A Quick Introduction to Maintenance, Installation, and Repair

This section includes skill standards for the manufacturing concentration of Maintenance, Installation, and Repair. These skill standards were developed by the Manufacturing Skill Standards Council (MSSC), under the auspices of the National Skill Standards Board (NSSB).

For a detailed explanation of each aspect of the standards, see *A Quick Orientation*, one of the guidebooks included with your binder.

Skill Standards: A Brief Explanation

The MSSC developed skill standards for six concentrations – major areas of frontline manufacturing work covering families of related jobs. The standards in this document cover the Maintenance, Installation, and Repair concentration. The Maintenance, Installation, and Repair concentration is defined as follows:

MAINTENANCE, INSTALLATION, AND REPAIR	
DEFINITION	**SAMPLE JOBS COVERED**
Ensure that the maintenance of the manufacturing system fulfills customer and business requirements. Install and repair equipment on the manufacturing floor.	Industrial maintenance mechanic, industrial maintenance electrician, and millwright

The skill standards are made up of two major components. They are:

Information *About the Work.* This component describes what workers need to be able to do on the job to perform competently. It includes:

- *Critical Work Functions* – The major responsibilities of work within a concentration.
- *Key Activities* – The major duties or tasks involved in carrying out a critical work function.
- *Performance Indicators* – Indicators of how to determine when someone is performing each key activity competently.

Information *About the Worker.* This aspect of the skill standards describes the knowledge and skills an individual needs to perform the work described by each critical work function, along with its key activities and performance indicators. There are three types of knowledge and skills:

- *Academic Knowledge and Skills* – Academic skills such as mathematics, reading, etc.
- *Employability Knowledge and Skills* – Broadly applicable skills such as working in teams, analyzing and solving problems, etc.
- *Occupational and Technical Knowledge and Skills* – Occupational and technical skills that tend to be specific to an industry or concentration, such as skill in using inspection tools and equipment, knowledge of manufacturing processes, etc.

For the academic and employability knowledge and skills, the MSSC skill standards provide:

Complexity Ratings: These ratings tells us, for a given critical work function, the level of complexity required in a particular academic or employability knowledge and skill. For example, if writing is required in order to perform a given critical work function, the complexity rating would tell us whether someone needs to write telephone messages versus technical manuals. These ratings were developed using the NSSB Academic and Employability Skill Scales. For more information on the scales and complexity ratings, see *A Quick Orientation* and the *Skill Scales Companion Guide*. There are two types of complexity ratings in the skill standards:

Overall Complexity Rating: As the name implies, the overall complexity rating gives us a rough estimate of the overall level of complexity required for a given knowledge and skill. These ratings are provided for frontline workers (represented by the symbol "W") and first-line supervisors (represented by the symbol "S"). The scale is: **L = Low; M = Moderate; and H = High**

In some cases, the overall complexity rating was **NA (Non-Applicable)**. This means that this skill was deemed not to be needed to perform this given critical work function, so no complexity rating was assigned.

Subdimension Complexity Rating: To give users more detailed information, the MSSC skill standards also provide an individual rating for each subdimension in the NSSB Academic and Employability Skill Scale (See the *Skill Scales Companion Guide*). These ratings apply to frontline workers only. Ratings have not been developed for first-line supervisors at this time. The scale is: **L = Low; M = Moderate; and H = High**

In some cases, the subdimension complexity rating was **NA (Non-Applicable)**. This means that this *particular dimension* of the skill was deemed not to be needed to perform this given critical work function, so no complexity rating was assigned.

Occupational and Technical Knowledge and Skills

Occupational and technical knowledge and skills are unique to a given industry sector or concentration. In manufacturing, they include knowledge and skills in areas such as inspection tools and equipment, production tools and equipment, and manufacturing processes.

The MSSC standards describe the occupational and technical knowledge and skills needed to perform each critical work function. The occupational and technical knowledge and skills are grouped into categories, with specific examples under each category. Please note that the MSSC did not develop complexity ratings for the occupational and technical knowledge and skills. This may be a part of future research.

Tips for Getting Started

Here are step-by-step instructions to help you get started:

1. Find a critical work function that interests you. Read each of its key activities, along with its associated performance indicators. You will find this information in the "About the Work" section on the left-hand page.
2. Open the fold-out pages and examine the "About the Worker" sections that focus on the academic and employability knowledge and skills.
3. Start by looking at the first academic knowledge and skill, which is always math, and find out the overall complexity rating by looking across the table to the right. To understand what this rating means, see the *Skill Scales Companion Guide*.
4. To find out the subdimension ratings for math, look further across the standards, using the *Skill Scales Companion Guide* to understand what each rating means. Repeat process for rest of academic and employability knowledge and skills.
5. Now, look at the occupational and technical knowledge and skills needed for this critical work function. These are located on the back page of the two-page fold-out section.

Critical Work Function: Coordinate predictive and preventive maintenance to ensure that production process runs smoothly.

Critical work functions *describe the major responsibilities involved in carrying out a concentration*

Concentrations *are the major areas of front-line work covering families of related jobs. Separate standards were identified for each concentration.*

Key Activities **Key activities** *are the duties and tasks involved in carrying out a critical work function*	Performance Indicators **Performance indicators** *correlate to the key activities. The performance indicators provide information on how to determine when someone is performing each key activity competently*
Develop the maintenance schedule	The schedule includes routine jobs that need to be completed in a timely way. Schedule includes sufficient flexibility including plans for fall-back if tasks take longer and fill-in work if tasks are shorter than expected. Schedule priorities are determined according to company procedures considering production needs, output, and critical equipment. Preventive maintenance requirements for all equipment are included in the schedule. Scheduled task lists are distributed appropriately. The schedule provides adequate time for preventive maintenance. Parts required for maintenance are available when needed.
Identify special maintenance and repair needs	Operators are asked appropriate questions to determine needs. Tool and equipment histories are reviewed to find evidence of intermittent or chronic problems. Job safety analysis sheets are referred to as appropriate. Operators are observed to see that they are setting up and operating according to the job safety analysis. Repair histories are reviewed to see if correct repairs were done in the past. Repair histories are reviewed to determine current repair needs. Worn or malfunctioning equipment is identified accurately and in a timely way to prevent breakdown.
Check on availability of workers and other resources	Special tools and parts are located. Existing preventive maintenance protocols are accessed from the preventive maintenance sheets. Staffing requirements are determined based on tasks that need to be performed. Retooled parts meet specifications. If a part is not available, follow-up occurs to ensure that adequate supplies are maintained.
Perform predictive and preventive maintenance	Hazardous materials procedures are followed with respect to handling and disposal. Safety procedures are followed and proper personal protective equipment is worn or used. Preventive maintenance sheet procedures are completely followed. Maintenance is performed with proper workers to ensure that the job is performed safely and efficiently. The required parts, tools and equipment are gathered prior to starting the maintenance. The required parts, tools and equipment are used to perform the work safely and efficiently. Maintenance job is documented and verified according to company or department procedure. Documentation is maintained according to policy and procedures. Documentation is turned in to the correct parties for processing. Maintenance required is performed on time. Housekeeping is performed when job is finished. Preventive maintenance plan is revised according to repair histories.
Check that equipment is working prior to releasing the equipment to the operator	Safety checklist is thoroughly completed. Safety checklist results are documented. The equipment is test-run to ensure it is operating properly and safely. If equipment is not operational, corrective measures are taken. Readiness of equipment to come back onto production line is communicated to correct parties before departing the site. Readiness of equipment to come back onto production line is documented according to company procedures. The appropriate items are inspected and verified according to the preventive maintenance sheet.

Knowledge and Skills

Describes what a worker needs to know or be able to do to perform the critical work function

ACADEMIC AND EMPLOYABILITY SKILLS

Skill	Overall Complexity Rating for Workers	Overall Complexity Rating for Supervisors	Complexity Dimension	Complexity Subdimension	Complexity Subdimension Rating for Workers
Math	**L**	**L**	Complexity of mathematics content	Number sense and computation	**M**
				Geometry, measurement, and spatial sense	**L**
				Complexity of data analysis, statistics, and probability	**L**
				Functions and algebraic thinking	**L**
				Complexity of representation and communication	**M**
			Complexity of problem solving	Mathematical methods	**L**
				Mathematical reasoning	**L**
				Mathematical tools	**M**
Science	**L**	**L**	Complexity of scientific inquiry	Design	**M**
				Use of evidence	**M**
			Complexity of understanding the nature of science	Unifying concepts and processes	**M**
			Complexity of core scientific content	Physical science	**L**
				Life science	**NA**
				Earth and space science	**NA**
			Complexity of applied science	Science and technology	**L**
				Science in personal and social perspective	**NA**
Reading	**M**	**M**	Complexity of text		**M**
			Complexity of reading skills		**M**
			Complexity of reading purpose		**M**
Writing	**L**	**M**	Complexity of text	Complexity of text	**M**
			Complexity of writing product	Type of product	**M**
				Organization	**M**
				Elaboration	**L**
			Complexity of writing process	Writing development	**L**
				To inform	**M**
				To persuade	**L**
Listening	**M**	**M**	Complexity of communication	Content complexity	**M**
				Demands on attention	**M**
				Communication indirectness	**L**
			Barriers to communication	Limitations on interaction	**M**
				Distractions	**M**
Speaking	**M**	**M**	Complexity of communication	Content complexity	**M**
				Tact and sensitivity required	**M**
				Communication indirectness	**L**
			Context demands	Diversity of audience	**M**
				Constraints on preparation	**M**
				Distractions	**M**
				Listener resistance	**M**
Using Information and Communications Technology	**M**	**L**	Complexity of technology application	Complexity of equipment or technology	**M**
				Complexity of applications	**M**
				Training time constraints	**M**
			Frequency of technology change	New learning required	**M**
Gathering and Analyzing Information	**M**	**M**	Difficulty of information gathering	Amount of information	**M**
				Number and variety of sources	**M**
				Resourcefulness needed	**M**
			Complexity of analysis	Complexity of information and analysis	**M**
				Need to evaluate source information	**M**
				Lack of analysis guidelines	**L**

ACADEMIC AND EMPLOYABILITY SKILLS

Skill	Overall Complexity Rating for Workers	Overall Complexity Rating for Supervisors	Complexity Dimension	Complexity Subdimension	Complexity Subdimension Rating for Workers
Analyzing and Solving Problems	**M**	**M**	Problem complexity	Problem uniqueness or difficulty	**M**
				Number and range of problems	**M**
			Solution complexity	Number and complexity of possible solutions	**M**
Making Decisions and Judgments	**M**	**M**	Degree of judgment or inference required	Lack of guidance or precedents	**M**
				Integration difficulty	**M**
				Quantity or ambiguity of risks and consequences	**M**
			Individual decision-making responsibility	Accountability and autonomy	**M**
				Absence or ambiguity of rules or policy constraints	**M**
Organizing and Planning	**M**	**M**	Complexity of plans	Goal complexity or ambiguity	**M**
				Flexibility required	**M**
				Resource coordination required	**M**
				Scope and effects of planning	**M**
			Constraints on planning	Lack of guidelines	**M**
				Lack of feedback	**M**
				Constraints on resource availability	**M**
Using Social Skills	**M**	**L**	Complexity of social interactions	Diversity	**M**
				Structure or protocol required	**M**
				Tact and sensitivity required	**M**
Adaptability	**M**	**M**	Degree of adaptability required	Frequency of change	**M**
			Difficulty of adapting	Unpredictability of change	**M**
				Lack of support for change	**M**
Working in Teams	**M**	**M**	Degree of collaboration required	Task interdependence	**H**
			Team member heterogeneity	Team diversity	**M**
			Goal or role ambiguity	Lack of clarity or support for team goals	**M**
				Lack of clarity or stability of responsibilities	**M**
Leading Others	**M**	**M**	Work challenges	Challenges to goal attainment	**M**
				Work structuring requirements	**M**
				Scope and complexity of leadership responsibility	**M**
			People challenges	Coaching or monitoring needs	**M**
				Conflict management needs	**M**
Building Consensus	**M**	**M**	Consensus process inhibitors	Number and diversity of stakeholders	**M**
				Ambiguity of goals	**M**
				Lack of organizational support, incentives, or consensus leadership	**M**
				High consensus standard	**M**
			Difficulty of issues requiring consensus	Complexity of issues	**M**
				Contentiousness of issues	**M**
				Lack of opportunities for agreement	**M**
Self and Career Develop-ment	**M**	**M**	Need for learning and development	Self and career development requirements	**M**
			Limitations on learning and development opportunities	Time, resource, or support constraints	**M**
				Application constraints	**L**

Overall complexity ratings: The *overall* level of complexity required in a skill in order to perform the critical work function. *Scale*: H=high complexity; M=moderate complexity; and L=low complexity. Two separate ratings are provided: one for *workers* (entry-level up to first-line supervisors) and the other for *supervisors* (first-line supervisors). In some cases, the overall complexity rating was **NA (Non-Applicable)**. This means that this skill was deemed not to be needed to perform this given critical work function, so no complexity rating was assigned.
Complexity Subdimension ratings: These are complexity level ratings for individual aspects of the particular skill. *Scale*: H=high complexity; M=moderate complexity; and L=low complexity. At this time, these ratings are provided for workers only. In some cases, the subdimension complexity rating was **NA (Non-Applicable)**. This means that this *particular dimension* of the skill was deemed not to be needed to perform this given critical work function, so no complexity rating was assigned.

