# Assessment Development Process

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The Automotive Manufacturing Technical Education Collaborative (AMTEC) National Center of Excellence in Advanced Automotive Manufacturing is funded by the National Science Foundation as an Advanced Technological Education Center. AMTEC was designed and established as a recognized collaboration of community colleges and automotive original equipment manufacturers and suppliers working to strengthen the competency and global competitiveness of our automotive manufacturing and service technology. As Figure 1 below indicates, their core functions include three major components: (1) the identification and validation of international occupational standards, (2) the linking of occupational standards to related training curriculum, and (3) assessing the occupational standards through standardized tests and certification. The value of the AMTEC program is that they are committed to delivering the entire package with an innovative instructional methodology linked to the program.

**Figure 1**
**Core Function of Occupational and Certification Programs**

The following information describes each of the three core functions as developed through the AMTEC partnerships.

## Core Function 1--Developing Occupational Standards

AMTEC has developed a comprehensive list of occupational standards through a process called DACUM. DACUM is an acronym for Develop a Curriculum and uses guided group discussion with expert workers. AMTEC used an enhanced DACUM process, referred to as Turbo-DACUM, which is a systematic, methodical, and rigorous process that results in an extremely detailed document focused on the actual work performed by multi-skilled maintenance technicians in the modern manufacturing production process. The occupational standards were identified using the following steps:

1. Used the subject matter experts to identify the standards
   In September, 2007, the AMTEC standards were developed by subject matter experts in the classification of Multi-Skilled maintenance technicians at the Toyota Motor Manufacturing plant in Georgetown, KY. The subject matter experts represented maintenance technicians from various departments at Toyota including building facilities, stamping, plastics, paint, body-weld, powertrain, and assembly. All of the experts were actual workers--not their supervisors, nor trainers. The experts were asked to detail the tasks they actually perform on their job.

2. Collected details and work enablers

The AMTEC leadership knew that a general description of the standards was not sufficient for curriculum and assessment development; therefore, the Turbo-DACUM process breaks the skills down into details. For example, one of the maintenance standards identified was "Troubleshooting/repairing/replacing brakes and clutches." However, the Turbo-DACUM process collected specific details about the task by asking the subject matter experts to identify specific work performed on brakes and clutches and provides details such as inspecting the breaks for wear and disassembling the disks and pads.

3. Identified work enablers required to perform each standard

All occupational standards or tasks require enabling content knowledge, skills, or attributes to be effectively performed. Therefore, the Turbo-DACUM process used the subject matter experts to identify the following work enablers

**Tools and Equipment:** What types of tools and equipment are needed to perform this task, and what skills do maintenance workers need to operate these tools and equipment?

**Calculations:** What calculations are required to perform this task, and what math skills are required to perform these calculations?

**Communications:** How much does the maintenance worker communicate with others to perform this task, and what communication skills are required to do so?

**Technology:** What technology is needed to perform this task, and what technological skills must the worker have in order to do so?

**Safety:** What safety practices are associated with performing this task, and what knowledge of safety practices must the maintenance work know in order to successfully accomplish this task?

The result of the process is a comprehensive set of 26 "duty areas" and more than 170 occupational standards in the form of detailed and task statements of actual work performed. Appendix A contains the comprehensive list of duties and task.

4. Weighted the importance of each duty area and rated the criticality of each occupational standard by plant

AMTEC automotive partners and AMTEC educational institutions operate in different ways across regions and state lines. Therefore, AMTEC used an electronic Delphi process to have each automotive partner weigh the duty areas and rate the standards for their specific application and plant needs. This analysis provides the educational partners in a local region the ability to customize their work to meet their specific needs. Such

knowledge gives the local college a tremendous amount of information about how the local plant operates and, hence, how to emphasize or de-emphasize the different standards in their region.

5. Synthesized data to develop a "core" set of standards for all partners

In August, 2008, AMTEC conducted a workshop where industry partners along with college partners, systematically analyzed the data from the Delphi to create a "core" list of occupational standards. The core standards include approximately 20 duty areas and 100 task-based standards. Appendix B contains the list of core competencies along with the grand mean scores from the Delphi study. This set of core standards provides the colleges with an excellent model to build their academic programs in alignment to industry core needs.

Following an analysis of the DACUM using a Delphi process, a written assessment was created that aligned to a common core of competencies taken from the customized job and task analysis. The pilot test version of the written test (Version A) contained 197 multiple choice test items.

**Core Function 2—Turning Occupational Standards into Curriculum**

AMTEC partners knew that the colleges' curriculum must be linked to the occupational standards if training was to be relevant to the real world of work. Therefore, the needs for employment (occupational standards) were translated into a language that can be understood in education and training, which enable the college partners to plan and deliver relevant academic programs. AMTEC began working with the college partners to develop concrete linkages between the industry-developed standards and their curricula. AMTEC completed the following steps to help turn the occupational standards into curriculum or training:

1. Conducted a series of regional gap analysis of current delivery

An important step of the AMTEC identification of the standards was to have the actual college instructors examine the list of standards required and identify which skills are being currently being taught and which were not taught. This gap analysis helps both the companies and colleges determine gaps in their current curriculum, producing increased efficiency and productivity in both the delivery and learning process and allowing for a high level of acceleration given individual and industry needs.

2. Used industry partners to create a model academic curriculum

AMTEC conducted a workshop in which industry and college partners collaboratively allocated the list of "core" standards into academic courses and then broke the courses into modules. Using an academic structure of approximately 45 credit hours for an associate degree, the partners collaboratively allocated the core standards into 12 courses that include estimates on clock time for lecture and lab opportunities. They then

allocated the standards identified for each course into smaller curriculum modules which were also provided with clock time estimates. The academic curriculum structure serves as a model that could be adopted by the colleges as they provide training for their local industry partners. The workshop also collected industry and college partners' recommendations for curriculum resources and provided opportunities for curriculum sharing.

## Core Function 3--Assessing of Occupational Standards

The AMTEC partners collaborated to create a credentialing assessment of occupational standards as a critical link in the project. The assessment is directly linked to and developed from the occupational standards. The certification has multiple objectives:

a. For **students and incumbent workers**, the assessment can lead to certification, assist in initial job entry and upward and horizontal career mobility, and in the context of lifelong learning, provide a method of documenting competencies learned at different times and through different avenues.

b. For **employers**, certifications and assessments assist in hiring, promotion, and planning for internal training.

c. For **educational institutions**, certification and assessments provide a method for benchmarking the quality of skills and knowledge provided against the occupational standards actually required in an occupation.

The assessment development process included the following steps:

1. Create a table of test specification (test blueprint)

   Using the Delphi mean ratings, a test specification was created as the blueprint for the assessments. Appendix C contains the test specification by duty area and Appendix D contains the test specification by task.

2. Used industry subject matter experts to develop a test item bank and develop the pilot test version

   AMTEC conducted a series of item writing sessions to develop a comprehensive test item bank linked to individual occupational standards. The items were written by using industry subject matter experts as well as faculty at the community colleges.

3. Administered the pilot assessment to incumbent workers to identified training needs

   AMTEC administered the standardized assessments linked to the core standards to incumbent industry workers. This data served as the pilot test of the assessment.

## Cut Score Process

A standard setting workshop was held on May 28, 2010, via conference call. The workshop was conducted by Dr. Katherine Manley, Professor, Ferris State University, Big Rapids, MI. Dr. Manley explained the process that would be used to establish the cut score on the custom-developed AMTEC Version A assessment. The expert panel used to set this cut score was composed of industry content experts who were involved in the job analysis and test development phases of the project. This report contains the process used to establish the cut score for the multiple-choice format written test.

There are numerous methods for setting cut scores on written assessments. Dr. Manley recommended the Jaeger method and believes that this method has greater validity in occupational competency testing. The Jaeger method has been used for setting standards on high stakes tests, such as high school graduation tests, and is widely accepted as a valid standard setting method. The method requires reviewers to identify which items on an examination an examinee should be able to answer correctly.

Therefore, the criterion question used for this test was:

- *"Is it essential that a candidate answer this item correctly in order to be certified as a Multi-Skilled Automotive Maintenance Technician by AMTEC"?*

The panel was provided a copy of the written test and asked to rate each item by providing a "yes" or "no" judgment about the item relative to the criterion question. Participants were asked to articulate the reason(s) for these decisions, followed by discussion, and consensus (majority rule) was used to determine the item judgment. A summary of the panel's judgments by item on the written assessment may be found in Appendix E.

The Jaeger method also requires that the panel assess the validity of the items against data from a sample group of test takers. AMTEC had pilot tested the items with a group of 214 candidates. Therefore, the panel was provided with a copy of the test along with the answer noted and the percentage of pilot test takers selecting each distracter. The results of the panel decisions for Round One are found in Table 1 below.

**Table 1**
**Results of Panel Judgments on Test Items after Round One**

| Test Category | Number of Test Questions | Number of Questions Determined to be Essential After Round 1 | Percent Required for Passing |
|---|---|---|---|
| A: Mechanical Equipment | 13 | 12 | 92.3% |
| B: Pneumatic/Hydraulic Equipment | 14 | 12 | 85.7% |
| D: Predictive/Corrective Maintenance | 8 | 8 | 100.0% |
| E: Blueprint Reading/Schematics | 13 | 11 | 84.6% |
| F: Equipment Controls and Sensors | 12 | 10 | 83.3% |
| G: Electrical Equipment | 11 | 9 | 81.8% |
| H: Electronic Equipment | 8 | 6 | 75.0% |

| | | | |
|---|---|---|---|
| I: Networking | 8 | 7 | 87.5% |
| J: PLC | 13 | 12 | 92.3% |
| L: Robots | 10 | 9 | 90.0% |
| M: Resistance Welding | 7 | 7 | 100.0% |
| O: Fabricate | 8 | 8 | 100.0% |
| P: Computer Literacy | 11 | 11 | 100.0% |
| Q: Preventative Maintenance | 12 | 9 | 75.0% |
| U: Specialty Equipment | 10 | 9 | 90.0% |
| V: Metrology | 7 | 6 | 85.7% |
| W: Safety and Documentation | 13 | 10 | 76.9% |
| X: Laser Etcher | 5 | 4 | 80.0% |
| Y: Automatic Welder | 4 | 3 | 75.0% |
| Total Number of Items Deemed Essential | 187 | 163 | 87.2% |
| Total Number of Items | | 187 | |
| Percent Required for Passing | | 87.2% | |

As a result of the Round One analysis, 10 items were eliminated and approximately 50 items were revised to have a more visible correct answer. In order to not penalize the pilot test group for any misleading or miscoded test items, their scores were recalculated to reflect these changes. Appendix E contains a list of the changes made to each item in the column labeled “Comment” that impacted scoring.

