weldingq	**600**
1. Use and maintenance of oxygen/acetylene welding equipment	
2. Weld repairing super alloy and precision case mold equipment	

Appendix A

WORK PROCESS SCHEDULE
WELDING-MACHINE OPERATOR, ARC
O*NET/SOC CODE: 51-4122.01 RAPIDS CODE: 0945

	APPROXIMATE HOURS
D. Fusewelding (Powder)	**600**
1. Use and maintenance of fusewelding torch and related equipment	
2. Repairs to cast iron mold equipment where build-up type repair or alteration is required	
E. Plasma Spray	**1800**
1. Set-up as required for mold, roll, plunger, and related forming equipment spraying	
2. Dimensional checks of items prior to, between coatings, and after coating	
3. Spraying techniques in horizontal and vertical positions	
4. Equipment preparation prior to coating application	
F. Wire Spray	**120**
1. Set-up and maintenance of equipment	
2. Surface build-up of forming related equipment	
G. Electric Welding	**240**
1. Set-up and operation of various electrical welding equipment	
2. Welding non-ferrous and ferrous alloys including: cast iron, hoot and cold rolled steel, stainless steel, and aluminum	
3. Job preparation	
H. Miscellaneous	**300**
1. Grinding (weld preparation)	
2. Preheat	
3. Safety involved	
4. Operation of blase cleaning equipment	
TOTAL HOURS	**6000**

Appendix A

RELATED INSTRUCTION:
WELDING-MACHINE OPERATOR, ARC

O*NET/SOC CODE: 51-4122.01 RAPIDS CODE: 0945

Related instruction - This instruction may include, but not be limited to:

Note: Due to regional and local code differences and climate conditions, duration of instructional competencies/modules are suggested estimates.

	Hours
A. Safety in welding and cutting	12
B. Practical arithmetic	72
C. Elements of print reading	12
D. Reading shop prints	24
E. Formulas	12
F. Industrial accident prevention	24
G. Going metric	12
H. Measuring instruments	24
I. Metallurgy of iron	12
J. Metallurgy of steel	12
K. Metallurgy of non-ferrous metals	24
L. Metallography	12
M. Hardening and tempering	12
N. Heat treatment	24
O. Gas welding equipment	12
P. Gas welding techniques	36
Q. Gas cutting	24
R. Electricity	36
S. Arc welding equipment	36
T. Arc welding techniques	24
U. Arc welding of low carbon steel	24
V. Arc welding of alloy steels and iron	12
W. Arc welding of non-ferrous metals and overlapping	12
X. Gas shielded arc welding	36
Y. Fabrication of pipe by welding	24
Z. Inspection and testing of welds	12
AA. Bench work	24
BB. Drawings for welded parts (4 drawings/1 unit)	12
CC. D-C generators and motors	12
DD. A-C motors, generators and rectifiers	12
EE. Welded and riveted joints	12

TOTAL HOURS 648

Appendix A

WORK PROCESS SCHEDULE
Machine Operator I
O*NET/SOC CODE: 51-4081.01 RAPIDS CODE: 0511

DESCRIPTION: Sets up and operates metal fabricating machines, such as brakes, rolls, shears, saws, and presses, to cut, bend, straighten, and form metal plates, sheets, and structural shapes according to blueprints and specifications: Reads and interprets blueprints, engineering specifications, and shop orders to determine machine setup, production methods, and sequence of operation. Selects, positions, and secures dies, blades, cutters, and fixtures onto machine, using rule, square, shims, templates, handtools, and built-in gauges. Positions and clamps stops, guides, and turntables. Adjusts controls to set and regulate machining factors, such as pressure and depth of ram stroke, adjustment rolls, blade angle, and machine speed. Locates and marks bending or cutting lines and reference points on workpiece, using instruments, such as rule and compass, or by tracing from templates. Positions workpiece against stops and guides or aligns layout marks with dies or cutting blades manually or using hoist. Starts machine and observes machine operation to reposition workpiece, change dies, or adjust machine settings for multiple or successive passes. Inspects or measures work, using rule, gauges, and templates. May operate machines to fabricate nonmetallic materials, such as composites or plastics. May set up and operate sheet-metal fabricating machines.

ON-THE-JOB TRAINING:

	APPROXIMATE HOURS
KNOWLEDGE OF MACHINE OPERATION	500
MACHINE SET-UP	500
CARE AND USE OF TOOLS	500
OPERATION INSPECTION	500
TOTAL HOURS	**2000**

RELATED INSTRUCTION:

Machine Operator I
O*NET/SOC CODE: 51-4081.01 RAPIDS CODE: 0511

Related instruction - This instruction may include, but not be limited to:

Note: Due to regional and local code differences and climate conditions, duration of instructional competencies/modules are suggested estimates.

Mathematics
Blueprint Reading

Total Hours 144