About the Worker

Knowledge and Skills

Describes what a worker needs to know or be able to do to perform the critical work function

OCCUPATIONAL AND TECHNICAL KNOWLEDGE AND SKILLS

These are the technical knowledge and skills needed to perform the critical work function.

Skill Category	Specific Knowledge and Skills	Specific Knowledge and Skills
Maintenance Procedures	A. Knowledge of equipment operation, start up and shutdown procedures. B. Knowledge of daily preventive maintenance checklist tasks in order to check machine performance measurements (i.e., oil levels, adjustments, cleaning, slide wear). C. Knowledge of company-specific Standard Operating Procedures (SOPs) and manuals associated with equipment maintenance. D. Knowledge of lubricants and other necessary materials to perform maintenance.	E. Skill in monitoring and correcting operation parameters during tests. F. Skill in estimating and forecasting time and resources needed to perform task. G. Knowledge of maintenance procedures used to ensure correct action to reduce time on task. H. Knowledge of maintenance and repair requirements in work areas such as mechanical, fluid, electrical or thermal systems.
Business Policies and Procedures	A. Knowledge of standards and procedures used in the manufacture of machinery to apply that information to any given task to be performed.	B. Knowledge of policies and procedures for ordering parts.
Maintenance Management Systems	A. Knowledge of maintenance systems, such as Computer Maintenance Management, to develop and maintain schedule. B. Knowledge of diagnostic testing to forecast preventive maintenance needs. C. Knowledge of how to accurately estimate time required for maintenance. D. Skill in applying documented qualifications of workers to appropriately schedule tasks. E. Skill in cause and effect analysis to determine the root cause of a particular problem. F. Knowledge of hardware and troubleshooting techniques to eliminate downtime.	G. Knowledge of how to use a task history database to identify trends in machine problems. H. Knowledge of equipment history database to determine future needs, time availability, and parts required. I. Knowledge of general manufacturing processes to aid in troubleshooting. J. Knowledge of equipment repair methods in order to replace broken or worn parts. K. Knowledge of equipment specific testing techniques. L. Skill in using elementary statistical methods (i.e., Statistical Process Control (SPC) or passive data collection) to check how close the machine is running to specifications.
Safety and Environmental Procedures	A. Knowledge of how to isolate energy sources (i.e., lock out, tag out) B. Knowledge of how to use Material Safety Data Sheets (MSDS) to determine the proper safety procedure for a specific chemical or material. C. Knowledge of company safety procedures and rules required during maintenance. D. Knowledge of HAZMAT/ HAZCOM (Hazardous Materials and Hazard Communications) procedures to ensure safety when handling hazardous materials.	E. Knowledge of safety procedures and regulations in order to perform tasks safely (e.g., OSHA) F. Knowledge of Personal Protective Equipment (PPE) needed for each procedure. G. Knowledge of environmental regulations (e.g., EPA)
Manufacturing Process	A. Knowledge of plant operations and production schedule to plan and coordinate maintenance schedule. B. Knowledge of run-time and run priorities in order to prioritize tasks to maximize run time.	C. Knowledge of quality control inspection methods, scheduled audits, and corrective actions. D. Knowledge of product handling protocol procedures to facilitate maintenance procedures.
Inventory and Material Handling Process	A. Knowledge of inventory planning to enhance availability of critical items and spare parts. B. Knowledge of parts inventory and descriptions to identify available parts for repairs.	C. Skill in inventory control to ensure that back-up parts are clean and in good working order, replacement parts are stocked and special tools are in good repair. D. Skill in using materials management systems to order reserve materials with appropriate lead time for main tasks.
Scheduling	A. Knowledge of manufacturing schedules, part availability, and staffing needed for proper preventive maintenance. B. Skill in reviewing past predictive and preventive maintenance records to determine necessary procedures. C. Knowledge of how to schedule preventive maintenance while minimizing impact.	D. Skill in determining or recommending optimum frequency of preventive maintenance. E. Skill in interpreting diagnostic reports to determine necessary repairs. F. Knowledge of how to accurately estimate time required for maintenance. G. Skill in determining or recommending which machines takes priority over others in order to meet production goals. H. Knowledge of priorities of schedules or requirements.

Knowledge and Skills

Describes what a worker needs to know or be able to do to perform the critical work function

OCCUPATIONAL AND TECHNICAL KNOWLEDGE AND SKILLS *(continued)*

These are the technical knowledge and skills needed to perform the critical work function.

Skill Category	Specific Knowledge and Skills	Specific Knowledge and Skills
Documentation of Maintenance	A. Skill in updating and referencing maintenance log to indicate actions performed, such as parts replaced, and time spent. B. Skill in documenting, revising and recommending maintenance procedures for future reference.	C. Knowledge of required documentation procedures to ensure that all information about corrective actions, including who was involved, why the action was required, and when it took place, are accurately described in a log. D. Skill in reviewing equipment manuals and past history files to determine appropriate procedures.
Training	A. Skill in training others in how to operate machines properly.	B. Skill in training peers in required maintenance, installation and repair functions.
Equipment, Testing and Prove-In	A. Knowledge of testing processes to ensure test run meets set specifications before equipment can be released to production.	B. Skill in performing diagnostic analysis and tests to check equipment wear.
Staffing and Work Role Knowledge	A. Knowledge of the necessary skills that are required to perform the maintenance.	B. Knowledge of the equipment problems or demands to determine required workers for maintenance.
Tools and Equipment	A. Skill in properly using diagnostics tools and equipment to perform maintenance according to procedures. B. Skill in determining if tools and parts meet the specifications of the equipment. C. Knowledge of what parts are required for each piece of equipment. D. Knowledge of required tools to perform the maintenance, including any special tools required and where they are located.	E. Knowledge of equipment identification numbers in order to generate work orders and get part lists. F. Knowledge of equipment specifications and the personnel that are qualified to work on the equipment.

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Critical Work Function: Coordinate predictive and preventive maintenance to ensure that production process runs smoothly		
Knowledge/skill	**Mean Importance**	**Examples**
Using Information and Communication Technology	3.82	Understand production output using production planning software results in order to schedule maintenance procedures
		Utilize information database to review repair histories to prioritize equipment repairs
		Use communication technologies to facilitate timely dissemination of information
		Use email system to send repair part requirements to the parts supplier
		Access repair needs on database; identify which parts are needed via database; use email to communicate with engineer if repair is beyond current knowledge
Gathering and Analyzing Information	4.08	Understand preventive maintenance procedures using failure mode evaluation analysis (FMEA) procedures to determine priorities of the scheduled maintenance steps
		Gather information from operators and observation of equipment to perform effective maintenance
		Coordinate plan for preventive maintenance board on previous maintenance schedules to ensure proper scheduling of preventive maintenance
		Get info on all equipment from manuals to create preventive maintenance schedule and order replacement parts
Analyzing and Solving Problems	3.54	Anticipate special maintenance issues in order to coordinate predictive and preventive maintenance
		Anticipate and plan for equipment outages after abnormal operations and order parts
		Identify equipment limits and adhere to guidelines
		Identify factors in work environment that could cause equipment malfunction
		Identify all preventive maintenance problems to coordinate maintenance schedule to ensure no lapses in mfg. process
Making Decisions and Judgments	3.69	Apply statistics process control to preventive maintenance to schedule preventive maintenance with consistency for production needs
		Decide on the special maintenance requirements of the equipment to reduce repair costs
		Schedule routine maintenance so as not to impact the production schedule
		Make sure parts are available
		Predictive failure helps to make the right decision to prevent production loss with an unexpected failure of equipment such as bad bearings

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Organizing and Planning	4.00	Organize, allocate and plan maintenance activities to increase return on investment and allow smooth production runs
		Schedule maintenance by setting up equipment software to send email to all involved manufacturing and maintenance people to know ahead of time
		Apply SPC to predict maintenance needs and therefore minimize the impact on production where maintenance is performed
		Plan preventive maintenance schedules and organize work crew and resources
		Plan what equipment is to be checked each day; Check and make minor repairs
		Schedule labor and material for job to be done
Using Social Skills	3.19	Interact with operations and craft personnel to gain better understanding of their point of view
		Contact the qualified operator and ask his/her needs and explain management priorities
		Meet with production managers and discuss ways to minimize impact on production while maintenance activities are performed
		Communicate with other employees regarding machine availability and to identify special maintenance and repair needs
		Ask for input on preventive maintenance schedules from workers, supervisors, and other stakeholders
Adaptability	3.35	Change the maintenance schedule to do critical production needs
		Adjust scheduling to accommodate personnel changes/shortages, etc.
		Change regular maintenance schedule to accommodate production line working overtime
		Change behavior to meet the needs of today's ever-changing business needs
		Be able to adjust resources to keep production running
Working in Teams	4.08	Work with operators and craft personnel to implement production preventive maintenance schedule
		Work on teams to identify failure mechanisms using FMEA to predict preventive maintenance timing
		Work collaboratively with co-workers in safety department and those in storeroom to coordinate activities for efficient repair
		Team with necessary personnel for early machine defect detection
		Team with production and other trades to establish the best preventive maintenance schedule
Leading Others	3.00	Influence others to the importance of preventive maintenance plan and staffing levels
		Lead maintenance personnel to correct equipment malfunctions
		Lead frontline workers to safely, effectively, and accurately perform repairs
		Leader should keep all employees informed of changes made in job
		Instruct new employees on preventive maintenance procedures and follow up to make sure they understand

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Building Consensus	3.46	Work with operations and crafts to build preventive maintenance programs
		Decide with the planning team that the schedule is the best that can be designed under the circumstances
		Build consensus with maintenance and production by agreeing on a time to perform preventative maintenance
Self and Career Development	3.20	Obtain training on operations research type computer tools scheduler in order to properly schedule maintenance
		Identify training opportunities to improve coordination of maintenance equipment activities
		Study manuals and print before job; Take a course on items you do not know
Speaking	3.42	Express concerns over staffing level or budgetary constraints that affect equipment operations and reliability
		Present the facts to manufacturing workers in order to get everyone on the same page
		Present preventative maintenance schedules to co-workers in team meetings
		Convey maintenance information to others in language they understand
		Present the maintenance schedule to the entire workgroup for their feedback (SAME AS #3?)
Listening	3.96	Listen to operator's concerns about a tool in order to prioritize scheduled maintenance
		Listen to operator's equipment concerns to develop appropriate maintenance action
		Listen to production scheduling requirements when creating a maintenance schedule
		Listen to operator and understand to determine what, when, and where preventive maintenance is needed
Writing	3.72	Create detailed schedule for routine and preventive maintenance work to communicate plan to workforce
		Compose email to persons concerned with preventive maintenance
		Develop maintenance schedule for production directors
		Request information from production on production needs to develop the maintenance plan
		Write preventive maintenance schedules and/or procedures; Write problem reports

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Reading	4.28	Review maintenance schedule history in order to stay current on preventive maintenance
		Read email in order to respond to manufacturing requests
		Read and follow equipment technical manual
		Read materials safety data sheets to understand product specifications
		Follow written procedures, plans and safety rules to troubleshoot, diagnose, and repair equipment
Math	3.79	Estimate staffing requirements to ensure preventive maintenance procedures are completed
		Calculate number of days for preventive maintenance using GANTT charts
		Apply statistical process control techniques to production control and preventative maintenance
		Calculate projected hours needed to perform maintenance
		Calculate capacities of equipment run for efficiency and long life
Science	3.04	
		Test pipelines to ensure wall thickness is maintained
		solutions
		Test possibilities of future failures through analysis of failure mode
		Develop several alternative maintenance schedules based on different scientific hypotheses

MIR2

Critical Work Function: Communicate with others to ensure that maintenance and repairs meet business needs.