The panel used this data to determine if the passing scores in specific test categories was too high or too low and was asked to revise their "yes-no" decisions to lower the cut score in specific categories during Round Two. The results of their second round are found in Table 4 below.

**Table 4**
**Results of Panel Judgments on Test Items after Round Two**

| Test Category | Number of Test Questions | Number of Questions Determined to be Essential after Round 2 | Percent Required for Passing |
|---|---|---|---|
| A: Mechanical Equipment | 13 | 10 | 76.9% |
| B: Pneumatic/Hydraulic Equipment | 14 | 11 | 78.6% |
| D: Predictive/Corrective Maintenance | 8 | 7 | 87.5% |
| E: Blueprint Reading/Schematics | 13 | 10 | 76.9% |
| F: Equipment Controls and Sensors | 12 | 10 | 83.3% |
| G: Electrical Equipment | 11 | 9 | 81.8% |
| H: Electronic Equipment | 8 | 6 | 75.0% |

| | | | |
|---|---|---|---|
| I: Networking | 8 | 6 | 75.0% |
| J: PLC | 13 | 12 | 92.3% |
| L: Robots | 10 | 9 | 90.0% |
| M: Resistance Welding | 7 | 6 | 85.7% |
| O: Fabricate | 8 | 7 | 87.5% |
| P: Computer Literacy | 11 | 11 | 100.0% |
| Q: Preventative Maintenance | 12 | 9 | 75.0% |
| U: Specialty Equipment | 10 | 8 | 80.0% |
| V: Metrology | 7 | 6 | 85.7% |
| W: Safety and Documentation | 13 | 10 | 76.9% |
| X: Laser Etcher | 5 | 4 | 80.0% |
| Y: Automatic Welder | 4 | 3 | 75.0% |
| Total Number of Items Deemed Essential | 187 | 154 | 154 |
| Total Number of Items | | 187 | 187 |
| Percent Required for Passing | | 82.4% | **82.4%** |

The summary of the recalculated scores along with information on the number of pilot group that would have passed by section is found in Table 3. Appendix F contains the number of pilot test takers passing by task. Appendix G and H contain sample score reports provided to an individual test taker.

**Table 3**
**Recalculated Average Score of Pilot Test Takers**
**With the Number of Test Takes Meeting or Exceeding the**
**Cut Score**

| | | No. of Items | Average Percent Correct N=214 | Overall Percent that Passed | Median Score |
|---|---|---|---|---|---|
| A | MECHANICAL EQUIPMENT | 13 | 72.8% | 51.9% | 76.9% |
| B | PNEUMATIC/HYDRAULIC EQUIPMENT | 14 | 67.9% | 36.9% | 71.4% |
| D | PREDICTIVE/CORRECTIVE MAINTENANCE | 8 | 46.6% | 1.9% | 50.0% |
| E | BLUEPRINT READING/SCHEMATICS | 13 | 49.8% | 5.6% | 46.2% |
| F | EQUIPMENT CONTROLS AND SENSORS | 12 | 63.8% | 15.4% | 66.7% |
| G | ELECTRICAL EQUIPMENT | 11 | 59.3% | 17.8% | 54.5% |
| H | ELECTRONIC EQUIPMENT | 8 | 58.9% | 35.5% | 62.5% |
| I | NETWORKING | 8 | 41.8% | 11.2% | 37.5% |
| J | PLC EQUIPMENT | 13 | 61.8% | 7.0% | 61.5% |
| L | ROBOTS | 10 | 78.1% | 40.2% | 80.0% |
| M | RESISTANCE WELDING | 7 | 62.2% | 22.4% | 71.4% |
| O | FABRICATE | 8 | 66.3% | 21.0% | 75.0% |
| P | COMPUTER LITERACY | 11 | 72.6% | 9.8% | 72.7% |
| Q | PREVENTATIVE MAINTENANCE | 12 | 70.0% | 53.7% | 75.0% |
| U | SPECIALIZED MACHINERY | 10 | 74.1% | 52.3% | 80.0% |
| V | METROLOGY | 7 | 54.2% | 5.6% | 57.1% |
| W | SAFETY AND DOCUMENTATION | 13 | 66.7% | 32.7% | 69.2% |
| X | LASER ETCHER | 5 | 35.0% | 7.9% | 40.0% |
| Y | AUTOMATIC WELDER | 4 | 54.0% | 42.5% | 50.0% |
| | | 187 | 62.6% | 0.9% | 63.6% |

The panel concurred that the category cut scores for the written assessment was appropriate. It is recommended that data continue to be collected to test the validity of these cut scores in fully qualifying candidates.

## Test Statistics

**Cronbach's α (alpha)** is a statistic commonly used as a measure of the internal consistency or reliability of a psychometric test score for a sample of examinees. The measure can be viewed as an extension of the Kuder-Richardson Formula 20 (KR-20). The Cronbach's Alpha calculation on the recalculated scores for Version A of the AMTEC assessment is shown below:

**Reliability Statistics**

| Cronbach's Alpha | N of Items |
|---|---|
| .873 | 187 |

A split half correlation coefficient is calculated between scores on two halves of a test, taken as an indication of the reliability of the test. The split half analysis of the recalculated scores for the AMTEC assessment is shown in the following table:

**Reliability Statistics**

| | | | |
|---|---|---|---|
| Cronbach's Alpha | Part 1 | Value | .738 |
| | | N of Items | 94[a] |
| | Part 2 | Value | .812 |
| | | N of Items | 93[b] |
| | Total N of Items | | 187 |
| Correlation Between Forms | | | .752 |
| Spearman-Brown Coefficient | Equal Length | | .858 |
| | Unequal Length | | .858 |
| Guttman Split-Half Coefficient | | | .855 |

**APPENDIX A**
**AMTEC Duties and Tasks from Original Turbo-DACUM Session**

| | | |
|---|---|---|
| **A** | | **MECHANICAL EQUIPMENT** |
| | **1** | **Troubleshoot/repair/replace brakes & clutches (electromechanical and mechanical)** |
| | **2** | **Troubleshoot/repair/replace gears** |
| | **3** | **Troubleshoot/replace belts, sheaves/pulley** |
| | **4** | **Troubleshoot/maintain chains and sprockets** |
| | **5** | **Troubleshoot/repair/replace cams** |
| | **6** | **Troubleshoot/repair/replace seals and o-rings** |
| | **7** | **Troubleshoot/repair/replace bearings and bushings** |
| | **8** | **Troubleshoot/repair/replace shafts** |
| | **9** | **Perform alignment and balancing** |
| | **10** | **Troubleshoot/repair/replace motors (AC and DC)** |
| | **11** | **Maintain couplings** |
| | **12** | **Maintain fans** |
| | **13** | **Install/maintain valves (cut-off, pressure relief...)** |
| **B** | | **PNEUMATIC/HYDRAULIC EQUIPMENT** |
| | **14** | **Troubleshoot/repair/replace pneumatic/hydraulic valves** |
| | **15** | **Troubleshoot/repair/replace cylinders and intensifiers** |
| | **16** | **Troubleshoot/repair/replace hoses and tubing** |
| | **17** | **Adjust pressures and flows mechanically and electronically** |
| | **18** | **Maintain fluid levels for hydraulic systems** |
| | **19** | **Replace filters on hydraulic/pneumatic systems** |
| | **20** | **Troubleshoot/repair/replace gauges** |
| | **21** | **Troubleshoot/repair/replace pneumatic/hydraulic pumps** |
| | **22** | **Troubleshoot/replace accumulators** |
| | **23** | **Troubleshoot/repair/replace air motors** |
| | **24** | **Maintain vacuum system on pneumatic equipment** |
| | **25** | **Maintain filtration systems** |
| | **26** | **Adjust switches and controls on hydraulic/pneumatic system** |
| | **27** | **Install/design hydraulic/pneumatic components to upgrade/enhance systems** |
| **C.** | | **STEAM SYSTEM** |
| | **28** | **Maintain steam traps** |
| | **29** | **Maintain steam regulators** |
| | **30** | **Maintain heat exchanger** |
| | **31** | **Maintain pipe insulation systems** |
| **D.** | | **PREDICTIVE/CORRECTIVE MAINTENANCE** |
| | **32** | **Perform route-based vibration analysis** |
| | **33** | **Collect oil samples for analysis** |
| | **34** | **Interpret and take action on oil analysis** |
| | **35** | **Perform alignment (laser system)** |
| | **36** | **Perform balancing** |
| | **37** | **Perform online motor current analysis** |
| | **38** | **Perform off-line motor current analysis** |
| | **39** | **Perform infrared thermography** |
| | **40** | **Perform ultrasonic maintenance** |
| **E** | | **BLUEPRINT READING/SCHEMATICS** |
| | **41** | **Interpret mechanical drawings** |
| | **42** | **Interpret pneumatic and hydraulic drawings** |
| | **43** | **Interpret electrical schematics** |
| | **44** | **Interpret piping and instrumentation diagram (P&ID)** |
| | **45** | **Operate basic drafting software (AutoCAD or Visio)** |
| **F** | | **EQUIPMENT CONTROLS AND SENSORS** |

