



Ignite. Educate. Accelerate.

Assessment Development Process



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:

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:

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

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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%

			#	% of
M		RESISTANCE WELDING	Items	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	#	% of
	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	#	% of
	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	#	% of
	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	#	% of
	139	Operate hoist and cranes	5	72.9%
	140	Perform rigging	5	75.2%
V		METROLOGY	#	% of
	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	#	% of
	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	#	% of
			Items	Group

				Correct
	148	Perform startup and shut down	5	35.0%
Y		AUTOMATIC WELDER	#	% of
	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%

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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%

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