Critical work functions *describe the major responsibilities involved in carrying out a concentration*

Concentrations *are the major areas of front-line work covering families of related jobs. Separate standards were identified for each concentration.*

Key Activities **Key activities** *are the duties and tasks involved in carrying out a critical work function*	Performance Indicators **Performance indicators** *correlate to the key activities. The performance indicators provide information on how to determine when someone is performing each key activity competently*
Educate others about benefits of predictive and preventive maintenance	Goals and benefits of predictive and preventive maintenance are clearly communicated. Education includes information on operator responsibility for predictive and preventive maintenance. Education is done regularly, according to company procedures. Education of production schedulers and managers promotes their understanding of the priorities and benefits of predictive and preventive maintenance.
Consult with others to set repair and maintenance priorities and schedule	Prior to shutdown period, the priorities, scheduling conflicts and tasks associated with repair and maintenance are agreed on by all parties. Repair and maintenance scheduling conflicts are resolved with all appropriate parties. Project management tools and feedback are used where applicable. Staffing requirements are accurately taken into account. Operator input is solicited and considered appropriately. Operators are notified with appropriate lead-time that maintenance is scheduled. Reports of critical problems are responded to in a timely way.
Communicate maintenance and repair resource needs	During the pre-planning process, the timetable, roles, parts and equipment needs are determined in a meeting with stakeholders. Resource requests are placed with appropriate parties. Coordination with other departments occurs to ensure all resources are on hand, access to equipment is available as needed and disruptions to the production line are minimized.
Prepare maintenance and repair logs for shift-to-shift communication	Documentation is completed in a timely manner. All important information is clearly communicated to the next shift. Repair report and preventive maintenance reschedule are submitted on time. Documentation is accessible to all appropriate parties. Status reports are clearly communicated from shift to shift.
Suggest ways to prevent future equipment malfunctions	Suggestions are made to appropriate parties. Suggestions are based on appropriate and accurate data or observations made during repairs. Suggestions are properly documented and include all supporting materials. Suggestions for improvement are submitted accurately and on time. Proper authorities are notified fast enough to permit them to correct an urgent problem.

Knowledge and Skills

Describes what a worker needs to know or be able to do to perform the critical work function

ACADEMIC AND EMPLOYABILITY SKILLS

Skill	Overall Complexity Rating for Workers	Overall Complexity Rating for Supervisors	Complexity Dimension	Complexity Subdimension	Complexity Subdimension Rating for Workers
Math	**L**	**L**	Complexity of mathematics content	Number sense and computation	**L**
				Geometry, measurement, and spatial sense	**L**
				Complexity of data analysis, statistics, and probability	**L**
				Functions and algebraic thinking	**L**
				Complexity of representation and communication	**M**
			Complexity of problem solving	Mathematical methods	**L**
				Mathematical reasoning	**M**
				Mathematical tools	**M**
Science	**NA**	**L**	Complexity of scientific inquiry	Design	**NA**
				Use of evidence	**NA**
			Complexity of understanding the nature of science	Unifying concepts and processes	**NA**
			Complexity of core scientific content	Physical science	**NA**
				Life science	**NA**
				Earth and space science	**NA**
			Complexity of applied science	Science and technology	**NA**
				Science in personal and social perspective	**NA**
Reading	**M**	**M**	Complexity of text		**M**
			Complexity of reading skills		**M**
			Complexity of reading purpose		**M**
Writing	**M**	**M**	Complexity of text	Complexity of text	**M**
			Complexity of writing product	Type of product	**M**
				Organization	**M**
				Elaboration	**M**
			Complexity of writing process	Writing development	**M**
				To inform	**M**
				To persuade	**M**
Listening	**M**	**M**	Complexity of communication	Content complexity	**M**
				Demands on attention	**M**
				Communication indirectness	**L**
			Barriers to communication	Limitations on interaction	**M**
				Distractions	**M**
Speaking	**M**	**M**	Complexity of communication	Content complexity	**M**
				Tact and sensitivity required	**M**
				Communication indirectness	**L**
			Context demands	Diversity of audience	**M**
				Constraints on preparation	**M**
				Distractions	**M**
				Listener resistance	**M**
Using Information and Communications Technology	**M**	**L**	Complexity of technology application	Complexity of equipment or technology	**M**
				Complexity of applications	**M**
				Training time constraints	**M**
			Frequency of technology change	New learning required	**M**
Gathering and Analyzing Information	**M**	**M**	Difficulty of information gathering	Amount of information	**M**
				Number and variety of sources	**M**
				Resourcefulness needed	**M**
			Complexity of analysis	Complexity of information and analysis	**M**
				Need to evaluate source information	**M**
				Lack of analysis guidelines	**M**

ACADEMIC AND EMPLOYABILITY SKILLS

Skill	Overall Complexity Rating for Workers	Overall Complexity Rating for Supervisors	Complexity Dimension	Complexity Subdimension	Complexity Subdimension Rating for Workers
Analyzing and Solving Problems	**M**	**M**	Problem complexity	Problem uniqueness or difficulty	**M**
				Number and range of problems	**M**
			Solution complexity	Number and complexity of possible solutions	**M**
Making Decisions and Judgments	**M**	**M**	Degree of judgment or inference required	Lack of guidance or precedents	**M**
				Integration difficulty	**M**
				Quantity or ambiguity of risks and consequences	**M**
			Individual decision-making responsibility	Accountability and autonomy	**M**
				Absence or ambiguity of rules or policy constraints	**M**
Organizing and Planning	**M**	**M**	Complexity of plans	Goal complexity or ambiguity	**M**
				Flexibility required	**M**
				Resource coordination required	**H**
				Scope and effects of planning	**M**
			Constraints on planning	Lack of guidelines	**M**
				Lack of feedback	**M**
				Constraints on resource availability	**M**
Using Social Skills	**M**	**M**	Complexity of social interactions	Diversity	**M**
				Structure or protocol required	**M**
				Tact and sensitivity required	**M**
Adaptability	**M**	**M**	Degree of adaptability required	Frequency of change	**M**
			Difficulty of adapting	Unpredictability of change	**M**
				Lack of support for change	**M**
Working in Teams	**M**	**M**	Degree of collaboration required	Task interdependence	**M**
			Team member heterogeneity	Team diversity	**M**
			Goal or role ambiguity	Lack of clarity or support for team goals	**M**
				Lack of clarity or stability of responsibilities	**M**
Leading Others	**M**	**M**	Work challenges	Challenges to goal attainment	**M**
				Work structuring requirements	**M**
				Scope and complexity of leadership responsibility	**M**
			People challenges	Coaching or monitoring needs	**M**
				Conflict management needs	**M**
Building Consensus	**M**	**M**	Consensus process inhibitors	Number and diversity of stakeholders	**M**
				Ambiguity of goals	**M**
				Lack of organizational support, incentives, or consensus leadership	**M**
				High consensus standard	**M**
			Difficulty of issues requiring consensus	Complexity of issues	**M**
				Contentiousness of issues	**M**
				Lack of opportunities for agreement	**M**
Self and Career Develop-ment	**M**	**M**	Need for learning and development	Self and career development requirements	**M**
			Limitations on learning and development opportunities	Time, resource, or support constraints	**M**
				Application constraints	**L**

Overall complexity ratings: The *overall* level of complexity required in a skill in order to perform the critical work function. *Scale*: H=high complexity; M=moderate complexity; and L=low complexity. Two separate ratings are provided: one for *workers* (entry-level up to first-line supervisors) and the other for *supervisors* (first-line supervisors). In some cases, the overall complexity rating was **NA (Non-Applicable)**. This means that this skill was deemed not to be needed to perform this given critical work function, so no complexity rating was assigned.
Complexity Subdimension ratings: These are complexity level ratings for individual aspects of the particular skill. *Scale*: H=high complexity; M=moderate complexity; and L=low complexity. At this time, these ratings are provided for workers only. In some cases, the subdimension complexity rating was **NA (Non-Applicable)**. This means that this *particular dimension* of the skill was deemed not to be needed to perform this given critical work function, so no complexity rating was assigned.

Knowledge and Skills

Describes what a worker needs to know or be able to do to perform the critical work function

OCCUPATIONAL AND TECHNICAL KNOWLEDGE AND SKILLS

These are the technical knowledge and skills needed to perform the critical work function.

Skill Category	Specific Knowledge and Skills	Specific Knowledge and Skills
Manufacturing Process	A. Knowledge of production scheduling to coordinate maintenance schedule with production schedule and meet customer needs. B. Knowledge of equipment and functionality to coordinate periodic testing and random performance exams. C. Skill in communicating equipment malfunctions that will cause delays in production. D. Knowledge of technical terms.	E. Skill in assessing resource needs in order to recommend or request resources. F. Skill in communicating how predictive and preventive maintenance results affect production demands and schedules. G. Knowledge of continuous improvement techniques in order to improve equipment reliability.
Documentation of Maintenance	A. Skill in using "pass down" sheets to communicate machine problems between shifts. B. Knowledge of how to document and share lessons learned regarding corrective actions and new skills.	C. Skill in reviewing past equipment files and history to recommend appropriate maintenance procedures. D. Skill in documenting modifications, repairs, and failures to equipment. E. Skill in documenting past equipment failures, tolerances of materials, and quality of parts.
Statistical Tools and Systems	A. Skill in prioritizing and scheduling programs in order to set maintenance priorities (i.e., shift to shift, department to department) and track equipment being repaired.	B. Knowledge of demand and resources to work with production to schedule maintenance efforts. C. Knowledge of software and/or printed media to maintain documentation of repair activities.
Training	A. Skill in training others. B. Knowledge of equipment operation so that operators and those who maintain the equipment can be trained in normal operations and preventive maintenance procedures. C. Knowledge of maintenance trends to share best practices with workers.	D. Knowledge of equipment specific preventive maintenance programs to train others in proper techniques. E. Skill in communicating the benefits of predictive maintenance, such as cost savings, more production and higher quality. F. Knowledge of the need to reduce variability in product by increasing the performance of tools and equipment.
Business Policies and Procedures	A. Knowledge of internal reporting procedures.	B. Knowledge of who needs to be notified of maintenance issues, who can resolve different types of problems, and when problems need to be escalated to a higher level within the organization.
Maintenance Procedures	A. Skill in analyzing and estimating equipment condition and evaluating repair needs. B. Knowledge of equipment history trends (i.e., parts ordered, malfunctions, review of reported maintenance issues) to schedule preventive maintenance to reduce impact on run. C. Knowledge of craft-specific techniques in manufacturing, installation, and repair to perform quality work. D. Skill in recognizing challenges of using certain maintenance practices in order to propose viable alternatives. E. Knowledge of maintenance procedures to know how long they will take and who is responsible. F. Skill in conducting diagnostic testing (i.e., testing for unusual sounds, visual problems, vibration problems).	G. Knowledge of repair process. H. Knowledge of correct resources required to address equipment needs (i.e., part #s, vendors, repair hubs) I. Knowledge of maintenance work order entry tracking analysis to determine down time costs and deviations from plan. J. Knowledge of the procedures and parts necessary for complete maintenance. K. Knowledge of maintenance needs in order to review equipment logs, communicate with end users, and to prioritize or identify needs. L. Knowledge of the special tools needed for maintenance. M. Skill in communicating with other maintenance personnel to determine better methods for maintenance.
Scheduling	A. Skill in prioritizing and recommending maintenance needs. B. Skill in assessing maintenance needs to develop maintenance schedule. C. Skill in communicating resources needed, such as maintenance personnel and parts. D. Skill in coordinating the needs between groups in order to avoid conflicts and set appropriate priorities.	E Knowledge of availability of parts, production demands and other department priorities to ensure that all required resources are available. F. Skill in determining personnel with the appropriate skills and certification to perform the maintenance.

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Critical Work Function: Communicate with others to ensure that maintenance and repairs meet business needs		
Knowledge/skill	**Mean Importance**	**Examples**
Using Information and Communication Technology	3.56	Use email to communicate schedule priorities and corrective action to prevent re-occurrence
		Use computer-based training for education
		Use intranet to identify specific maintenance problems from shift to shift or operator to engineer
		Input maintenance procedures into spreadsheet and data base to facilitate communications across shifts and ensure uniformity of procedures
		Use email and voicemail to communicate the schedule and appropriate downtime of machines
Gathering and Analyzing Information	3.77	Organize information from work order to coordinate/communicate equipment needs
		Share equipment-related problems and reminders with co-workers
		Consult with production scheduling to determine best time slot to perform actual maintenance
		Gather information from vendors and installers to ensure proper equipment management
		shifts
Analyzing and Solving Problems	3.23	Identify benefits and importance of predictive and preventive maintenance for operators, installers, maintenance, repairers in order to meet business needs
		Contact equipment engineering, process engineering and manufacturing to report planned downtime in a way to schedule appropriate and anticipated downtime
		Anticipate conditions that could cause equipment failure and communicate them to next shift
		Suggest improvements to the maintenance process to improve capability and efficiency in the process
		Make all levels of management aware of the specific maintenance needs
Making Decisions and Judgments	3.20	Decide manpower level and resources needed to complete tasks
		Determine who needs to know decisions in order to streamline communications
		Communicate to management the "man hours" required for repairs on a tool by calculating requirements and presenting them using presentation software and GANT charting
		Work with production/accounting to make sure timing of repair work in the calendar; Order parts when plant is in full operation- do work when slow
		Consult with team members to ensure that maintenance meets business needs