| | | |
|---|---|---|
| | 46 | Troubleshoot/replace/install circuit boards |
| | 47 | Install/maintain/troubleshoot photo eyes |
| | 48 | Install/maintain/troubleshoot servo motors |
| | 49 | Install/maintain/troubleshoot VFD drives (Variable Frequency Drive) |
| | 50 | Install/maintain/troubleshoot limit and proximity switches |
| | 51 | Troubleshoot/calibrate/adjust and replace sensors and input devices |
| | 52 | Calibrate process control loop (PID) |
| | 53 | Troubleshoot/replace transducers |
| G | | ELECTRICAL EQUIPMENT |
| | 54 | Install/replace wire |
| | 55 | Install/maintain solenoid valve |
| | 56 | Install/maintain relays |
| | 57 | Install/repair/replace motor starters |
| | 58 | Install/replace fuses and circuit breakers |
| | 59 | Operate electrical/electronic test equipment |
| H | | ELECTRONIC EQUIPMENT |
| | 60 | Maintain/install fiber optics |
| | 61 | Troubleshoot/repair/replace vision systems |
| | 62 | Install/maintain/troubleshoot bar code readers |
| | 63 | Troubleshoot/maintain (single rail transport) SRT monorail |
| | 64 | Maintain and calibrate quality touch center system (MARPOS) |
| I | | NETWORKING |
| | 65 | Use DeviceNet protocol |
| | 66 | Use Data Highway protocol |
| | 67 | Use TCP/IP protocol |
| | 68 | Use ControlNet protocol (Allen Bradley) |
| | 69 | Use FL net protocol |
| J | | PLC EQUIPMENT |
| | 70 | Create/modify/monitor PLC programs |
| | 71 | Program/maintain operator interface software |
| | 72 | Troubleshoot communication systems in PLC |
| | 73 | Replace PLC processor |
| | 74 | Perform backups of PLC software programs |
| | 75 | Install/maintain PCL hardware |
| | 76 | Edit/Program PLC |
| | 77 | Program/maintain operator interface software |
| K. | | MAINTAIN NC/CNC EQUIPMENT |
| | 78 | Setup CNC equipment |
| | 79 | Troubleshoot tooling/quality problem |
| | 80 | Modify programming language |
| | 81 | Replace components on NC/CNC equipment |
| | 82 | Modify system parameters |
| L. | | ROBOTS |
| | 83 | Install/Maintain robot systems |
| | 84 | Program/edit robot software |
| M | | RESISTANCE WELDING |
| | 85 | Perform visual inspection of resistance welding equipment operation |
| | 86 | Align components in resistance welding equipment |
| | 87 | Repair/replace failed components in resistance welding equipment |
| | 88 | Maintain and troubleshoot gun servos |
| | 89 | Perform parameter adjustments (weld conditions) on resistance and stud welding |
| | 90 | Troubleshoot/repair/replace location pins and datum surfaces |
| | 91 | Maintain cooling system in resistance welding equipment |
| | 92 | Perform resistance checks (resistance of cable and condition of insulators) |

| | | |
|---|---|---|
| **N** | | **ROBOTIC GMAW WELDING** |
| | **93** | **Perform visual inspection of Robotic-GMAW welding equipment operation** |
| | **94** | **Replace weld controller in Auto-mig welding equipment** |
| | **95** | **Maintain torch/brazing equipment** |
| | **96** | **Maintain welding gas regulating systems** |
| **O** | | **FABRICATE** |
| | **97** | **Perform pipefitting tasks** |
| | **98** | **Operate machining equipment** |
| | **99** | **Operate welding equipment for fabrication** |
| **P** | | **COMPUTER LITERACY** |
| | **100** | **Use operating systems** |
| | **101** | **Use computer software** |
| | **102** | **Use Maintenance Database System (LMS, MAXIMO, PeopleSoft, etc.)** |
| | **103** | **Use Internet and Intranet** |
| | **104** | **Use laptop for troubleshooting and installation** |
| | **105** | **Perform computer/workstation hardware repair or installations** |
| **Q** | | **PREVENTATIVE MAINTENANCE** |
| | **106** | **Perform general housekeeping** |
| | **107** | **Perform visual inspection of equipment** |
| | **108** | **Change filters** |
| | **109** | **Maintain oil and grease levels** |
| | **110** | **Perform equipment checks** |
| | **111** | **Monitor floor management development system (FMDS)** |
| **R** | | **DUST AND MIST COLLECTORS** |
| | **112** | **Maintain dust collector (dry and wet filter systems)** |
| | **113** | **Maintain mist collector** |
| **S** | | **UTILITIES** |
| | **114** | **Maintain boilers, deaireators and condensate return system** |
| | **115** | **Troubleshoot/maintain reverse osmosis [RO] system** |
| | **116** | **Troubleshoot waste water, pH and sewer systems** |
| | **117** | **Troubleshoot/maintain cooling tower** |
| | **118** | **Troubleshoot/maintain air compressors** |
| | **119** | **Perform inspection of fire and sprinkler system** |
| | **120** | **Maintain HVAC system** |
| | **121** | **Maintain evaporative cooler system** |
| | **122** | **Maintain lighting (including emergency)** |
| | **123** | **Maintain/repair vents and exhaust system** |
| | **124** | **Maintain/repair security/gate access system** |
| | **125** | **Maintain communication system** |
| | **126** | **Perform electronic board repair** |
| | **127** | **Maintain production functional inspection equipment** |
| | **128** | **Maintain buildings and grounds** |
| | **129** | **Maintain plant water supply system (potable and non-potable)** |
| | **130** | **Maintain production bulk supply tank farm** |
| | **131** | **Maintain plant environmental control system** |
| **T** | | **POWER DISTRIBUTION** |
| | **132** | **Maintain/repair switch gear** |
| | **133** | **Maintain/repair emergency generating equipment** |
| | **134** | **Maintain ground fault detection systems** |
| | **135** | **Repair/replace overhead buss systems** |
| | **136** | **Maintain/repair capacitors** |

| | | |
|---|---|---|
| | 137 | Install/maintain/troubleshoot transformers |
| | 138 | Install/maintain/troubleshoot fuses and breakers |
| U | | SPECIALIZED MACHINERY |
| | 139 | Operate hoist and cranes |
| | 140 | Perform rigging |
| | 141 | Operate mobile equipment |
| V | | METROLOGY |
| | 142 | Operate precision measuring equipment (digital, dial, manual, Metric and SAE) |
| | 143 | Determine panel quality (end quality) |
| | 144 | Maintain specialty tools and equipment |
| W | | SAFETY AND DOCUMENTATION |
| | 145 | Demonstrate knowledge of basic safety principles |
| | 146 | Maintain inventory for parts supply |
| | 147 | Perform pre-shift inspections |
| X | | LASER ETCHER |
| | 148 | Perform startup and shut down |
| | 149 | Troubleshoot Marking Problems |
| | 150 | Change laser bulb |
| | 151 | Perform Laser Etcher PM |
| Y | | AUTOMATIC WELDER |
| | 152 | Maintain/troubleshoot power supply |
| | 153 | Perform PM's |
| | 154 | Set power supply parameters |
| | 155 | Adjust frequency and other parameters |
| | 156 | Troubleshoot electrodes and torch body problems |
| | 157 | Maintain robotic/cam rotation parameters |
| | 158 | Maintain cooling and quenching systems |
| Z | | SPECIALIZED EQUIPMENT |
| | 159 | Troubleshoot and maintain induction heating systems |
| | 160 | Maintain induction hardeners |
| | 161 | Maintain electro-chemical deburring machine |
| | 162 | Maintain impregnation machine |
| | 163 | Maintain chip centrifuge units |
| | 164 | Maintain Andon system |
| | 165 | Maintain crank fillet rolling machine |
| | 166 | Maintain laser welders |
| | 167 | Maintain double blank analyzers in stamping |
| | 168 | Maintain laser skin measuring machine in plastics |
| | 169 | Maintain helium leak detector system |
| | 170 | Maintain gas mixing equipment for GMAW welding |

# APPENDIX B
## AMTEC Core with Delphi Grand Total Mean Ratings from Delphi Study

**Importance Rating Scale:**
4=Essential (not having skill/knowledge in this area will keep you from gaining employment in this occupation)
3=Very Important (skill/knowledge in this area WILL enhance employability in this area)
2=Important (skill/knowledge in this area MAY enhance employability in this area)
1=General Importance (skill/knowledge in this area will be learned on-the-job and would NOT affect employment in this occupation)
0=Not Important (skill/knowledge in this area are NOT important for employment in this occupation at all

| | | | | Grand Total Mean N=52 |
|---|---|---|---|---|
| **A** | | **MECHANICAL EQUIPMENT** | **AMTEC Core** | **3.34** |
| | **1** | **Troubleshoot/repair/replace brakes & clutches (electromechanical and mechanical)** | **x** | 2.98 |
| | **2** | **Troubleshoot/repair/replace gears** | **x** | 2.94 |
| | **3** | **Troubleshoot/replace belts, sheaves/pulley** | **x** | 3.08 |
| | **4** | **Troubleshoot/maintain chains and sprockets** | **x** | 2.88 |
| | **5** | **Troubleshoot/repair/replace cams** | **x** | 2.75 |
| | **6** | **Troubleshoot/repair/replace seals and o-rings** | **x** | 3.38 |
| | **7** | **Troubleshoot/repair/replace bearings and bushings** | **x** | 3.27 |
| | **8** | **Troubleshoot/repair/replace shafts** | **x** | 3.13 |
| | **9** | **Perform alignment and balancing** | **x** | 3.00 |
| | **10** | **Troubleshoot/repair/replace motors (AC and DC)** | **x** | 3.54 |
| | **11** | **Maintain couplings** | **x** | 3.06 |
| | **12** | **Maintain fans** | **x** | 3.00 |
| | **13** | **Install/maintain valves (cut-off, pressure relief...)** | **x** | 3.00 |
| **B** | | **PNEUMATIC/HYDRAULIC EQUIPMENT** | **AMTEC Core** | **3.23** |
| | **14** | **Troubleshoot/repair/replace pneumatic/hydraulic valves** | **x** | 3.29 |
| | **15** | **Troubleshoot/repair/replace cylinders and intensifiers** | **x** | 3.08 |
| | **16** | **Troubleshoot/repair/replace hoses and tubing** | **x** | 3.10 |
| | **17** | **Adjust pressures and flows mechanically and electronically** | **x** | 3.19 |
| | **18** | **Maintain fluid levels for hydraulic systems** | **x** | 3.08 |
| | **19** | **Replace filters on hydraulic/pneumatic systems** | **x** | 3.04 |
| | **20** | **Troubleshoot/repair/replace gauges** | **x** | 3.00 |
| | **21** | **Troubleshoot/repair/replace pneumatic/hydraulic pumps** | **x** | 3.17 |
| | **22** | **Troubleshoot/replace accumulators** | **x** | 2.88 |
| | **23** | **Troubleshoot/repair/replace air motors** | **x** | 2.88 |
| | **24** | **Maintain vacuum system on pneumatic equipment** | **x** | 2.77 |
| | **25** | **Maintain filtration systems** | **x** | 2.92 |
| | **26** | **Adjust switches and controls on hydraulic/pneumatic system** | **x** | 3.13 |
| | **27** | **Install/design hydraulic/pneumatic components to upgrade/enhance systems** | **x** | 2.98 |
| **D.** | | **PREDICTIVE/CORRECTIVE MAINTENANCE** | **AMTEC Core** | **2.95** |
| | **32** | **Perform route-based vibration analysis** | **Knowledge** | 2.82 |
| | **33** | **Collect oil samples for analysis** | **x** | 2.69 |
| | **34** | **Interpret and take action on oil analysis** | **Knowledge** | 2.65 |
| | **35** | **Perform alignment (laser system)** | **Knowledge** | 2.71 |
| | **36** | **Perform balancing** | **Knowledge** | 2.67 |
| | **37** | **Perform online motor current analysis** | **Knowledge** | 3.00 |
| | **38** | **Perform off-line motor current analysis** | **Knowledge** | 2.84 |

| | | | | |
|---|---|---|---|---|
| | 39 | Perform infrared thermography | Knowledge | 2.88 |
| | 40 | Perform ultrasonic maintenance | Knowledge | 2.63 |
| E | | BLUEPRINT READING/SCHEMATICS | AMTEC Core | 3.76 |
| | 41 | Interpret mechanical drawings | x | 3.60 |
| | 42 | Interpret pneumatic and hydraulic drawings | x | 3.48 |
| | 43 | Interpret electrical schematics | x | 3.73 |
| | 44 | Interpret piping and instrumentation diagram (P&ID) | x | 2.96 |
| | 45 | Operate basic drafting software (AutoCAD or Visio) | Introduction | 2.62 |
| F | | EQUIPMENT CONTROLS AND SENSORS | AMTEC Core | 3.61 |
| | 46 | Troubleshoot/replace/install circuit boards | x | 3.20 |
| | 47 | Install/maintain/troubleshoot photo eyes | x | 3.52 |
| | 48 | Install/maintain/troubleshoot servo motors | x | 3.52 |
| | 49 | Install/maintain/troubleshoot VFD drives (Variable Frequency Drive) | x | 3.46 |
| | 50 | Install/maintain/troubleshoot limit and proximity switches | x | 3.64 |
| | 51 | Troubleshoot/calibrate/adjust and replace sensors and input devices | x | 3.60 |
| | 52 | Calibrate process control loop (PID) | x | 2.86 |
| | 53 | Troubleshoot/replace transducers | x | 3.24 |
| G | | ELECTRICAL EQUIPMENT | AMTEC Core | 3.57 |
| | 54 | Install/replace wire | x | 3.63 |
| | 55 | Install/maintain solenoid valve | x | 3.52 |
| | 56 | Install/maintain relays | x | 3.54 |
| | 57 | Install/repair/replace motor starters | x | 3.58 |
| | 58 | Install/replace fuses and circuit breakers | x | 3.52 |
| | 59 | Operate electrical/electronic test equipment | x | 3.65 |
| H | | ELECTRONIC EQUIPMENT | AMTEC Core | 2.64 |
| | 60 | Maintain/install fiber optics | Introduction | 2.41 |
| | 61 | Troubleshoot/repair/replace vision systems | Introduction | 2.53 |
| | 62 | Install/maintain/troubleshoot bar code readers | Introduction | 2.65 |
| I | | NETWORKING | AMTEC Core | 2.42 |
| | 65 | Use DeviceNet protocol | Introduction | 2.51 |
| | 66 | Use Data Highway protocol | Introduction | 2.45 |
| | 67 | Use TCP/IP protocol | Introduction | 2.51 |
| J | | PLC EQUIPMENT | AMTEC Core | 3.69 |
| | 70 | Create/modify/monitor PLC programs | x | 3.60 |
| | 71 | Program/maintain operator interface software | x | 3.56 |
| | 72 | Troubleshoot communication systems in PLC | x | 3.58 |
| | 73 | Replace PLC processor | x | 3.56 |
| | 74 | Perform backups of PLC software programs | x | 3.54 |
| | 75 | Install/maintain PCL hardware | x | 3.60 |
| | 76 | Edit/Program PLC | x | 3.50 |
| L. | | ROBOTS | AMTEC Core | 3.14 |
| | 83 | Install/Maintain robot systems | x | 3.19 |
| | 84 | Program/edit robot software | Introduction | 2.87 |
| M | | RESISTANCE WELDING | AMTEC Core | 1.80 |
| | 85 | Perform visual inspection of resistance welding equipment operation | x | 2.00 |
| | 86 | Align components in resistance welding equipment | x | 1.92 |
| | 87 | Repair/replace failed components in resistance welding equipment | x | 1.92 |
| | 88 | Maintain and troubleshoot gun servos | x | 1.87 |
| | 89 | Perform parameter adjustments (weld conditions) on resistance and stud welding | x | 1.90 |
| | 90 | Troubleshoot/repair/replace location pins and datum surfaces | x | 1.94 |

| | | | | |
|---|---|---|---|---|
| | 91 | Maintain cooling system in resistance welding equipment | x | 1.85 |
| | 92 | Perform resistance checks (resistance of cable and condition of insulators) | x | 1.92 |
| O | | FABRICATE | AMTEC Core | 2.57 |
| | 97 | Perform pipefitting tasks | x | 2.27 |
| | 98 | Operate machining equipment | x | 2.58 |
| | 99 | Operate welding equipment for fabrication | x | 2.58 |
| P | | COMPUTER LITERACY | AMTEC Core | 3.65 |
| | 100 | Use operating systems | x | 3.60 |
| | 101 | Use computer software | x | 3.65 |
| | 102 | Use Maintenance Database System (LMS, MAXIMO, PeopleSoft, etc.) | x | 3.23 |
| | 103 | Use Internet and Intranet | x | 3.50 |
| | 104 | Use laptop for troubleshooting and installation | x | 3.60 |
| | 105 | Perform computer/workstation hardware repair or installations | x | 3.00 |
| Q | | PREVENTATIVE MAINTENANCE | AMTEC Core | 3.83 |
| | 106 | Perform general housekeeping | x | 3.48 |
| | 107 | Perform visual inspection of equipment | x | 3.69 |
| | 108 | Change filters | x | 3.44 |
| | 109 | Maintain oil and grease levels | x | 3.48 |
| | 110 | Perform equipment checks | x | 3.60 |
| | 111 | Monitor floor management development system (FMDS) | x | 2.73 |
| U | | SPECIALIZED MACHINERY | AMTEC Core | 2.88 |
| | 139 | Operate hoist and cranes | x | 2.81 |
| | 140 | Perform rigging | x | 2.79 |
| V | | METROLOGY | AMTEC Core | 2.59 |
| | 142 | Operate precision measuring equipment (digital, dial, manual, Metric and SAE) | x | 2.90 |
| | 144 | Maintain specialty tools and equipment | x | 2.53 |
| W | | SAFETY AND DOCUMENTATION | AMTEC Core | 3.84 |
| | 145 | Demonstrate knowledge of basic safety principles | x | 3.83 |
| | 146 | Maintain inventory for parts supply | x | 3.48 |
| | 147 | Perform pre-shift inspections | x | 3.69 |
| X | | LASER ETCHER | AMTEC Core | 1.31 |
| | 148 | Perform startup and shut down | Introduction | 1.44 |
| Y | | AUTOMATIC WELDER | AMTEC Core | 1.69 |
| | 152 | Maintain/troubleshoot power supply | x | 1.87 |
| | 153 | Perform PM's | x | 1.88 |
| | 154 | Set power supply parameters | x | 1.85 |
| | 155 | Adjust frequency and other parameters | x | 1.87 |
| | 156 | Troubleshoot electrodes and torch body problems | x | 1.85 |
| | 157 | Maintain robotic/cam rotation parameters | x | 1.77 |
| | 158 | Maintain cooling and quenching systems | x | 1.77 |
| Z | | SPECIALIZED EQUIPMENT | AMTEC Core | 1.61 |
| | 170 | Maintain gas mixing equipment for GMAW welding | x | 1.42 |

## APPENDIX C
## Table of Test Specifications by Duty

| | | Fundamental | Percent | Number of Items Based on 200 items |
|---|---|---|---|---|
| A | MECHANICAL EQUIPMENT | x | 6% | 11 |
| B | PNEUMATIC/HYDRAULIC EQUIPMENT | x | 5% | 11 |
| D. | PREDICTIVE/CORRECTIVE MAINTENANCE | Knowledge | 5% | 10 |
| E | BLUEPRINT READING/SCHEMATICS | x | 6% | 12 |
| F | EQUIPMENT CONTROLS AND SENSORS | x | 6% | 12 |
| G | ELECTRICAL EQUIPMENT | x | 6% | 13 |
| H | ELECTRONIC EQUIPMENT | Intro | 4% | 8 |
| I | NETWORKING | Intro | 4% | 8 |
| J | PLC EQUIPMENT | x | 6% | 13 |
| L. | ROBOTS | x | 5% | 11 |
| M | RESISTANCE WELDING | x | 3% | 7 |
| O | FABRICATE | x | 4% | 9 |
| P | COMPUTER LITERACY | x | 6% | 12 |
| Q | PREVENTATIVE MAINTENANCE | x | 6% | 12 |
| U | SPECIALIZED MACHINERY | x | 5% | 10 |
| V | METROLOGY | x | 5% | 9 |
| W | SAFETY AND DOCUMENTATION | x | 7% | 13 |
| X | LASER ETCHER | Intro | 3% | 5 |
| Y | AUTOMATIC WELDER | x | 3% | 7 |
| Z | SPECIALIZED EQUIPMENT | x | 3% | 5 |
| | | | 100% | 200 |