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Organizing and Planning	3.77	Organize stakeholders (equipment operators, maintenance, installers) efforts during maintenance's scheduling to reduce negative effect on business needs
		Obtain production plans and calculate number of machines required
		Review material needed for the job; gather materials and tools
		Plan ahead of time for preventive maintenance
Using Social Skills	3.96	Interact with co-workers in a friendly and courteous way to provide training/work requirements/requests for their time
		Communicate respectfully with co-workers when delivering training
		Communicate with other employees concerning issues from shift to shift and also needs of their own shift
		Make all team members aware of the positive side of performing the work as needed; Try to get agreement on work to be completed
Adaptability	3.38	Communicate changes to schedule
		Suggest new method of performing machine maintenance to save time
		Adapt to learner's style when delivering training; adapt communication medium to the needs or desires of a specific person (e.g., face-to-face, phone or email)
		Show ability to accept new procedures to solve problems
		Equipment that has been determined a problem can deteriorate very fast and you must adapt and communicate these conditions to prevent unplanned outage
Working in Teams	3.81	Team with maintenance personnel to facilitate scheduled and unscheduled maintenance
		Communicate the preventive maintenance plan to all co-workers and train new employees on preventive maintenance importance
		Provide feedback to production and business managers concerning the status of maintenance activities
		Team with other functions and shifts to get the best work done on time

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Leading Others	3.31	Influence frontline workers to accurately record shift activities and maintenance logs
		Influence workers as to the importance of communications
		Influence scheduling to allow time for repairs into the schedule; Lead the organization to an understanding of maintenance needs
		Tell supervisor of equipment needs and help new employees prepare for shutdown
		Coordinate repairs and take responsibility for them to be done in a timely manner
Building Consensus	3.73	Engage co-workers in prioritizing and scheduling work
		Agree on what repairs are needed to keep from having down time
		Consult with others to set repair and maintenance schedule to avoid conflict
Self and Career Development	3.12	Learn new methods of communication styles
		Identify learning opportunities in communicating maintenance needs
		Ask the pro's for engine or machine specifics so you better understand the machine and process
Speaking	4.00	Talk with co-workers about preventive maintenance program to get buy-in from all employees
		Discuss future business plans with manufacturing in order to get a comprehensive schedule plan
		Provide feedback to operators when presented with special maintenance issues
		Inform production management of the timetable for performing a particular repair
		Provide clear information in order to result in fewer misunderstandings and better relations between production and maintenance

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Listening	4.12	Listen to concerns about equipment health
		Receive feedback from all levels before communicating new objectives
		Listen to the planning department in order to understand customer needs
		Listen to operators and customers discuss good maintenance practices
		Listen to all parties on better ways to prevent equipment malfunction
Writing	4.16	Document maintenance action (time, equipment, resources, outcome)
		Develop and convey maintenance and documents to business managers
		Distribute written direction to identify goals of educating the workforce on preventive maintenance
		Fill out documentation or pass down reports for supervisor, engineers and customer information
		Write shift to shift logs communicating operating changes, equipment failures, repairs, problem reporting or problem resolution
Reading	4.04	Read and understand procedures for performing maintenance, installation or repair
		Read reports and memos relevant to business operation and project the impact of unscheduled maintenance on business operations
		Read emails from co-workers to get feedback or answers to technical questions
		Read documentation for what is to be checked when doing the preventive maintenance on a tool and what is to be replaced without checking
		Review equipment histories, follow testing and operating procedures
Math	3.28	Measure preventive maintenance program trends and communicate to management that preventive maintenance procedures must be done by qualified workforce
		Calculate margins and product costs
		Show data and conclusion about how the preventive maintenance schedule is derived
		Provide management with graphic charts, tables, and other quantitative data pertaining to maintenance activities
		Calculate needed resources to meet scheduled maintenance
Science	2.93	Apply principles of SPC to preventive maintenance program to ensure reliability and availability of equipment
		Apply principles of physics to display effect preventive maintenance in reducing equipment functions
		Apply knowledge of physics, chemistry to assure proper operation of equipment
		Knowledge of physics to understand reasons for the equipment failure
		Apply physics (calc of pressures, cool down times, etc.) and chemistry (pressure, temp, stress) in shutdown procedures

MIR3

Critical Work Function: Maintain hands-on knowledge of equipment operation to identify maintenance needs.

Critical work functions *describe the major responsibilities involved in carrying out a concentration*

Concentrations *are the major areas of front-line work covering families of related jobs. Separate standards were identified for each concentration.*

Key Activities **Key activities** *are the duties and tasks involved in carrying out a critical work function*	Performance Indicators **Performance indicators** *correlate to the key activities. The performance indicators provide information on how to determine when someone is performing each key activity competently*
Observe equipment operation during normal operating cycle to identify potential problems	Observation of equipment is performed regularly. All unusual behaviors or unsafe conditions observed are reported immediately to appropriate personnel. All aspects of equipment operations are documented. Safety requirements are in place during observation. Equipment and process operations are observed a number of times for consistency. Equipment and process data is analyzed regularly.
Maintain up-to-date knowledge of all documentation related to equipment	All relevant materials are easily available. Machine identifiers, equipment lists and process data are utilized to locate relevant information. All relevant databases are used in a timely manner. Information relevant and specific to the requirements of the work to be performed is pulled from the documents quickly. All information used is up-to-date. Interpretations and questions on materials, specifications and diagnostics are discussed and resolved.
Maintain information about equipment use and reliability	Data on equipment life is accurately maintained. Documentation is up-to-date. Tool change data is accurately documented. Contact information on tool vendor is readily available. Information is gathered to identify the proper tool for maintenance and repair tasks.
Maintain all relevant equipment operation and repair certifications	Certifications are properly planned and scheduled in advance. Certification is performed by a qualified person. Certifications are properly documented and information is reported to the correct parties. Inspections of equipment are performed and documented according to all applicable laws and regulations. Records are current and accurate. Level of detail of certification documentation is appropriate. Tool and equipment obsolescence information is passed on to certify the repair, rebuild or replacement. All relevant equipment and tool certifications are current and readily available.
Maintain personal certification and licensure	Certifications are performed by the appropriate parties, as required. Certifications are updated as appropriate. New requirements are communicated appropriately. Documentation is available to appropriate personnel. Training requirements for certifications are identified. All necessary training is obtained.

Knowledge and Skills

Describes what a worker needs to know or be able to do to perform the critical work function

ACADEMIC AND EMPLOYABILITY SKILLS

Skill	Overall Complexity Rating for Workers	Overall Complexity Rating for Supervisors	Complexity Dimension	Complexity Subdimension	Complexity Subdimension Rating for Workers
Math	**L**	**L**	Complexity of mathematics content	Number sense and computation	**M**
				Geometry, measurement, and spatial sense	**M**
				Complexity of data analysis, statistics, and probability	**M**
				Functions and algebraic thinking	**L**
				Complexity of representation and communication	**L**
			Complexity of problem solving	Mathematical methods	**L**
				Mathematical reasoning	**L**
				Mathematical tools	**M**
Science	**L**	**L**	Complexity of scientific inquiry	Design	**M**
				Use of evidence	**M**
			Complexity of understanding the nature of science	Unifying concepts and processes	**L**
			Complexity of core scientific content	Physical science	**M**
				Life science	**NA**
				Earth and space science	**NA**
			Complexity of applied science	Science and technology	**M**
				Science in personal and social perspective	**NA**
Reading	**M**	**M**	Complexity of text		**M**
			Complexity of reading skills		**M**
			Complexity of reading purpose		**M**
Writing	**L**	**L**	Complexity of text	Complexity of text	**M**
			Complexity of writing product	Type of product	**M**
				Organization	**L**
				Elaboration	**M**
			Complexity of writing process	Writing development	**L**
				To inform	**L**
				To persuade	**L**
Listening	**L**	**M**	Complexity of communication	Content complexity	**M**
				Demands on attention	**M**
				Communication indirectness	**L**
			Barriers to communication	Limitations on interaction	**L**
				Distractions	**M**
Speaking	**L**	**L**	Complexity of communication	Content complexity	**M**
				Tact and sensitivity required	**L**
				Communication indirectness	**L**
			Context demands	Diversity of audience	**M**
				Constraints on preparation	**M**
				Distractions	**M**
				Listener resistance	**L**
Using Information and Communications Technology	**M**	**M**	Complexity of technology application	Complexity of equipment or technology	**M**
				Complexity of applications	**M**
				Training time constraints	**M**
			Frequency of technology change	New learning required	**M**
Gathering and Analyzing Information	**M**	**M**	Difficulty of information gathering	Amount of information	**M**
				Number and variety of sources	**M**
				Resourcefulness needed	**M**
			Complexity of analysis	Complexity of information and analysis	**M**
				Need to evaluate source information	**M**
				Lack of analysis guidelines	**M**

ACADEMIC AND EMPLOYABILITY SKILLS

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Analyzing and Solving Problems	**M**	**M**	Problem complexity	Problem uniqueness or difficulty	**M**
				Number and range of problems	**M**
			Solution complexity	Number and complexity of possible solutions	**M**
Making Decisions and Judgments	**M**	**M**	Degree of judgment or inference required	Lack of guidance or precedents	**M**
				Integration difficulty	**M**
				Quantity or ambiguity of risks and consequences	**M**
			Individual decision-making responsibility	Accountability and autonomy	**M**
				Absence or ambiguity of rules or policy constraints	**M**
Organizing and Planning	**M**	**L**	Complexity of plans	Goal complexity or ambiguity	**M**
				Flexibility required	**M**
				Resource coordination required	**M**
				Scope and effects of planning	**M**
			Constraints on planning	Lack of guidelines	**M**
				Lack of feedback	**M**
				Constraints on resource availability	**M**
Using Social Skills	**NA**	**L**	Complexity of social interactions	Diversity	**NA**
				Structure or protocol required	**NA**
				Tact and sensitivity required	**NA**
Adaptability	**NA**	**M**	Degree of adaptability required	Frequency of change	**NA**
			Difficulty of adapting	Unpredictability of change	**NA**
				Lack of support for change	**NA**
Working in Teams	**L**	**L**	Degree of collaboration required	Task interdependence	**M**
			Team member heterogeneity	Team diversity	**M**
			Goal or role ambiguity	Lack of clarity or support for team goals	**L**
				Lack of clarity or stability of responsibilities	**L**
Leading Others	**L**	**L**	Work challenges	Challenges to goal attainment	**M**
				Work structuring requirements	**M**
				Scope and complexity of leadership responsibility	**L**
			People challenges	Coaching or monitoring needs	**M**
				Conflict management needs	**L**
Building Consensus	**L**	**L**	Consensus process inhibitors	Number and diversity of stakeholders	**M**
				Ambiguity of goals	**L**
				Lack of organizational support, incentives, or consensus leadership	**L**
				High consensus standard	**M**
			Difficulty of issues requiring consensus	Complexity of issues	**M**
				Contentiousness of issues	**L**
				Lack of opportunities for agreement	**M**
Self and Career Develop-ment	**M**	**M**	Need for learning and development	Self and career development requirements	**M**
			Limitations on learning and development opportunities	Time, resource, or support constraints	**M**
				Application constraints	**L**

Overall complexity ratings: The *overall* level of complexity required in a skill in order to perform the critical work function. *Scale*: H=high complexity; M=moderate complexity; and L=low complexity. Two separate ratings are provided: one for *workers* (entry-level up to first-line supervisors) and the other for *supervisors* (first-line supervisors). In some cases, the overall complexity rating was **NA (Non-Applicable)**. This means that this skill was deemed not to be needed to perform this given critical work function, so no complexity rating was assigned.
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Knowledge and Skills

Describes what a worker needs to know or be able to do to perform the critical work function

OCCUPATIONAL AND TECHNICAL KNOWLEDGE AND SKILLS

These are the technical knowledge and skills needed to perform the critical work function.

Skill Category	Specific Knowledge and Skills	Specific Knowledge and Skills
Tools and Equipment	A. Knowledge of how to interpret data tags and equipment identification numbers so that spare parts can be ordered prior to shutdown. B. Skill in assessing and using vendor list for equipment. C. Skill in observing equipment operations to identify problems (i.e., noticing abnormal vibrations, smoke, or high temperatures).	D. Skill in operating machine at a basic level. E. Skill in assessing and reading schematics and drawings. F. Skill in using equipment history to prevent early failures and identify problems.
Documentation of Maintenance	A. Skill in setting up files and maintaining history of equipment. B. Knowledge of assessing equipment and vendor information. C. Skill in understanding equipment manuals. D. Knowledge of Occupational Safety and Health Administration (OSHA) standards and how to remain in compliance. E. Skill in accessing equipment records (e.g., all machine repairs and parts by capital asset number)	F. Skill in completing documentation, including work completed on preventive maintenance, to use as a history for replacement of equipment costs. G. Knowledge of where all documentation is located for a particular piece of equipment. H. Knowledge of how to ensure that the next shift has the information it needs. I. Knowledge of what observations should be documented and/or reported.
Statistical Tools and Systems	A. Skill in reading schematics for use in troubleshooting components or systems. B. Knowledge of statistical applications to determine deviations and out of specification conditions.	C. Knowledge of diagnostic testing. D. Knowledge of software and/or printed media in order to maintain documentation of repair activities.
Maintenance Procedures	A. Skill in diagnosing, troubleshooting and repairing equipment in a timely fashion. B. Knowledge of mechanical concepts to ensure mechanical assemblies are performing to specification. C. Knowledge of failure modes, time and motion, and operational analysis to understand acceptable failure rate of machine parts. D. Knowledge of qualification or calibration procedures to determine if the equipment operation is within specification. E. Knowledge of production process. F. Knowledge of equipment design, operational parameters, and constraints in order to inspect equipment for proper operation and equipment health.	G. Skill in recognizing symptoms of improper equipment operations. H. Knowledge of equipment discard limits to help identify what and when replacement needs to take place. I. Knowledge of equipment vendor catalogue and how to keep listings of contacts (i.e., email, phone numbers) up to date for each piece of equipment. J. Skill in maintaining equipment documentation to have ready access to training manuals, and Original Equipment Manufacture (OEM) specification sheets to monitor normal operations. K. Knowledge of equipment data in order to interpret the data to find out about the "health history" of equipment.
Experimenting, Prototyping, and Trials	A. Knowledge of testing processes to ensure test run meets set specifications before equipment can be released to production.	
Training	A. Skill in completing training on equipment to properly maintain and address repair needs. B. Skill in obtaining and maintaining certification on equipment. C. Knowledge of equipment requirements to keep all certifications up to date. D. Knowledge of what certifications and licensures are needed. E. Knowledge of how to handle hazardous materials and disposals to be certified.	F. Skill in reading equipment manuals and past history files to maintain up-to-date knowledge of equipment repairs. G. Knowledge of job specific roles, responsibilities, and accountabilities to maintain certification. H. Skill in developing cross-training of operators. I. Knowledge of the personnel certified to work on specific equipment. J. Skill in qualifying operators and maintenance personnel.