## APPENDIX D
## Test Specification by Task

| | | | Fundamental | Based on 200 items |
|---|---|---|---|---|
| **A** | | **MECHANICAL EQUIPMENT** | **Fundamental** | **Needed Items** |
| | 1 | Troubleshoot/repair/replace brakes & clutches (electromechanical and mechanical) | x | 1 |
| | 2 | Troubleshoot/repair/replace gears | x | 1 |
| | 3 | Troubleshoot/replace belts, sheaves/pulley | x | 1 |
| | 4 | Troubleshoot/maintain chains and sprockets | x | 1 |
| | 5 | Troubleshoot/repair/replace cams | x | 1 |
| | 6 | Troubleshoot/repair/replace seals and o-rings | x | 1 |
| | 7 | Troubleshoot/repair/replace bearings and bushings | x | 1 |
| | 8 | Troubleshoot/repair/replace shafts | x | 1 |
| | 9 | Perform alignment and balancing | x | 1 |
| | 10 | Troubleshoot/repair/replace motors (AC and DC) | x | 1 |
| | 11 | Maintain couplings | x | 1 |
| | 12 | Maintain fans | x | 1 |
| | 13 | Install/maintain valves (cut-off, pressure relief...) | x | 1 |
| **B** | | **PNEUMATIC/HYDRAULIC EQUIPMENT** | **Fundamental** | **Needed Items** |
| | 14 | Troubleshoot/repair/replace pneumatic/hydraulic valves | x | 1 |
| | 15 | Troubleshoot/repair/replace cylinders and intensifiers | x | 1 |
| | 16 | Troubleshoot/repair/replace hoses and tubing | x | 1 |
| | 17 | Adjust pressures and flows mechanically and electronically | x | 1 |
| | 18 | Maintain fluid levels for hydraulic systems | x | 1 |
| | 19 | Replace filters on hydraulic/pneumatic systems | x | 1 |
| | 20 | Troubleshoot/repair/replace gauges | x | 1 |
| | 21 | Troubleshoot/repair/replace pneumatic/hydraulic pumps | x | 1 |
| | 22 | Troubleshoot/replace accumulators | x | 1 |
| | 23 | Troubleshoot/repair/replace air motors | x | 1 |
| | 24 | Maintain vacuum system on pneumatic equipment | x | 1 |
| | 25 | Maintain filtration systems | x | 1 |
| | 26 | Adjust switches and controls on hydraulic/pneumatic system | x | 1 |
| | 27 | Install/design hydraulic/pneumatic components to upgrade/enhance systems | x | 1 |
| **D.** | | **PREDICTIVE/CORRECTIVE MAINTENANCE** | **Fundamental** | **Needed Items** |
| | 32 | Perform route-based vibration analysis | Knowledge | 1 |
| | 33 | Collect oil samples for analysis | x | 1 |
| | 34 | Interpret and take action on oil analysis | Knowledge | 1 |
| | 35 | Perform alignment (laser system) | Knowledge | 1 |

| | | | | |
|---|---|---|---|---|
| | 36 | Perform balancing | Knowledge | 1 |
| | 37 | Perform online motor current analysis | Knowledge | 1 |
| | 38 | Perform off-line motor current analysis | Knowledge | 1 |
| | 39 | Perform infrared thermography | Knowledge | 1 |
| | 40 | Perform ultrasonic maintenance | Knowledge | 1 |
| E | | BLUEPRINT READING/SCHEMATICS | Fundamental | Needed Items |
| | 41 | Interpret mechanical drawings | x | 3 |
| | 42 | Interpret pneumatic and hydraulic drawings | x | 3 |
| | 43 | Interpret electrical schematics | x | 3 |
| | 44 | Interpret piping and instrumentation diagram (P&ID) | x | 2 |
| | 45 | Operate basic drafting software (AutoCAD or Visio) | Introduction | 2 |
| F | | EQUIPMENT CONTROLS AND SENSORS | Fundamental | Needed Items |
| | 46 | Troubleshoot/replace/install circuit boards | x | 1 |
| | 47 | Install/maintain/troubleshoot photo eyes | x | 2 |
| | 48 | Install/maintain/troubleshoot servo motors | x | 2 |
| | 49 | Install/maintain/troubleshoot VFD drives (Variable Frequency Drive) | x | 2 |
| | 50 | Install/maintain/troubleshoot limit and proximity switches | x | 2 |
| | 51 | Troubleshoot/calibrate/adjust and replace sensors and input devices | x | 2 |
| | 52 | Calibrate process control loop (PID) | x | 1 |
| | 53 | Troubleshoot/replace transducers | x | 1 |
| G | | ELECTRICAL EQUIPMENT | Fundamental | Needed Items |
| | 54 | Install/replace wire | x | 2 |
| | 55 | Install/maintain solenoid valve | x | 2 |
| | 56 | Install/maintain relays | x | 2 |
| | 57 | Install/repair/replace motor starters | x | 2 |
| | 58 | Install/replace fuses and circuit breakers | x | 2 |
| | 59 | Operate electrical/electronic test equipment | x | 2 |
| H | | ELECTRONIC EQUIPMENT | Fundamental | Needed Items |
| | 60 | Maintain/install fiber optics | Introduction | 3 |
| | 61 | Troubleshoot/repair/replace vision systems | Introduction | 3 |
| | 62 | Install/maintain/troubleshoot bar code readers | Introduction | 3 |
| I | | NETWORKING | Fundamental | Needed Items |
| | 65 | Use DeviceNet protocol | Introduction | 3 |
| | 66 | Use Data Highway protocol | Introduction | 3 |
| | 67 | Use TCP/IP protocol | Introduction | 3 |
| J | | PLC EQUIPMENT | Fundamental | Needed Items |
| | 70 | Create/modify/monitor PLC programs | x | 2 |
| | 71 | Program/maintain operator interface software | x | 2 |
| | 72 | Troubleshoot communication systems in PLC | x | 2 |
| | 73 | Replace PLC processor | x | 2 |
| | 74 | Perform backups of PLC software programs | x | 2 |

| | | | | |
|---|---|---|---|---|
| | 75 | Install/maintain PCL hardware | x | 2 |
| | 76 | Edit/Program PLC | x | 2 |
| | 77 | Program/maintain operator interface software | x | 2 |
| L. | | ROBOTS | Fundamental | Needed Items |
| | 83 | Install/Maintain robot systems | x | 6 |
| | 84 | Program/edit robot software | Introduction | 5 |
| M | | RESISTANCE WELDING | Fundamental | Needed Items |
| | 85 | Perform visual inspection of resistance welding equipment operation | x | 1 |
| | 86 | Align components in resistance welding equipment | x | 1 |
| | 87 | Repair/replace failed components in resistance welding equipment | x | 1 |
| | 88 | Maintain and troubleshoot gun servos | x | 1 |
| | 89 | Perform parameter adjustments (weld conditions) on resistance and stud welding | x | 1 |
| | 90 | Troubleshoot/repair/replace location pins and datum surfaces | x | 1 |
| | 91 | Maintain cooling system in resistance welding equipment | x | 1 |
| | 92 | Perform resistance checks (resistance of cable and condition of insulators) | x | 1 |
| O | | FABRICATE | Fundamental | Needed Items |
| | 97 | Perform pipefitting tasks | x | 3 |
| | 98 | Operate machining equipment | x | 3 |
| | 99 | Operate welding equipment for fabrication | x | 3 |
| P | | COMPUTER LITERACY | Fundamental | Needed Items |
| | 100 | Use operating systems | x | 2 |
| | 101 | Use computer software | x | 2 |
| | 102 | Use Maintenance Database System (LMS, MAXIMO, PeopleSoft, etc.) | x | 2 |
| | 103 | Use Internet and Intranet | x | 2 |
| | 104 | Use laptop for troubleshooting and installation | x | 2 |
| | 105 | Perform computer/workstation hardware repair or installations | x | 2 |
| Q | | PREVENTATIVE MAINTENANCE | Fundamental | Needed Items |
| | 106 | Perform general housekeeping | x | 2 |
| | 107 | Perform visual inspection of equipment | x | 2 |
| | 108 | Change filters | x | 2 |
| | 109 | Maintain oil and grease levels | x | 2 |
| | 110 | Perform equipment checks | x | 2 |
| | 111 | Monitor floor management development system (FMDS) | x | 2 |
| U | | SPECIALIZED MACHINERY | Fundamental | Needed Items |
| | 139 | Operate hoist and cranes | x | 5 |
| | 140 | Perform rigging | x | 5 |

| | | | | |
|---|---|---|---|---|
| **V** | | **METROLOGY** | **Fundamental** | **Needed Items** |
| | **142** | **Operate precision measuring equipment (digital, dial, manual, Metric and SAE)** | **x** | **5** |
| | **144** | **Maintain specialty tools and equipment** | **x** | **4** |
| **W** | | **SAFETY AND DOCUMENTATION** | **Fundamental** | **Needed Items** |
| | **145** | **Demonstrate knowledge of basic safety principles** | **x** | **5** |
| | **146** | **Maintain inventory for parts supply** | **x** | **4** |
| | **147** | **Perform pre-shift inspections** | **x** | **4** |
| **X** | | **ETCHER** | **Fundamental** | **Needed Items** |
| | **148** | **Perform startup and shut down** | **Introduction** | **5** |
| **Y** | | **AUTOMATIC WELDER** | **Fundamental** | **Needed Items** |
| | **152** | **Maintain/troubleshoot power supply** | **x** | **1** |
| | **153** | **Perform PM's** | **x** | **1** |
| | **154** | **Set power supply parameters** | **x** | **1** |
| | **155** | **Adjust frequency and other parameters** | **x** | **1** |
| | **156** | **Troubleshoot electrodes and torch body problems** | **x** | **1** |
| | **157** | **Maintain robotic/cam rotation parameters** | **x** | **1** |
| | **158** | **Maintain cooling and quenching systems** | **x** | **1** |
| **Z** | | **SPECIALIZED EQUIPMENT** | **Fundamental** | **Needed Items** |
| | **170** | **Maintain gas mixing equipment for GMAW welding** | **x** | **5** |

**APPENDIX E**
**Panel Decisions for Written Assessment Items**

**APPENDIX E--AMTEC Version A**
**PANEL JUDGMENTS--Essential Items**
**A: Mechanical Equipment**

| Item | First Round | Second Round | Comment |
|---|---|---|---|
| 1 | Yes | Yes | |
| 2 | Yes | Yes | |
| 3 | Yes | Yes | |
| 4 | No | No | |
| 5 | Yes | Yes | |
| 6 | Yes | Yes | |
| 7 | Yes | Yes | Credit for All |
| 8 | Yes | Yes | Credit B, D, C |
| 9 | Yes | Yes | |
| 10 | Yes | Yes | |
| 11 | Yes | Yes | |
| 12 | Yes | No | |
| 13 | Yes | No | |
| | 12 | 10 | |

**B: Pneumatic/Hydraulic Equipment**

| Item | First Round | Second Round | Comment |
|---|---|---|---|
| 14 | Yes | Yes | |
| 15 | Yes | Yes | |
| 16 | Yes | No | |
| 17 | No | No | |
| 18 | Yes | Yes | |
| 19 | Yes | Yes | |
| 20 | No | No | |
| 21 | Yes | Yes | |
| 22 | Yes | Yes | |
| 23 | Yes | Yes | |
| 24 | Yes | Yes | |
| 25 | Yes | Yes | |
| 26 | Yes | Yes | |
| 27 | Yes | Yes | |
| | 12 | 11 | |

**D: Predictive/Corrective Maintenance**

| Item | First | Second | Comment |
|---|---|---|---|

| | Round | Round | |
|---|---|---|---|
| 28 | Yes | Yes | |
| 29 | Yes | Yes | |
| 30 | Yes | Yes | |
| 31 | Yes | Yes | |
| 32 | Yes | Yes | |
| 33 | Yes | No | |
| 34 | Eliminate | Eliminate | Eliminate |
| 35 | Yes | Yes | |
| 36 | Yes | Yes | |
| | 8 | 7 | |

**E: Blueprint Reading/Schematics**

| Item | First Round | Second Round | Comment |
|---|---|---|---|
| 37 | Yes | No | |
| 38 | Yes | Yes | |
| 39 | Yes | Yes | |
| 40 | Yes | Yes | |
| 41 | No | No | |
| 42 | No | No | |
| 43 | Yes | Yes | |
| 44 | Yes | Yes | |
| 45 | Yes | Yes | |
| 46 | Yes | Yes | |
| 47 | Yes | Yes | Credit all (no diagram) |
| 48 | Yes | Yes | |
| 49 | Yes | Yes | |
| | 11 | 10 | |

**F: Equipment Controls and Sensors**

| Item | First Round | Second Round | Comment |
|---|---|---|---|
| 50 | Yes | Yes | |
| 51 | Yes | Yes | |
| 52 | No | No | Credit A and B |
| 53 | No | No | Correct is B not C |
| 54 | Yes | Yes | |
| 55 | Yes | Yes | |
| 56 | Yes | Yes | Credit all (no diagram) |
| 57 | Yes | Yes | |
| 58 | Yes | Yes | |
| 59 | Yes | Yes | |
| 60 | Yes | Yes | Credit A and B |
| 61 | Yes | Yes | |

10 10

**G: Electrical Equipment**

| Item | First Round | Second Round | Comment |
|---|---|---|---|
| 62 | Yes | Yes | Credit for A an D |
| 63 | Yes | Yes | |
| 64 | Yes | Yes | |
| 65 | No | No | |
| 66 | Yes | Yes | |
| 67 | Yes | Yes | |
| 68 | No | No | |
| 69 | Yes | Yes | |
| 70 | Yes | Yes | |
| 71 | Yes | Yes | |
| 72 | Yes | Yes | |

9 9

**H: Electronic Equipment**

| Item | First Round | Second Round | Comment |
|---|---|---|---|
| 73 | Yes | Yes | |
| 74 | No | No | |
| 75 | No | No | |
| 76 | Yes | Yes | |
| 77 | Yes | Yes | |
| 78 | Yes | Yes | |
| 79 | Eliminate | Eliminate | Eliminate |
| 80 | Yes | Yes | |
| 81 | Yes | Yes | |

6 6

**I: Networking**

| Item | First Round | Second Round | Comment |
|---|---|---|---|
| 82 | Yes | Yes | |
| 83 | Yes | No | |
| 84 | Yes | Yes | |
| 85 | Yes | Yes | |
| 86 | Yes | Yes | |
| 87 | Yes | Yes | |
| 88 | No | No | |
| 89 | Yes | Yes | |

7 6

**J: PLC**

| Item | First Round | Second Round | Comment |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 90 | Yes | Yes | Credit All--typo in stem |
| 91 | Yes | Yes | |
| 92 | Yes | Yes | |
| 93 | Yes | Yes | Credit All--typo in stem |
| 94 | Yes | Yes | |
| 95 | Yes | Yes | |
| 96 | Yes | Yes | |
| 97 | Yes | Yes | Credit C and D |
| 98 | Yes | Yes | Credit A and C |
| 99 | Yes | Yes | |
| 100 | No | No | |
| 101 | Yes | Yes | |
| 102 | Yes | Yes | |
| 103 | Eliminate | Eliminate | Eliminate |
| | 12 | 12 | |

**L: Robots**

| Item | First Round | Second Round | Comment |
|---|---|---|---|
| 104 | Yes | Yes | |
| 105 | Yes | Yes | |
| 106 | Yes | Yes | |
| 107 | Yes | Yes | |
| 108 | Yes | Yes | |
| 109 | Yes | Yes | |
| 110 | Yes | Yes | |
| 111 | Yes | Yes | Credit for B and D |
| 112 | Eliminate | Eliminate | Eliminate |
| 113 | No | No | |
| 114 | Yes | Yes | Credit--rewrote item |
| | 9 | 9 | |

**M: Resistance Welding**

| Item | First Round | Second Round | Comment |
|---|---|---|---|
| 115 | Yes | Yes | |
| 116 | Yes | Yes | |
| 117 | Yes | No | |
| 118 | Eliminate | Eliminate | Eliminate |
| 119 | Yes | Yes | |
| 120 | Yes | Yes | |
| 121 | Yes | Yes | |
| 122 | Yes | Yes | |
| | 7 | 6 | |

**O: Fabricate**

| Item | First Round | Second Round | Comment |
|---|---|---|---|
| 123 | Eliminate | Eliminate | Eliminate |
| 124 | Yes | Yes | |
| 125 | Yes | Yes | |
| 126 | Yes | Yes | |
| 127 | Yes | No | Credit for A |
| 128 | Yes | Yes | |
| 129 | Yes | Yes | |
| 130 | Yes | Yes | |
| 131 | Yes | Yes | |
| | 8 | 7 | |

**P: Computer Literacy**

| Item | First Round | Second Round | Comment |
|---|---|---|---|
| 132 | Yes | Yes | |
| 133 | Yes | Yes | |
| 134 | Yes | Yes | |
| 135 | Yes | Yes | |
| 136 | Yes | Yes | |
| 137 | Eliminate | Eliminate | Eliminate |
| 138 | Yes | Yes | |
| 139 | Yes | Yes | |
| 140 | Yes | Yes | |
| 141 | Yes | Yes | |
| 142 | Yes | Yes | |
| 143 | Yes | Yes | |
| | 11 | 11 | |

**Q: Preventative Maintenance**

| Item | First Round | Second Round | Comment |
|---|---|---|---|
| 144 | Yes | Yes | |
| 145 | Yes | Yes | |
| 146 | Yes | Yes | |
| 147 | No | No | |
| 148 | Yes | Yes | |
| 149 | Yes | Yes | |
| 150 | Yes | Yes | |
| 151 | No | No | Credit for C |
| 152 | No | No | |
| 153 | Yes | Yes | |
| 154 | Yes | Yes | Credit B and D |
| 155 | Yes | Yes | |
| | 9 | 9 | |

**U: Specialty Equipment**

| Item | First Round | Second Round | Comment |
|---|---|---|---|
| 156 | Yes | Yes | |
| 157 | Yes | Yes | |
| 158 | Yes | No | |
| 159 | Yes | Yes | |
| 160 | Yes | Yes | |
| 161 | Yes | Yes | |
| 162 | Yes | Yes | |
| 163 | No | No | |
| 164 | Yes | Yes | |
| 165 | Yes | Yes | |
| | 9 | 8 | |

**V: Metrology**

| Item | First Round | Second Round | Comment |
|---|---|---|---|
| 166 | No | No | |
| 167 | Yes | Yes | |
| 168 | Eliminate | Eliminate | Eliminate |
| 169 | Yes | Yes | |
| 170 | Yes | Yes | Credit C and D |
| 171 | Yes | Yes | |
| 172 | Yes | Yes | Correct B and credit C |
| 173 | Eliminate | Eliminate | Eliminate |
| 174 | Yes | Yes | |
| | 6 | 6 | |

**W: Safety and Documentation**

| Item | First Round | Second Round | Comment |
|---|---|---|---|
| 175 | Yes | Yes | |
| 176 | Yes | Yes | |
| 177 | Yes | Yes | |
| 178 | No | No | |
| 179 | Yes | Yes | |
| 180 | No | No | |
| 181 | Yes | Yes | |
| 182 | Yes | Yes | |
| 183 | Yes | Yes | |
| 184 | Yes | Yes | |
| 185 | Yes | Yes | |
| 186 | Yes | Yes | |
| 187 | No | No | |
| | 10 | 10 | |

**X: Laser Etcher**

| Item | First Round | Second Round | Comment |
|---|---|---|---|
| 188 | Yes | Yes | |
| 189 | Yes | Yes | |
| 190 | No | No | |
| 191 | Yes | Yes | |
| 192 | Yes | Yes | |
| | 4 | 4 | |

**Y: Automatic Welder**

| Item | First Round | Second Round | Comment |
|---|---|---|---|
| 193 | Yes | Yes | |
| 194 | Yes | Yes | |
| 195 | Yes | Yes | |
| 196 | No | No | |
| 197 | Eliminate | Eliminate | Eliminate |
| | 3 | 3 | |