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Critical Work Function: Maintain hands-on knowledge of equipment operation to identify maintenance needs		
Knowledge/skill	**Mean Importance**	**Examples**
Using Information and Communication Technology	3.63	Use computer application in order to identify maintenance needs (e.g. production planning)
		Use database to ensure certification and licenses stay up to date
		Utilize database for equipment repair histories and changes
		Use computer-based training to upgrade skills
		Use document database to view documents for tool operation and qualification
		Collect info from maintenance logs and operators to determine how equipment has been performing
Gathering and Analyzing Information	3.96	Gather information from meetings and fill orders in order to identify and assess maintenance needs
		Gather information from equipment history to better train employees
		Observe equipment operation to assure consistent operation
		Gather equipment data and analyze equipment performance against normal equipment specifications
		Organize equipment information data from operators, engineers, etc to analyze for future use and view past trends
Analyzing and Solving Problems	3.71	Observe equipment to identify proper operation to minimize equipment failure
		Recognize sub-optimal operating conditions in order to correct the condition
		Observe and diagnose maintenance problems to insure proper corrective actions are taken
		Use an experienced technician to explain the problem and then proceed to correct it
		Analyze training and schedule retraining in-house or with manufacturers of machines
Making Decisions and Judgments	3.48	Decide if equipment is performing within OEM specifications and identify maintenance needs based on performance
		Determine causes of equipment failure
		Establish priorities for certification
		Determine if current info is up to date; Determine how much data is necessary
		Knowledge of equipment history will help in deciding timing of repairs

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Organizing and Planning	3.32	Review piece/part history to predict needs for replacement parts
		Plan the training and certification process in order to maintain maintenance milestones
		Organize work time and prioritize tasks to ensure critical maintenance functions take place
		Organize database on equipment and personnel certification
		Observe equipment and have knowledge of how equipment should operate
Using Social Skills	2.60	Contact maintenance personnel to identify and determine equipment operating status
		Communicate equipment problems to co-workers to increase equipment reliability
		Request feedback from operator on the performance of the equipment
		Contact a supplier in a courteous manner to obtain the latest equipment manuals
		Communicate all up-to-date equipment information in an appropriate manner
Adaptability	2.88	Share lessons learned on tool and be open to accepting learned results from others
		Change or modify equipment documents to keep up-to-date records
		Demonstrate flexibility by learning a new maintenance function
		Demonstrate receptivity to new ideas from retooling, changing equipment or equipment upgrades
		Be able to learn new updates and change equipment to new specs
Working in Teams	3.24	Team operators with maintenance, installers and repair personnel to identify and resolve maintenance issues
		Share lessons learned with peers in order to upgrade everyone's technical skills
		Review employee's training log to make sure all certifications are up to date
		Share information regarding a tool among team members for effective repair/maintenance
		Team with production other crafts, vendors, etc. to gain full understanding of the equipment
Leading Others	3.27	Demonstrate by example correct maintenance operation and documentation
		Demonstrate leadership by maintaining up-to-date certification
		Influence others by maintaining knowledge base on the equipment
		Lead production operators to ensure proper operation of equipment
		Work with other maintenance personnel to teach/train them on new machines; sharing info creates a better team

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Building Consensus	2.65	Resolve possible differences between vendors schedules and plant schedules
		Provide accurate and factual data on equipment histories to assist with production schedules
		Coordinate maintenance efforts across equipment by assisting equipment personnel
		Meet with maintenance team and share info and knowledge of equipment
Self and Career Development	4.40	Remain current on technology changes and new tools
		Attend training at the supplier to improve troubleshooting efficiency
		Pursue certification in aspects of equipment maintenance
		Schedule training with manufacturer for better knowledge of equipment
		Attend seminars related to work to refresh and update knowledge and skills (e.g., hyphaulics)
Speaking	3.04	Discuss equipment health with work groups and share best practices
		Openly present potential equipment problems in order to get better runs
		Talk with operators about data from a certain tool in order to obtain feedback of final test results
		Make a presentation to management on equipment obsolescence to obtain new capital
		Talk to manufacturer of equipment to better understand equipment operation
Listening	3.44	Listen to operators to identify particular maintenance needs
		Receive feedback from trained personnel in equipment operations
		Listen in meetings, rack-ups, shift to shift changes to gain knowledge of repairs made, problems, projected failures, etc.
		Listen to equipment in operation and ask operators about problem
Writing	3.56	Fill out information log sheets
		Create detailed procedures and certifications for legal documents
		Write specifications for tool maintenance
		Send correspondence to a supplier
		Create a written maintenance log on a specific piece of equipment
Reading	4.44	Read and understand standard equipment maintenance procedures
		Read reports on tool uptime, production loss issues and upcoming development
		Read standard practices for operating equipment
		Read and understand reports of critical problems

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Math	3.60	Review equipment performance by measuring trends via database (SPC)
		Calculate piece/hour for the tool
		Compare optimal to actual equipment standards and recommend appropriate maintenance actions
		Calculate the amount of time the equipment is running to establish a machine reliability log
Science	3.39	Conduct metallurgical analysis in order to find better ways to weld alloys
		Know the process the tool provides in order to assist the process engineer in troubleshooting
		Apply knowledge of physics, chemistry to assure proper operation of equipment
		Conduct a study of equipment life expectancy and review the results with management

MIR4

Critical Work Function: Ensure safe use of equipment in the workplace.

Critical work functions *describe the major responsibilities involved in carrying out a concentration*

Concentrations *are the major areas of front-line work covering families of related jobs. Separate standards were identified for each concentration.*

Key Activities **Key activities** *are the duties and tasks involved in carrying out a critical work function*	Performance Indicators **Performance indicators** *correlate to the key activities. The performance indicators provide information on how to determine when someone is performing each key activity competently*
Train others to use equipment safely	New operators are given a complete orientation to the equipment. All important information regarding equipment safety is communicated clearly and effectively. Maintenance workers obtain certification to train others in technical skills and knowledge, where applicable. Suggestions regarding training materials and content are made to correct parties. Evaluations and feedback are utilized to improve training materials and methods. During training, trainee has the correct tools to do the job. Post- training evaluation indicates that workers can operate equipment safely. Training and facilitation techniques used are appropriate for the audience. Quality and effectiveness of training are documented appropriately.
Suggest process and procedures that support safety and effectiveness of work environment	Health and safety representatives are consulted in the development of suggestions. Operator feedback is solicited and used in suggestions on how to create a safer, more effective work environment. Suggestions are made to correct parties, according to company procedure. Suggestions are properly documented. Content of suggestions appropriately responds to safety, quality and productivity issues.
Fulfill safety and health requirements for maintenance, installation and repair	Communication regarding safety is made regularly to all employees. Job safety analyses are reviewed regularly according to company policy. Hazardous materials procedures and policies, such as Material Safety Data Sheet and "right to know" are accurately followed. Environmental testing of workplace is performed on a regular basis as required by company policy or regulation. Equipment is audited to ensure there are no by-passes of safety guards. All regulatory and company safety procedures are followed including lock-out & tag-out, confined space and ergonomics. Good housekeeping procedures are followed. Safety and personal protective equipment is available, performs correctly, and has current certification.
Monitor equipment and operator performance	Monitoring is performed regularly. Out-of-compliance or unsafe conditions are reported immediately. Corrective action is taken on out-of-compliance or unsafe conditions. Equipment is checked to ensure it is operating according to specifications. Tools are checked to ensure they are in compliance with specifications. Accident and injury data is forwarded to appropriate personnel for inclusion in OSHA recordables. Information on the equipment use is gathered from operators to reveal existing or potential problems. Equipment and process are adjusted correctly. All monitoring data is accurately documented.

Knowledge and Skills

Describes what a worker needs to know or be able to do to perform the critical work function

ACADEMIC AND EMPLOYABILITY SKILLS

Skill	Overall Complexity Rating for Workers	Overall Complexity Rating for Supervisors	Complexity Dimension	Complexity Subdimension	Complexity Subdimension Rating for Workers
Math	**L**	**L**	Complexity of mathematics content	Number sense and computation	**L**
				Geometry, measurement, and spatial sense	**L**
				Complexity of data analysis, statistics, and probability	**NA**
				Functions and algebraic thinking	**NA**
				Complexity of representation and communication	**L**
			Complexity of problem solving	Mathematical methods	**NA**
				Mathematical reasoning	**L**
				Mathematical tools	**L**
Science	**L**	**L**	Complexity of scientific inquiry	Design	**L**
				Use of evidence	**L**
			Complexity of understanding the nature of science	Unifying concepts and processes	**L**
			Complexity of core scientific content	Physical science	**L**
				Life science	**NA**
				Earth and space science	**NA**
			Complexity of applied science	Science and technology	**L**
				Science in personal and social perspective	**L**
Reading	**M**	**M**	Complexity of text		**M**
			Complexity of reading skills		**M**
			Complexity of reading purpose		**M**
Writing	**M**	**M**	Complexity of text	Complexity of text	**M**
			Complexity of writing product	Type of product	**M**
				Organization	**M**
				Elaboration	**M**
			Complexity of writing process	Writing development	**L**
				To inform	**M**
				To persuade	**M**
Listening	**M**	**M**	Complexity of communication	Content complexity	**M**
				Demands on attention	**M**
				Communication indirectness	**M**
			Barriers to communication	Limitations on interaction	**M**
				Distractions	**M**
Speaking	**M**	**M**	Complexity of communication	Content complexity	**M**
				Tact and sensitivity required	**M**
				Communication indirectness	**L**
			Context demands	Diversity of audience	**M**
				Constraints on preparation	**M**
				Distractions	**M**
				Listener resistance	**M**
Using Information and Communications Technology	**L**	**L**	Complexity of technology application	Complexity of equipment or technology	**M**
				Complexity of applications	**L**
				Training time constraints	**L**
			Frequency of technology change	New learning required	**M**
Gathering and Analyzing Information	**M**	**M**	Difficulty of information gathering	Amount of information	**M**
				Number and variety of sources	**M**
				Resourcefulness needed	**M**
			Complexity of analysis	Complexity of information and analysis	**M**
				Need to evaluate source information	**L**
				Lack of analysis guidelines	**L**

ACADEMIC AND EMPLOYABILITY SKILLS

Skill	Overall Complexity Rating for Workers	Overall Complexity Rating for Supervisors	Complexity Dimension	Complexity Subdimension	Complexity Subdimension Rating for Workers
Analyzing and Solving Problems	**M**	**M**	Problem complexity	Problem uniqueness or difficulty	**M**
				Number and range of problems	**M**
			Solution complexity	Number and complexity of possible solutions	**M**
Making Decisions and Judgments	**M**	**M**	Degree of judgment or inference required	Lack of guidance or precedents	**L**
				Integration difficulty	**M**
				Quantity or ambiguity of risks and consequences	**M**
			Individual decision-making responsibility	Accountability and autonomy	**M**
				Absence or ambiguity of rules or policy constraints	**L**
Organizing and Planning	**M**	**M**	Complexity of plans	Goal complexity or ambiguity	**L**
				Flexibility required	**M**
				Resource coordination required	**M**
				Scope and effects of planning	**M**
			Constraints on planning	Lack of guidelines	**L**
				Lack of feedback	**L**
				Constraints on resource availability	**M**
Using Social Skills	**M**	**M**	Complexity of social interactions	Diversity	**M**
				Structure or protocol required	**M**
				Tact and sensitivity required	**M**
Adaptability	**L**	**L**	Degree of adaptability required	Frequency of change	**M**
			Difficulty of adapting	Unpredictability of change	**M**
				Lack of support for change	**L**
Working in Teams	**M**	**M**	Degree of collaboration required	Task interdependence	**M**
			Team member heterogeneity	Team diversity	**M**
			Goal or role ambiguity	Lack of clarity or support for team goals	**L**
				Lack of clarity or stability of responsibilities	**L**
Leading Others	**M**	**M**	Work challenges	Challenges to goal attainment	**M**
				Work structuring requirements	**M**
				Scope and complexity of leadership responsibility	**M**
			People challenges	Coaching or monitoring needs	**M**
				Conflict management needs	**M**
Building Consensus	**NA**	**M**	Consensus process inhibitors	Number and diversity of stakeholders	**NA**
				Ambiguity of goals	**NA**
				Lack of organizational support, incentives, or consensus leadership	**NA**
				High consensus standard	**NA**
			Difficulty of issues requiring consensus	Complexity of issues	**NA**
				Contentiousness of issues	**NA**
				Lack of opportunities for agreement	**NA**
Self and Career Develop-ment	**M**	**L**	Need for learning and development	Self and career development requirements	**M**
			Limitations on learning and development opportunities	Time, resource, or support constraints	**L**
				Application constraints	**M**

Overall complexity ratings: The *overall* level of complexity required in a skill in order to perform the critical work function. *Scale*: H=high complexity; M=moderate complexity; and L=low complexity. Two separate ratings are provided: one for *workers* (entry-level up to first-line supervisors) and the other for *supervisors* (first-line supervisors). In some cases, the overall complexity rating was **NA (Non-Applicable)**. This means that this skill was deemed not to be needed to perform this given critical work function, so no complexity rating was assigned.