## APPENDIX F
## Task level Analysis of Pilot Test Group
## Using Recalculated Scores

| A | | MECHANICAL EQUIPMENT | # Items | % of Group Correct |
|---|---|---|---|---|
| | 1 | Troubleshoot/repair/replace brakes & clutches (electromechanical and mechanical) | 1 | 68.7% |
| | 2 | Troubleshoot/repair/replace gears | 1 | 46.7% |
| | 3 | Troubleshoot/replace belts, sheaves/pulley | 1 | 96.7% |
| | 4 | Troubleshoot/maintain chains and sprockets | 1 | 13.1% |
| | 5 | Troubleshoot/repair/replace cams | 1 | 96.3% |
| | 6 | Troubleshoot/repair/replace seals and o-rings | 1 | 97.7% |
| | 7 | Troubleshoot/repair/replace bearings and bushings | 1 | 100.0% |
| | 8 | Troubleshoot/repair/replace shafts | 1 | 94.4% |
| | 9 | Perform alignment and balancing | 1 | 43.0% |
| | 10 | Troubleshoot/repair/replace motors (AC and DC) | 1 | 52.8% |
| | 11 | Maintain couplings | 1 | 75.2% |
| | 12 | Maintain fans | 1 | 72.4% |
| | 13 | Install/maintain valves (cut-off, pressure relief...) | 1 | 88.8% |
| B | | PNEUMATIC/HYDRAULIC EQUIPMENT | # Items | % of Group Correct |
| | 14 | Troubleshoot/repair/replace pneumatic/hydraulic valves | 1 | 42.5% |
| | 15 | Troubleshoot/repair/replace cylinders and intensifiers | 1 | 60.7% |
| | 16 | Troubleshoot/repair/replace hoses and tubing | 1 | 53.3% |
| | 17 | Adjust pressures and flows mechanically and electronically | 1 | 76.6% |
| | 18 | Maintain fluid levels for hydraulic systems | 1 | 85.0% |
| | 19 | Replace filters on hydraulic/pneumatic systems | 1 | 73.4% |
| | 20 | Troubleshoot/repair/replace gauges | 1 | 54.7% |
| | 21 | Troubleshoot/repair/replace pneumatic/hydraulic pumps | 1 | 69.6% |
| | 22 | Troubleshoot/replace accumulators | 1 | 58.4% |
| | 23 | Troubleshoot/repair/replace air motors | 1 | 53.3% |
| | 24 | Maintain vacuum system on pneumatic equipment | 1 | 77.6% |
| | 25 | Maintain filtration systems | 1 | 76.2% |
| | 26 | Adjust switches and controls on hydraulic/pneumatic system | 1 | 78.5% |
| | 27 | Install/design hydraulic/pneumatic components to upgrade/enhance systems | 1 | 90.2% |
| D. | | PREDICTIVE/CORRECTIVE MAINTENANCE | # Items | % of Group Correct |
| | 32 | Perform route-based vibration analysis | 1 | 81.8% |
| | 33 | Collect oil samples for analysis | 1 | 21.0% |
| | 34 | Interpret and take action on oil analysis | 1 | 24.3% |
| | 35 | Perform alignment (laser system) | 1 | 96.3% |
| | 36 | Perform balancing | 1 | 32.7% |
| | 37 | Perform online motor current analysis | 1 | 23.8% |
| | 39 | Perform infrared thermography | 1 | 17.8% |
| | 40 | Perform ultrasonic maintenance | 1 | 75.2% |
| E | | BLUEPRINT READING/SCHEMATICS | # | % of |

| | | | Items | Group Correct |
|---|---|---|---|---|
| | 41 | Interpret mechanical drawings | 3 | 68.7% |
| | 42 | Interpret pneumatic and hydraulic drawings | 3 | 24.9% |
| | 43 | Interpret electrical schematics | 3 | 53.1% |
| | 44 | Interpret piping and instrumentation diagram (P&ID) | 2 | 72.7% |
| | 45 | Operate basic drafting software (AutoCAD or Visio) | 2 | 30.8% |
| F | | EQUIPMENT CONTROLS AND SENSORS | # Items | % of Group Correct |
| | 46 | Troubleshoot/replace/install circuit boards | 1 | 74.3% |
| | 47 | Install/maintain/troubleshoot photo eyes | 1 | 9.3% |
| | 48 | Install/maintain/troubleshoot servo motors | 2 | 59.3% |
| | 49 | Install/maintain/troubleshoot VFD drives (Variable Frequency Drive) | 2 | 45.6% |
| | 50 | Install/maintain/troubleshoot limit and proximity switches | 2 | 96.0% |
| | 51 | Troubleshoot/calibrate/adjust and replace sensors and input devices | 2 | 84.1% |
| | 52 | Calibrate process control loop (PID) | 1 | 63.6% |
| | 53 | Troubleshoot/replace transducers | 1 | 48.6% |
| G | | ELECTRICAL EQUIPMENT | # Items | % of Group Correct |
| | 54 | Install/replace wire | 2 | 85.0% |
| | 55 | Install/maintain solenoid valve | 2 | 40.0% |
| | 56 | Install/maintain relays | 1 | 32.7% |
| | 57 | Install/repair/replace motor starters | 2 | 60.7% |
| | 58 | Install/replace fuses and circuit breakers | 2 | 82.7% |
| | 59 | Operate electrical/electronic test equipment | 2 | 41.4% |
| H | | ELECTRONIC EQUIPMENT | # Items | % of Group Correct |
| | 60 | Maintain/install fiber optics | 3 | 31.3% |
| | 61 | Troubleshoot/repair/replace vision systems | 3 | 71.7% |
| | 62 | Install/maintain/troubleshoot bar code readers | 2 | 81.1% |
| I | | NETWORKING | # Items | % of Group Correct |
| | 65 | Use DeviceNet protocol | 3 | 48.0% |
| | 66 | Use Data Highway protocol | 2 | 39.5% |
| | 67 | Use TCP/IP protocol | 3 | 37.1% |
| J | | PLC EQUIPMENT | # Items | % of Group Correct |
| | 70 | Create/modify/monitor PLC programs | 2 | 64.5% |
| | 71 | Program/maintain operator interface software | 2 | 80.8% |
| | 72 | Troubleshoot communication systems in PLC | 2 | 45.1% |
| | 73 | Replace PLC processor | 2 | 66.8% |
| | 74 | Perform backups of PLC software programs | 2 | 61.2% |
| | 75 | Install/maintain PCL hardware | 2 | 63.8% |
| | 76 | Edit/Program PLC | 1 | 38.8% |
| L. | | ROBOTS | # Items | % of Group Correct |
| | 83 | Install/Maintain robot systems | 6 | 74.6% |
| | 84 | Program/edit robot software | 4 | 83.3% |

| M | | RESISTANCE WELDING | # Items | % of Group Correct |
|---|---|---|---|---|
| | 85 | Perform visual inspection of resistance welding equipment operation | 1 | 62.1% |
| | 86 | Align components in resistance welding equipment | 1 | 64.0% |
| | 87 | Repair/replace failed components in resistance welding equipment | 1 | 41.6% |
| | 89 | Perform parameter adjustments (weld conditions) on resistance and stud welding | 1 | 75.7% |
| | 90 | Troubleshoot/repair/replace location pins and datum surfaces | 1 | 71.0% |
| | 91 | Maintain cooling system in resistance welding equipment | 1 | 31.3% |
| | 92 | Perform resistance checks (resistance of cable and condition of insulators) | 1 | 89.7% |
| O | | FABRICATE | # Items | % of Group Correct |
| | 97 | Perform pipefitting tasks | 2 | 81.8% |
| | 98 | Operate machining equipment | 3 | 65.7% |
| | 99 | Operate welding equipment for fabrication | 3 | 56.5% |
| P | | COMPUTER LITERACY | # Items | % of Group Correct |
| | 100 | Use operating systems | 2 | 57.9% |
| | 101 | Use computer software | 2 | 80.6% |
| | 102 | Use Maintenance Database System (LMS, MAXIMO, PeopleSoft, etc.) | 1 | 52.3% |
| | 103 | Use Internet and Intranet | 2 | 94.2% |
| | 104 | Use laptop for troubleshooting and installation | 2 | 71.0% |
| | 105 | Perform computer/workstation hardware repair or installations | 2 | 69.4% |
| Q | | PREVENTATIVE MAINTENANCE | # Items | % of Group Correct |
| | 106 | Perform general housekeeping | 2 | 90.9% |
| | 107 | Perform visual inspection of equipment | 2 | 64.0% |
| | 108 | Change filters | 2 | 62.1% |
| | 109 | Maintain oil and grease levels | 2 | 63.3% |
| | 110 | Perform equipment checks | 2 | 58.9% |
| | 111 | Monitor floor management development system (FMDS) | 2 | 80.6% |
| U | | SPECIALIZED MACHINERY | # Items | % of Group Correct |
| | 139 | Operate hoist and cranes | 5 | 72.9% |
| | 140 | Perform rigging | 5 | 75.2% |
| V | | METROLOGY | # Items | % of Group Correct |
| | 142 | Operate precision measuring equipment (digital, dial, manual, Metric and SAE) | 4 | 47.2% |
| | 144 | Maintain specialty tools and equipment | 3 | 63.6% |
| W | | SAFETY AND DOCUMENTATION | # Items | % of Group Correct |
| | 145 | Demonstrate knowledge of basic safety principles | 5 | 70.0% |
| | 146 | Maintain inventory for parts supply | 4 | 62.4% |
| | 147 | Perform pre-shift inspections | 4 | 66.9% |
| X | | LASER ETCHER | # Items | % of Group |

| | | | | Correct |
|---|---|---|---|---|
| | **148** | **Perform startup and shut down** | **5** | 35.0% |
| **Y** | | **AUTOMATIC WELDER** | **# Items** | **% of Group Correct** |
| | **152** | **Maintain/troubleshoot power supply** | **1** | 76.2% |
| | **154** | **Set power supply parameters** | **1** | 62.6% |
| | **155** | **Adjust frequency and other parameters** | **1** | 40.2% |
| | **156** | **Troubleshoot electrodes and torch body problems** | **1** | 36.9% |
| | | | 187 | |

## APPENDIX G
## Sample Candidate Score Report

**Recalculated Scores**
**Version A**

Name:
Location

| | Category | Number of Items | Your Percent Correct Score | Status Based on National Passing Score |
|---|---|---|---|---|
| A | MECHANICAL EQUIPMENT | 13 | 76.9% | Pass |
| B | PNEUMATIC/HYDRAULIC EQUIPMENT | 14 | 78.6% | Pass |
| D | PREDICTIVE/CORRECTIVE MAINTENANCE | 8 | 25.0% | N.I. |
| E | BLUEPRINT READING/SCHEMATICS | 13 | 76.9% | Pass |
| F | EQUIPMENT CONTROLS AND SENSORS | 12 | 75.0% | N.I. |
| G | ELECTRICAL EQUIPMENT | 11 | 54.5% | N.I. |
| H | ELECTRONIC EQUIPMENT | 8 | 37.5% | N.I. |
| I | NETWORKING | 8 | 50.0% | N.I. |
| J | PLC EQUIPMENT | 13 | 38.5% | N.I. |
| L | ROBOTS | 10 | 60.0% | N.I. |
| M | RESISTANCE WELDING | 7 | 57.1% | N.I. |
| O | FABRICATE | 8 | 100.0% | Pass |
| P | COMPUTER LITERACY | 11 | 72.7% | N.I. |
| Q | PREVENTATIVE MAINTENANCE | 12 | 66.7% | N.I. |
| U | SPECIALIZED MACHINERY | 10 | 70.0% | N.I. |
| V | METROLOGY | 7 | 57.1% | N.I. |
| W | SAFETY AND DOCUMENTATION | 13 | 76.9% | Pass |
| X | LASER ETCHER | 5 | 20.0% | N.I. |
| Y | AUTOMATIC WELDER | 4 | 0.0% | N.I. |
| | | 187 | 62.0% | |

"Pass" = you met or exceeded the passing score
"N.I." = Needs Improvement. Use the chart below to identify low scoring areas in that test category

**APPENDIX H**
**Task Level Score Report**

| A | | MECHANICAL EQUIPMENT | # Items | Your Percent Correct |
|---|---|---|---|---|
| | 1 | Troubleshoot/repair/replace brakes & clutches (electromechanical and mechanical) | 1 | 0.0% |
| | 2 | Troubleshoot/repair/replace gears | 1 | 0.0% |
| | 3 | Troubleshoot/replace belts, sheaves/pulley | 1 | 100.0% |
| | 4 | Troubleshoot/maintain chains and sprockets | 1 | 100.0% |
| | 5 | Troubleshoot/repair/replace cams | 1 | 100.0% |
| | 6 | Troubleshoot/repair/replace seals and o-rings | 1 | 100.0% |
| | 7 | Troubleshoot/repair/replace bearings and bushings | 1 | 100.0% |
| | 8 | Troubleshoot/repair/replace shafts | 1 | 100.0% |
| | 9 | Perform alignment and balancing | 1 | 0.0% |
| | 10 | Troubleshoot/repair/replace motors (AC and DC) | 1 | 100.0% |
| | 11 | Maintain couplings | 1 | 100.0% |
| | 12 | Maintain fans | 1 | 100.0% |
| | 13 | Install/maintain valves (cut-off, pressure relief...) | 1 | 100.0% |
| B | | PNEUMATIC/HYDRAULIC EQUIPMENT | # Items | |
| | 14 | Troubleshoot/repair/replace pneumatic/hydraulic valves | 1 | 0.0% |
| | 15 | Troubleshoot/repair/replace cylinders and intensifiers | 1 | 100.0% |
| | 16 | Troubleshoot/repair/replace hoses and tubing | 1 | 0.0% |
| | 17 | Adjust pressures and flows mechanically and electronically | 1 | 0.0% |
| | 18 | Maintain fluid levels for hydraulic systems | 1 | 100.0% |
| | 19 | Replace filters on hydraulic/pneumatic systems | 1 | 100.0% |
| | 20 | Troubleshoot/repair/replace gauges | 1 | 100.0% |
| | 21 | Troubleshoot/repair/replace pneumatic/hydraulic pumps | 1 | 100.0% |
| | 22 | Troubleshoot/replace accumulators | 1 | 100.0% |
| | 23 | Troubleshoot/repair/replace air motors | 1 | 100.0% |
| | 24 | Maintain vacuum system on pneumatic equipment | 1 | 100.0% |
| | 25 | Maintain filtration systems | 1 | 100.0% |
| | 26 | Adjust switches and controls on hydraulic/pneumatic system | 1 | 100.0% |
| | 27 | Install/design hydraulic/pneumatic components to upgrade/enhance systems | 1 | 100.0% |
| D. | | PREDICTIVE/CORRECTIVE MAINTENANCE | # Items | |
| | 32 | Perform route-based vibration analysis | 1 | 100.0% |
| | 33 | Collect oil samples for analysis | 1 | 0.0% |
| | 34 | Interpret and take action on oil analysis | 1 | 0.0% |
| | 35 | Perform alignment (laser system) | 1 | 100.0% |
| | 36 | Perform balancing | 1 | 0.0% |
| | 37 | Perform online motor current analysis | 1 | 0.0% |
| | 39 | Perform infrared thermography | 1 | 0.0% |
| | 40 | Perform ultrasonic maintenance | 1 | 0.0% |
| E | | BLUEPRINT READING/SCHEMATICS | # Items | |
| | 41 | Interpret mechanical drawings | 3 | 100.0% |
| | 42 | Interpret pneumatic and hydraulic drawings | 3 | 100.0% |
| | 43 | Interpret electrical schematics | 3 | 33.3% |
| | 44 | Interpret piping and instrumentation diagram (P&ID) | 2 | 100.0% |

| | | | | |
|---|---|---|---|---|
| | 45 | Operate basic drafting software (AutoCAD or Visio) | 2 | 50.0% |
| F | | EQUIPMENT CONTROLS AND SENSORS | # Items | |
| | 46 | Troubleshoot/replace/install circuit boards | 1 | 100.0% |
| | 47 | Install/maintain/troubleshoot photo eyes | 1 | 0.0% |
| | 48 | Install/maintain/troubleshoot servo motors | 2 | 100.0% |
| | 49 | Install/maintain/troubleshoot VFD drives (Variable Frequency Drive) | 2 | 50.0% |
| | 50 | Install/maintain/troubleshoot limit and proximity switches | 2 | 100.0% |
| | 51 | Troubleshoot/calibrate/adjust and replace sensors and input devices | 2 | 100.0% |
| | 52 | Calibrate process control loop (PID) | 1 | 100.0% |
| | 53 | Troubleshoot/replace transducers | 1 | 0.0% |
| G | | ELECTRICAL EQUIPMENT | # Items | |
| | 54 | Install/replace wire | 2 | 100.0% |
| | 55 | Install/maintain solenoid valve | 2 | 50.0% |
| | 56 | Install/maintain relays | 1 | 0.0% |
| | 57 | Install/repair/replace motor starters | 2 | 50.0% |
| | 58 | Install/replace fuses and circuit breakers | 2 | 100.0% |
| | 59 | Operate electrical/electronic test equipment | 2 | 0.0% |
| H | | ELECTRONIC EQUIPMENT | # Items | |
| | 60 | Maintain/install fiber optics | 3 | 0.0% |
| | 61 | Troubleshoot/repair/replace vision systems | 3 | 66.7% |
| | 62 | Install/maintain/troubleshoot bar code readers | 2 | 50.0% |
| I | | NETWORKING | # Items | |
| | 65 | Use DeviceNet protocol | 3 | 66.7% |
| | 66 | Use Data Highway protocol | 2 | 0.0% |
| | 67 | Use TCP/IP protocol | 3 | 66.7% |
| J | | PLC EQUIPMENT | # Items | |
| | 70 | Create/modify/monitor PLC programs | 2 | 50.0% |
| | 71 | Program/maintain operator interface software | 2 | 50.0% |
| | 72 | Troubleshoot communication systems in PLC | 2 | 0.0% |
| | 73 | Replace PLC processor | 2 | 0.0% |
| | 74 | Perform backups of PLC software programs | 2 | 50.0% |
| | 75 | Install/maintain PCL hardware | 2 | 100.0% |
| | 76 | Edit/Program PLC | 1 | 0.0% |
| L. | | ROBOTS | # Items | |
| | 83 | Install/Maintain robot systems | 6 | 50.0% |
| | 84 | Program/edit robot software | 4 | 75.0% |
| M | | RESISTANCE WELDING | # Items | |
| | 85 | Perform visual inspection of resistance welding equipment operation | 1 | 100.0% |
| | 86 | Align components in resistance welding equipment | 1 | 100.0% |
| | 87 | Repair/replace failed components in resistance welding equipment | 1 | 0.0% |
| | 89 | Perform parameter adjustments (weld conditions) on resistance and stud welding | 1 | 100.0% |
| | 90 | Troubleshoot/repair/replace location pins and datum surfaces | 1 | 0.0% |
| | 91 | Maintain cooling system in resistance welding equipment | 1 | 0.0% |
| | 92 | Perform resistance checks (resistance of cable and condition of insulators) | 1 | 100.0% |
| O | | FABRICATE | # Items | |
| | 97 | Perform pipefitting tasks | 2 | 100.0% |

| | | | | |
|---|---|---|---|---|
| | 98 | Operate machining equipment | 3 | 100.0% |
| | 99 | Operate welding equipment for fabrication | 3 | 100.0% |
| P | | COMPUTER LITERACY | # Items | |
| | 100 | Use operating systems | 2 | 100.0% |
| | 101 | Use computer software | 2 | 100.0% |
| | 102 | Use Maintenance Database System (LMS, MAXIMO, PeopleSoft, etc.) | 1 | 0.0% |
| | 103 | Use Internet and Intranet | 2 | 100.0% |
| | 104 | Use laptop for troubleshooting and installation | 2 | 50.0% |
| | 105 | Perform computer/workstation hardware repair or installations | 2 | 50.0% |
| Q | | PREVENTATIVE MAINTENANCE | # Items | |
| | 106 | Perform general housekeeping | 2 | 100.0% |
| | 107 | Perform visual inspection of equipment | 2 | 100.0% |
| | 108 | Change filters | 2 | 0.0% |
| | 109 | Maintain oil and grease levels | 2 | 50.0% |
| | 110 | Perform equipment checks | 2 | 50.0% |
| | 111 | Monitor floor management development system (FMDS) | 2 | 100.0% |
| U | | SPECIALIZED MACHINERY | # Items | |
| | 139 | Operate hoist and cranes | 5 | 80.0% |
| | 140 | Perform rigging | 5 | 60.0% |
| V | | METROLOGY | # Items | |
| | 142 | Operate precision measuring equipment (digital, dial, manual, Metric and SAE) | 4 | 50.0% |
| | 144 | Maintain specialty tools and equipment | 3 | 100.0% |
| W | | SAFETY AND DOCUMENTATION | # Items | |
| | 145 | Demonstrate knowledge of basic safety principles | 5 | 80.0% |
| | 146 | Maintain inventory for parts supply | 4 | 75.0% |
| | 147 | Perform pre-shift inspections | 4 | 75.0% |
| X | | LASER ETCHER | # Items | |
| | 148 | Perform startup and shut down | 5 | 20.0% |
| Y | | AUTOMATIC WELDER | # Items | |
| | 152 | Maintain/troubleshoot power supply | 1 | 0.0% |
| | 154 | Set power supply parameters | 1 | 0.0% |
| | 155 | Adjust frequency and other parameters | 1 | 0.0% |
| | 156 | Troubleshoot electrodes and torch body problems | 1 | 0.0% |
| | | | 187 | |