Complexity Subdimension ratings: These are complexity level ratings for individual aspects of the particular skill. *Scale*: H=high complexity; M=moderate complexity; and L=low complexity. At this time, these ratings are provided for workers only. In some cases, the subdimension complexity rating was **NA (Non-Applicable)**. This means that this *particular dimension* of the skill was deemed not to be needed to perform this given critical work function, so no complexity rating was assigned.

Knowledge and Skills

Describes what a worker needs to know or be able to do to perform the critical work function

OCCUPATIONAL AND TECHNICAL KNOWLEDGE AND SKILLS

These are the technical knowledge and skills needed to perform the critical work function.

Skill Category	Specific Knowledge and Skills	Specific Knowledge and Skills
Regulatory Compliance	A. Knowledge of government policies, procedures, and regulations governing the safe use of equipment. B. Knowledge of procedures to prevent or reduce emissions and spills. C. Knowledge of Hazardous Materials (HAZMAT) procedures information. D. Knowledge of Material Safety Data Sheets (MSDS). E. Knowledge of applicable safety standards	F. Knowledge of which tools and equipment require safety certification. G. Knowledge of what the law requires companies to post or publish in order to keep employees abreast of OSHA and other government regulations. H. Knowledge of EPA required documentation for (a) disposal of hazardous waste generated during maintenance or (b) transportation of contaminated items.
Maintenance Procedures	A. Knowledge of equipment operation and design parameters to determine if machine is operating safely. B. Skill in reviewing environmental data systems in the factory.	C. Skill in making adjustments to equipment to ensure that is operating within established parameters. D. Skill in regularly monitoring equipment for unsafe conditions.
Training	A. Knowledge in identifying safety training courses B. Knowledge of equipment manual and standard practice manual to repair equipment safely. C. Knowledge of certifications needed for regulatory compliance (i.e., Cardio Pulmonary Resuscitation (CPR), Fire extinguisher, and Blood born Pathogens). D. Skill in conducting equipment safety demonstrations.	E. Skill in training other workers in proper safety procedures during maintenance process. F. Knowledge of the tools and materials needed to operate equipment to train others. G. Skill in using monthly safety meetings to improve the safety environment and communicate changes in regulations.
Safety Procedures	A. Skill in developing safety checklists. B. Knowledge of equipment safety systems to verify that they are operating properly. C. Knowledge to how prevent unsafe shutdown of equipment. D. Knowledge of personal protective equipment that should be worn. E. Skill in performing leak checks to determine if toxic or hazardous material is escaping from a piece of equipment. F. Skill in evaluating workplace safety using safety audit processes. G. Knowledge of hazard to document and communicate corrective actions and monitor performance.	H. Knowledge of company safety policies (e.g., Lock out/Tag out). I. Knowledge of proper and safe installation techniques as described in manuals, checklists, and regulations. J. Skill in recognizing and proposing ways to improve safety practices to propose alternative practices. K. Knowledge of Material Safety Data Sheets L. Knowledge of Hazardous Materials (HAZMAT) policies and procedures. M. Skill at modifying machines as prescribed to prevent injuries and improve ergonomics. N. Skill in generating and sharing near miss reports.

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Critical Work Function: Ensure safe use of equipment in the workplace		
Knowledge/skill	**Mean Importance**	**Examples**
Using Information and Communication Technology	4.12	Prepare and deliver PowerPoint presentations
		Email concerned individuals about safety needs or conditions
		Use computer to document and monitor performance training
		Use technology to research safety practices and guidelines
		Use computer and other telecomm equipment to communicate safety information
		Use document database to view documents for tool operation and qualification
Gathering and Analyzing Information	4.15	Determine the topics of training (by reading maintenance manuals, participating in vendor training, and reviewing OSHA standards) to assess training needs
		Orient new operators in the proper use of equipment and suggest process improvements
		Review safety requirements for a piece of equipment and integrate the requirements into the production procedures
		Organize information to meet safety requirements; put safety information at a central location for all maintenance persons involved
		Gather and track safety metrics so that the workforce can be educated on how better they may utilize equipment safety
Analyzing and Solving Problems	3.62	Anticipate, identify and provide responsive preventive training for safe use of equipment
		Identify safety problems of aging equipment and replace or bring up to date
		Evaluate operator suggestion and ideas for safe improvements
		Analyze processes to ensure safety standards have been met
Making Decisions and Judgments	4.08	Determine if equipment is being operated within appropriate safety standards
		Make a judgment about improving processes to reduce or eliminate safety injuries
		Determine best safety practices, policies and procedures for equipment
		Judge effectiveness/content of safety; Determine adequacy of safety plan for maintenance
		Check to see if job is safe; if it is not safe, make necessary changes and document why changes were made
Organizing and Planning	3.65	Plan safety-related training for equipment based on operator, maintenance, installer experience
		Organize time to ensure that safety operations are performed when needed
		Plan down time so as to minimize it
		Plan the safety items and tasks needed in preventive maintenance or maintenance
		Develop plan to train all people who use equipment on safety procedures and practices

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Using Social Skills	3.81	Interact with the user in positive manner to assure that proper safety methods are followed
		Make suggestions or provide training in a courteous way
		Communicate with operators regarding proper operations; also solicit feedback regarding machine operation
		Train others to use equipment safely; Suggest improvements and interact with operators
		Use social skills to sell the positives of good safety practices
Adaptability	3.46	Shut down out of compliant equipment to assure unsafe practices or out of compliance does not occur
		Change the training method to ensure safe equipment operation
		Demonstrate openness to new safety procedures
		Understand differences in learning styles and modify methods accordingly
		Be adaptable to msd's and OSHA standard changes
Working in Teams	3.92	Team operators with safety personnel to eliminate or reduce the impact of workplace hazards
		Have teams write procedures on safe use of equipment in the workplace
		Work with team to identify root cause and implement corrective measures
		Gather information from team members and identify corrective/ preventive action
		Share knowledge and experience with team members to increase the knowledge of entire team
Leading Others	4.00	Practice safety in all areas, leading others by example
		Perform on the spot corrections of unsafe practices and procedures
		Influence others by following safety procedures, making suggestions for improvements and doing a good job
		Influence employees to attend equipment safety training
		Give proper training and coaching on how to safely use equipment

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Building Consensus	3.69	Facilitate safety training classes by combining operations and maintenance personnel
		Provide examples of acceptable work practices and discuss the features and benefits of each
		Build consensus among all maintenance employees to ensure proper safety guidelines are followed
		Pass on info about unsafe conditions, equipment or operations to appropriate organizations (internal) for resolution
Self and Career Development	3.88	Identify opportunities in safety such as safety rep positions
		Attend OSHA and operator-related training
		Constantly monitor changes in safety practices
		Know what is required for safety compliance and what is really needed to keep employees safe, to reduce cost and injury
		Attend safety and OSHA training on equipment; Improve safe working conditions
Speaking	4.13	Talk to new employees about dangers of work place
		Give presentation on proper use and safety of tools and equipment to co-workers
		Explain to new operators the location and function of safety devices on the equipment they are using
		Train others to use equipment safely; Report issues and problems effectively
Listening	4.29	Listen to feedback from machine operators once a safety procedure is introduced
		Listen to verbal communication of safety and OSHA regulations from supervisors (e.g., accidents, loss time, workers comp)
		Listen to and evaluate operator feedback for use in better safety procedures
Writing	3.88	Create detailed near miss reports to educate co-workers about unsafe situations and corrective measures
		Create detailed safety operating procedures for equipment maintenance
		Document how a piece of equipment complies with regulations
		Write safety rules, safe procedures and practices, etc.
		Develop a written lock-out tag-out program so everyone knows what is going to take place

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Reading	4.56	Read and understand equipment maintenance safety procedures before operating equipment
		Read equipment operation and service documents
		Review the material safety data sheets for a new piece of equipment
		Read documentation on personal protective equipment needed when working on a tool
		Read training materials, safety rules, equipment operating procedures
Math	3.60	Compute calculations to determine environmental impact
		Compare and contrast man hours of safe to unsafe practices (ROI, CBA)
		Apply statistical analysis to preventative maintenance operations
		Estimate performance of equipment after repairs are completed
		Perform necessary calculations to ensure tools comply with specs
Science	3.85	Explain HAZMAT requirements for equipment maintenance procedures (MSDS, PPE, OSHA)
		Apply knowledge of physics, chemistry to safety activities in the workplace
		Apply principles of physics to identify reduction in ergonomic injuries
		Identify which chemicals are in the facility by material safety data sheets
		Apply environmental/safety and hazards standards in equipment operations

MIR5

Critical Work Function: Identify, diagnose and/or repair equipment problems.

Critical work functions *describe the major responsibilities involved in carrying out a concentration*

Concentrations *are the major areas of front-line work covering families of related jobs. Separate standards were identified for each concentration.*

Key Activities **Key activities** *are the duties and tasks involved in carrying out a critical work function*	Performance Indicators **Performance indicators** *correlate to the key activities. The performance indicators provide information on how to determine when someone is performing each key activity competently*
Gather equipment information and history to identify and/or diagnose problems	Operator and operator logs are consulted to determine the nature of the problem. Equipment, repair and diagnostics reports are checked for previous problems. Equipment is checked to identify problems. The most appropriate information is gathered to rapidly diagnose the problem. Appropriate and accurate sources of information are consulted such as prints, OEM manuals, process diagrams and engineering department calibrations.
Follow procedures to isolate system and component failure	Possible causes of failure are identified by drawing on available information, past experience, operator feedback and knowledge of equipment. Information about the nature and possible causes of failure is systematically gathered through visual inspection, observation of equipment during operations and disassembly of equipment, as appropriate. Proper diagnostic tests are performed and repeated as necessary to determine the nature of the problem. Diagnosis is timely and effective. Manufacturer's performance specifications are used when evaluating equipment performance. Procedure for isolating problems is initiated correctly and followed through completely.
Identify root cause of problem	Appropriate root cause identification process is used to determine contributing factors. The correct tests and inspections are performed on failed component(s). Data gathered through diagnostic procedures is analyzed to develop a hypothesis regarding possible root causes. Analysis is repeated until problem is solved.
Develop corrective action plan to fix the problem	All future repairs and modifications required to address underlying causes are correctly specified. Action plan addresses the need for timely repair. Plan includes proper repair procedures, proper tools and parts and estimated time required for repair. The right people needed for the repair are informed and involved. Plan reflects production needs. Plan accounts for variables in schedule, staffing and availability of parts.
Execute corrective action plan	Applicable safety procedures are used. Proper personal protective equipment is worn. Existing repair procedures are followed in accordance with OEM manuals or company procedures. Correct disassembly, repair/replacement and reassembly procedures are used. Equipment is safety checked and a test run performed prior to return to production. Post- repair tests confirm that equipment performs to requirements. Repairs are completed within specified time frames. Appropriate staffing and parts are used to effectively execute the plan.
Document diagnosis, case history plan and repair outcome	Documentation and verification are performed according to company and department policies and procedures. Documents and appropriate files are input into database, filed or distributed to correct parties. Post repair reviews are conducted to determine if customer is satisfied. Preventive maintenance schedule is properly adjusted to reflect repairs made. Equipment manufacturer is notified of any reliability and maintainability issues.

Knowledge and Skills

Describes what a worker needs to know or be able to do to perform the critical work function

ACADEMIC AND EMPLOYABILITY SKILLS

Skill	Overall Complexity Rating for Workers	Overall Complexity Rating for Supervisors	Complexity Dimension	Complexity Subdimension	Complexity Subdimension Rating for Workers
Math	**M**	**M**	Complexity of mathematics content	Number sense and computation	**M**
				Geometry, measurement, and spatial sense	**M**
				Complexity of data analysis, statistics, and probability	**M**
				Functions and algebraic thinking	**M**
				Complexity of representation and communication	**M**
			Complexity of problem solving	Mathematical methods	**M**
				Mathematical reasoning	**M**
				Mathematical tools	**M**
Science	**M**	**M**	Complexity of scientific inquiry	Design	**M**
				Use of evidence	**M**
			Complexity of understanding the nature of science	Unifying concepts and processes	**M**
			Complexity of core scientific content	Physical science	**M**
				Life science	**NA**
				Earth and space science	**NA**
			Complexity of applied science	Science and technology	**M**
				Science in personal and social perspective	**NA**
Reading	**M**	**M**	Complexity of text		**H**
			Complexity of reading skills		**M**
			Complexity of reading purpose		**M**
Writing	**M**	**M**	Complexity of text	Complexity of text	**M**
			Complexity of writing product	Type of product	**M**
				Organization	**M**
				Elaboration	**M**
			Complexity of writing process	Writing development	**M**
				To inform	**M**
				To persuade	**M**
Listening	**M**	**M**	Complexity of communication	Content complexity	**M**
				Demands on attention	**M**
				Communication indirectness	**L**
			Barriers to communication	Limitations on interaction	**M**
				Distractions	**M**
Speaking	**L**	**M**	Complexity of communication	Content complexity	**M**
				Tact and sensitivity required	**L**
				Communication indirectness	**L**
			Context demands	Diversity of audience	**M**
				Constraints on preparation	**M**
				Distractions	**M**
				Listener resistance	**L**
Using Information and Communications Technology	**M**	**M**	Complexity of technology application	Complexity of equipment or technology	**M**
				Complexity of applications	**M**
				Training time constraints	**M**
			Frequency of technology change	New learning required	**M**
Gathering and Analyzing Information	**H**	**H**	Difficulty of information gathering	Amount of information	**H**
				Number and variety of sources	**M**
				Resourcefulness needed	**M**
			Complexity of analysis	Complexity of information and analysis	**H**
				Need to evaluate source information	**M**
				Lack of analysis guidelines	**M**

ACADEMIC AND EMPLOYABILITY SKILLS

Skill	Overall Complexity Rating for Workers	Overall Complexity Rating for Supervisors	Complexity Dimension	Complexity Subdimension	Complexity Subdimension Rating for Workers
Analyzing and Solving Problems	**H**	**H**	Problem complexity	Problem uniqueness or difficulty	**H**
				Number and range of problems	**H**
			Solution complexity	Number and complexity of possible solutions	**M**
Making Decisions and Judgments	**M**	**H**	Degree of judgment or inference required	Lack of guidance or precedents	**M**
				Integration difficulty	**M**
				Quantity or ambiguity of risks and consequences	**M**
			Individual decision-making responsibility	Accountability and autonomy	**M**
				Absence or ambiguity of rules or policy constraints	**M**
Organizing and Planning	**M**	**M**	Complexity of plans	Goal complexity or ambiguity	**M**
				Flexibility required	**M**
				Resource coordination required	**M**
				Scope and effects of planning	**M**
			Constraints on planning	Lack of guidelines	**M**
				Lack of feedback	**M**
				Constraints on resource availability	**M**
Using Social Skills	**L**	**L**	Complexity of social interactions	Diversity	**M**
				Structure or protocol required	**L**
				Tact and sensitivity required	**M**
Adaptability	**M**	**M**	Degree of adaptability required	Frequency of change	**M**
			Difficulty of adapting	Unpredictability of change	**M**
				Lack of support for change	**M**
Working in Teams	**L**	**M**	Degree of collaboration required	Task interdependence	**M**
			Team member heterogeneity	Team diversity	**M**
			Goal or role ambiguity	Lack of clarity or support for team goals	**L**
				Lack of clarity or stability of responsibilities	**M**
Leading Others	**L**	**M**	Work challenges	Challenges to goal attainment	**M**
				Work structuring requirements	**M**
				Scope and complexity of leadership responsibility	**L**
			People challenges	Coaching or monitoring needs	**L**
				Conflict management needs	**M**
Building Consensus	**L**	**L**	Consensus process inhibitors	Number and diversity of stakeholders	**M**
				Ambiguity of goals	**L**
				Lack of organizational support, incentives, or consensus leadership	**L**
				High consensus standard	**M**
			Difficulty of issues requiring consensus	Complexity of issues	**M**
				Contentiousness of issues	**L**
				Lack of opportunities for agreement	**M**
Self and Career Develop-ment	**M**	**M**	Need for learning and development	Self and career development requirements	**M**
			Limitations on learning and development opportunities	Time, resource, or support constraints	**M**
				Application constraints	**M**

Overall complexity ratings: The *overall* level of complexity required in a skill in order to perform the critical work function. *Scale*: H=high complexity; M=moderate complexity; and L=low complexity. Two separate ratings are provided: one for *workers* (entry-level up to first-line supervisors) and the other for *supervisors* (first-line supervisors). In some cases, the overall complexity rating was **NA (Non-Applicable)**. This means that this skill was deemed not to be needed to perform this given critical work function, so no complexity rating was assigned.
Complexity Subdimension ratings: These are complexity level ratings for individual aspects of the particular skill. *Scale*: H=high complexity; M=moderate complexity; and L=low complexity. At this time, these ratings are provided for workers only. In some cases, the subdimension complexity rating was **NA (Non-Applicable)**. This means that this *particular dimension* of the skill was deemed not to be needed to perform this given critical work function, so no complexity rating was assigned.

Knowledge and Skills

Describes what a worker needs to know or be able to do to perform the critical work function

OCCUPATIONAL AND TECHNICAL KNOWLEDGE AND SKILLS

These are the technical knowledge and skills needed to perform the critical work function.

Skill Category	Specific Knowledge and Skills	Specific Knowledge and Skills
Maintenance Procedures	A. Knowledge of repair procedures. B. Skill in using Original Equipment Manufacture (OEM) manuals. C. Knowledge of how to troubleshoot and diagnose equipment problems. D. Skill in developing corrective action procedures. E. Skill in isolating equipment problems and identifying the root cause. F. Knowledge of how equipment should function to determine appropriate testing. G. Knowledge of equipment shutdown procedures.	H. Knowledge of equipment warranty status. I. Knowledge of past procedures for dealing with failures in order to identify ways to prevent similar situations in the future. J. Skill in modifying procedures to prevent future failures. K. Skill in identifying all the relevant information on equipment failure prior to identifying potential cause. L. Knowledge of how to properly document tests and repairs in order to keep an accurate history.
Safety Procedures	A. Knowledge of how to use required tools in a safe manner. B. Knowledge of safety procedures that need to be followed in order to perform work safely (e.g., Lock out/Tag out).	C. Knowledge of which safety equipment to use when working on specific equipment.
Statistical Tools and Systems	A. Skill in gathering and applying equipment history data. B. Knowledge of blueprints and repair manuals. C. Skill in developing benchmarking to help with tooling, staffing, and equipment acquisition. D. Knowledge of specific diagnostic tests. E. Knowledge of schematics and mechanical diagrams to identify source of problem and perform tests.	F. Knowledge of troubleshooting techniques to identify root causes of equipment failure. G. Knowledge of how to locate and interpret diagrams for use in obtaining technical assistance. H. Knowledge of statistical methods to analyze problem situations such as OOC (out of control) and OOS (out of specification). I. Skill in conducting a trend analysis.
Tools and Equipment	A. Skill in selecting and operating various test equipment to diagnose equipment and machinery. B. Knowledge of metrology tools to assist with identification of root cause.	C. Knowledge of production processes performed by equipment. D. Knowledge of equipment operation theory (i.e.., electronics technology, mechanical technology, hydraulic technology).
Documentation of Maintenance	A. Skill in evaluating changes in preventive maintenance schedule. B. Skill in documenting diagnostic plans of actions. C. Skill in updating maintenance logs to reflect actions performed or deferred until scheduled maintenance. D. Knowledge of how to share information to prevent other units or plants from having same problems.	E. Knowledge of computer data log techniques. F. Skill in checking manufacturing specifications for equipment performance while the machine is in operation. G. Skill in following record keeping policies so that past histories of machines are known in case of future failure.
Staffing and Work Role Knowledge	A. Skill in using the knowledge and training of experienced employees to train new employees. B. Knowledge of how to assess personnel and materials needed for repairs in order to allocate resources.	C. Knowledge of personnel skills in order to recommend or assign the proper technician to perform the repairs.

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Critical Work Function: Identify, diagnose, and/or repair equipment problems		
Knowledge/skill	**Mean Importance**	**Examples**
Using Information and Communication Technology	4.04	Review repair history data base to help identify trends in equipment problems
		Use email to request technical assistance from outside resources to determine root cause of problem
		Use maintenance database to examine tool history
		Use maintenance log on PC to monitor prior maintenance and techniques
		Interface with machine to diagnose order parts on line, schedule down time and repair personnel; Communicate machine status with email, add repair to history database
Gathering and Analyzing Information	4.36	Gather information from maintenance logs, computer applications and equipment records to correct maintenance-related problems
		Troubleshoot equipment problems using repair history and Request for Corrective Action techniques
		Gather equipment failure history and analyze to diagnose problem
		Research past maintenance logs to troubleshoot an equipment malfunction
Analyzing and Solving Problems	4.31	Troubleshoot faulty equipment, repair or replace and verify new operating condition
		Identify equipment problems by performing proper preventive maintenance and diagnostic tests
		Identify symptoms by listening to operators in order to determine root cause
		Troubleshoot equipment failure in order to identify cause of problem
		Troubleshoot and repair a piece of equipment that is not operating
Making Decisions and Judgments	4.24	Determine if corrective action solved maintenance problem, or if problem was not thoroughly corrected
		Perform diagnostics and interpret data
		Judge appropriateness of troubleshooting steps; Determine root cause, determine appropriate team
		Head off unscheduled repair by setting up inspectors and scheduled machine shut down
		Make a decision on a machine diagnosis based on the troubleshooting guide in the OEM

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Organizing and Planning	3.69	Organize and implement positive corrective action to reduce failures
		Organize diagnosis data and plan equipment repair time
		Know what upgrades are to be made; Check with vendor to see how to accomplish this task
		Work through a set system on repairs; Have the normal repair parts in house for most repairs; Train all employees all shifts
		Identify problem and organize personnel and parts for repair
Using Social Skills	3.50	Meet with maintenance personnel to identify, correct, and document equipment failures
		Talk with equipment operators to acquire information that may facilitate repair activities
		Interact in a courteous manner with operator to determine how a tool was performing before it malfunctioned
		Troubleshoot and repair equipment cooperatively with operator, other trades
		Check previous data on equipment collected by other employees; Ask questions and compare with your data
Adaptability	3.23	Develop a new troubleshooting procedure to identify root cause and corrective action
		Demonstrate openness to all possible causes of equipment failure to ensure proper diagnosis
		Adapt to new and changing procedures and the latest techniques
		Understand the problem; Be able to look for new problems and new procedures for pm
		Be receptive to teammate suggestions on how to troubleshoot or repair a piece of equipment
Working in Teams	4.12	Bring up suggestions at team meetings or better ways to analyze and repair problems
		By everyone documenting the history, equipment failure "repeats" are diagnosed and can be stopped
Leading Others	3.04	
		Lead a corrective action team using brainstorming techniques and fishbone diagrams to solve issues
		Lead the implementation of a corrective plan for equipment with excess downtime
		Help others perform task if they are not sure
		Coach others on how to troubleshoot and perform corrective action

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Building Consensus	3.15	Resolve differences between following proper start up procedures and short cuts
		Resolve equipment malfunction by discussing operator practices with maintenance, installation and repair
		Acquire diagnostic data information with members of workgroup
		Build consensus on root causes, proper procedures, action plans to ensure efficient preventive maintenance and reduce down time
		Get opinions from all employees and work on the machine to find the source; Have informal meetings to let employees know of findings
Self and Career Development	3.68	Identify training for root cause and planning and scheduling to reduce equipment outage timeframes
		Obtain training on new equipment
		Acquire certifications relevant to conducting diagnosis and repair
		Attend training on diagnostic programs to improve problem identification skills
		Work with vendors on specific machine problems
Speaking	3.33	Discuss problems that have been identified, diagnosed and repaired with other subject matter experts
		Interview past maintenance people to identify problems and repair techniques
		Communicate with co-workers on identifying root cause of problems
		Talk to the machine operator in a calm, non-confrontational manner to discover what occurred just before breakdown
Listening	3.92	Get feedback from co-workers to help identify problem area and repairs
		Listen to operators describe equipment malfunctions in order to determine corrective actions
		Listen to all users about possible causes for equipment failure
		Solicit information from machine operators as to the cause of the failure
		Listen to operator descriptions of problems, perform root cause analysis from what you hear; Diagnose or repair based on what is learned from what you hear
Writing	3.68	Write up diagnosis and findings on computer log in a clear and concise manner
		Create detailed record of equipment malfunction and corrective action
		Include diagnostic data in maintenance documentation
		Develop written corrective action and document diagnostic history and repair outcome
		Submit to management a written synopsis of why the piece of equipment failed and the corrective action taken

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Reading	4.44	Review equipment repair history in order to troubleshoot problems
		Read and review fault isolation equipment maintenance procedures before correcting equipment malfunctions
		Read and follow diagnostic decision tree and procedures
		Read procedure manuals to understand proper diagnostic methodology
		Review manufacturer's operating specifications while performing troubleshooting activities
		Read blueprints, vendors' or manufacturers' manuals, troubleshooting charts, instructions, etc.
Math	4.20	Utilize SPC information- trends, log book, database, to help identify problems in equipment design or use
		Estimate run times based on history and personal experience and data collected
		Compare faulty equipment specifications to normal specs
		Measure repair and equipment troubleshooting downtime for historical records
		Perform necessary calculations to ensure tools comply with specs
Science	4.07	Pull samples and send them to lab to determine if the chemical meets specifications
		Apply principles of troubleshooting to identify equipment malfunction
		Apply concepts common to mechanical fluids, electrical and thermal systems to the diagnosis and repair of equipment
		Understand the principles driving the operation of the equipment to generate corrective action
		Follow scientific method to analyze and understand performance problems

MIR6

Critical Work Function: Support the installation, customization or upgrading of equipment.

Critical work functions *describe the major responsibilities involved in carrying out a concentration*

Concentrations *are the major areas of front-line work covering families of related jobs. Separate standards were identified for each concentration.*

Key Activities **Key activities** *are the duties and tasks involved in carrying out a critical work function*	Performance Indicators **Performance indicators** *correlate to the key activities. The performance indicators provide information on how to determine when someone is performing each key activity competently*
Coordinate preparation for the installation, customization and upgrading of equipment	Appropriate input is provided on equipment, environmental impact and material needs. Plan includes time, equipment, and personnel required to do the job. Proper customization, upgrade needs and capacity limits are determined. All appropriate approvals are obtained. Plan provides for the availability and use of proper materials and relevant vendor information. Plan anticipates the need for future modifications and likelihood of mechanical or operator errors. Plan includes ergonomics, safety requirements and environmental impact issues.
Obtain information from vendors to ensure proper installation, customization, or upgrade	Availability of in-house personnel and outside contractors is determined. Appropriate vendor personnel are contacted to determine facility, parts, equipment and materials needs prior to installation. Materials and parts are verified against vendor specifications prior to initiating installation, upgrade or customization. Information obtained from vendors includes safety and quality considerations. Accurate blueprints, specifications and documentation are available. Maintenance manuals are reviewed, checked for completeness and modified as necessary.
Participate in the installation, customization or upgrading of equipment	All safety procedures are followed. Tools, equipment, and personnel are efficiently organized to do the job. Blueprint and plan of action are followed to customize or upgrade equipment. Follow-up is performed to ensure completeness of installation. Appropriate lock-out/ tag-out devices are removed. Equipment installation, customization or upgrade is completed to specification and schedule.
Prepare installation, customization or upgrade team	The proper workers are scheduled to ensure effectiveness, efficiency and safety. Personnel are trained on the proper customization and upgrade procedures and equipment maintenance. Vendors are appropriately involved.
Move or remove equipment	The proper workers are scheduled to ensure effectiveness, efficiency and safety. Personnel are trained on the proper movement and removal procedures and equipment maintenance. Vendors are appropriately involved. Move or removal of equipment is completed safely and according to company and vendor procedures. Equipment works properly following its move.
Test the equipment to ensure proper function after installation, customization or upgrading	Proper testing procedures and methods are selected. Test procedures and methods are properly administered. Test is performed safely. Test results are correctly interpreted. All appropriate parties are notified that equipment is functioning properly. Equipment tests indicate that equipment performs to specification and meets safety standards. Test results are documented.

Knowledge and Skills

Describes what a worker needs to know or be able to do to perform the critical work function

ACADEMIC AND EMPLOYABILITY SKILLS

Skill	Overall Complexity Rating for Workers	Overall Complexity Rating for Supervisors	Complexity Dimension	Complexity Subdimension	Complexity Subdimension Rating for Workers
Math	L	M	Complexity of mathematics content	Number sense and computation	M
				Geometry, measurement, and spatial sense	M
				Complexity of data analysis, statistics, and probability	M
				Functions and algebraic thinking	L
				Complexity of representation and communication	L
			Complexity of problem solving	Mathematical methods	M
				Mathematical reasoning	M
				Mathematical tools	M
Science	M	M	Complexity of scientific inquiry	Design	M
				Use of evidence	M
			Complexity of understanding the nature of science	Unifying concepts and processes	M
			Complexity of core scientific content	Physical science	M
				Life science	NA
				Earth and space science	NA
			Complexity of applied science	Science and technology	M
				Science in personal and social perspective	NA
Reading	M	H	Complexity of text		M
			Complexity of reading skills		M
			Complexity of reading purpose		M
Writing	L	M	Complexity of text	Complexity of text	M
			Complexity of writing product	Type of product	M
				Organization	M
				Elaboration	M
			Complexity of writing process	Writing development	M
				To inform	M
				To persuade	L
Listening	M	M	Complexity of communication	Content complexity	M
				Demands on attention	M
				Communication indirectness	M
			Barriers to communication	Limitations on interaction	M
				Distractions	M
Speaking	M	M	Complexity of communication	Content complexity	M
				Tact and sensitivity required	M
				Communication indirectness	L
			Context demands	Diversity of audience	M
				Constraints on preparation	M
				Distractions	M
				Listener resistance	M
Using Information and Communications Technology	M	M	Complexity of technology application	Complexity of equipment or technology	M
				Complexity of applications	M
				Training time constraints	M
			Frequency of technology change	New learning required	M
Gathering and Analyzing Information	H	M	Difficulty of information gathering	Amount of information	H
				Number and variety of sources	M
				Resourcefulness needed	M
			Complexity of analysis	Complexity of information and analysis	M
				Need to evaluate source information	M
				Lack of analysis guidelines	M

ACADEMIC AND EMPLOYABILITY SKILLS

Skill	Overall Complexity Rating for Workers	Overall Complexity Rating for Supervisors	Complexity Dimension	Complexity Subdimension	Complexity Subdimension Rating for Workers
Analyzing and Solving Problems	**M**	**M**	Problem complexity	Problem uniqueness or difficulty	**M**
				Number and range of problems	**M**
			Solution complexity	Number and complexity of possible solutions	**M**
Making Decisions and Judgments	**M**	**M**	Degree of judgment or inference required	Lack of guidance or precedents	**M**
				Integration difficulty	**M**
				Quantity or ambiguity of risks and consequences	**M**
			Individual decision-making responsibility	Accountability and autonomy	**M**
				Absence or ambiguity of rules or policy constraints	**M**
Organizing and Planning	**H**	**M**	Complexity of plans	Goal complexity or ambiguity	**M**
				Flexibility required	**M**
				Resource coordination required	**H**
				Scope and effects of planning	**H**
			Constraints on planning	Lack of guidelines	**M**
				Lack of feedback	**M**
				Constraints on resource availability	**M**
Using Social Skills	**NA**	**M**	Complexity of social interactions	Diversity	**NA**
				Structure or protocol required	**NA**
				Tact and sensitivity required	**NA**
Adaptability	**NA**	**M**	Degree of adaptability required	Frequency of change	**NA**
			Difficulty of adapting	Unpredictability of change	**NA**
				Lack of support for change	**NA**
Working in Teams	**M**	**M**	Degree of collaboration required	Task interdependence	**M**
			Team member heterogeneity	Team diversity	**M**
			Goal or role ambiguity	Lack of clarity or support for team goals	**M**
				Lack of clarity or stability of responsibilities	**M**
Leading Others	**M**	**M**	Work challenges	Challenges to goal attainment	**M**
				Work structuring requirements	**M**
				Scope and complexity of leadership responsibility	**M**
			People challenges	Coaching or monitoring needs	**M**
				Conflict management needs	**M**
Building Consensus	**M**	**M**	Consensus process inhibitors	Number and diversity of stakeholders	**M**
				Ambiguity of goals	**M**
				Lack of organizational support, incentives, or consensus leadership	**M**
				High consensus standard	**M**
			Difficulty of issues requiring consensus	Complexity of issues	**M**
				Contentiousness of issues	**M**
				Lack of opportunities for agreement	**M**
Self and Career Develop-ment	**M**	**M**	Need for learning and development	Self and career development requirements	**M**
			Limitations on learning and development opportunities	Time, resource, or support constraints	**M**
				Application constraints	**M**

Overall complexity ratings: The *overall* level of complexity required in a skill in order to perform the critical work function. *Scale*: H=high complexity; M=moderate complexity; and L=low complexity. Two separate ratings are provided: one for *workers* (entry-level up to first-line supervisors) and the other for *supervisors* (first-line supervisors). In some cases, the overall complexity rating was **NA (Non-Applicable)**. This means that this skill was deemed not to be needed to perform this given critical work function, so no complexity rating was assigned.

Complexity Subdimension ratings: These are complexity level ratings for individual aspects of the particular skill. *Scale*: H=high complexity; M=moderate complexity; and L=low complexity. At this time, these ratings are provided for workers only. In some cases, the subdimension complexity rating was **NA (Non-Applicable)**. This means that this *particular dimension* of the skill was deemed not to be needed to perform this given critical work function, so no complexity rating was assigned.

Knowledge and Skills

Describes what a worker needs to know or be able to do to perform the critical work function

OCCUPATIONAL AND TECHNICAL KNOWLEDGE AND SKILLS

These are the technical knowledge and skills needed to perform the critical work function.

Skill Category	Specific Knowledge and Skills	Specific Knowledge and Skills
Documentation of Maintenance	A. Skill in documenting installation resource needs (I.e., parts, tools, time, personnel, and impact on production). B. Knowledge of document maintenance to maintain accurate and up-to-date material and dispose of out-of-date documentation.	C. Skill in documenting that all of the necessary steps have been completed prior to putting new or modified equipment into operation.
Maintenance Procedures	A. Knowledge of equipment requirements for installation (i.e., power, air, temperature/RH). B. Knowledge of facility capacity. C. Skill in coordinating installation with production departments. D. Knowledge of skill requirements for equipment installation (e.g., rigging and material movement). E. Knowledge of regularly scheduled downtimes to eliminate out-of-cycle downtimes that hinder production and production goals.	F. Skill in developing schedule for performing maintenance activities for new and upgraded equipment. G. Knowledge of the upgrades that are needed. H. Knowledge of logistics of equipment installation in order to coordinate tasks I. Knowledge of critical spare parts listings to establish on-hand quantities.
Safety Procedures	A. Knowledge of safety requirements, policies and procedures such as Material Safety Data Sheets (MSDS) and Lock out/ Tag out. B. Skill in training maintenance personnel and operators in safety procedures (e.g., training in Lock out/Tag out). C. Knowledge of analysis methods used to determine safe equipment operation standards.	D. Knowledge of procedures and support required to safely remove equipment and how other equipment could be affected. E. Knowledge of how to layout work area for safe operation. F. Knowledge of the safety implications for scheduling so that safety equipment, tools and devices will be available during installation. G. Skill in reviewing safety procedures for new or modified equipment with installation team prior to installation.
Statistical Tools and Systems	A. Knowledge of diagnostic test procedures and equipment associated with all new installations.	
Vendor Awareness	A. Skill in obtaining equipment specifications and manufacturer recommendations. B. Skill in obtaining current and future equipment vendor information and remaining current on available equipment.	C. Skill in reviewing vendor product information to determine whether it is compatible with existing equipment and facilities. D. Skill in analyzing specifications from vendors to make proper upgrades.
Staffing and Work Role Knowledge	A. Knowledge of the scope of the installation in order to plan for necessary personnel.	
Industry Awareness	A. Knowledge of future projects or installations to help coordinate equipment.	
Tools and Equipment	A. Knowledge of equipment operating parameters to test equipment after installation. B. Knowledge of technical documents (i.e., electrical/electronic schematics, OEM manuals, blueprints/diagrams) for use in installation, replacement, and removal of equipment.	C. Knowledge of the procedures for installing and relocating machines. D. Knowledge of new equipment or part specifications to ensure upgrade is functioning properly. E. Knowledge of tools needed to remove or replace equipment.

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Critical Work Function: Support the installation, customization, or upgrading of equipment		
Knowledge/skill	**Mean Importance**	**Examples**
Using Information and Communication Technology	3.57	Use technology to support equipment changes (e.g. modifications, upgrades, skill shifts)
		Communicate equipment manual to craftsman on proper repair procedures
		Communicate with suppliers on proper installation procedures
		Use email to schedule on-site vendor support at time of equipment delivery
		Share new info with team electronically, document changes on history database
Gathering and Analyzing Information	3.73	Gather and organize information from maintenance, r & d, production for equipment needs required by technology changes and trends
		Review the vendor's checklist of installation procedures by reading reference manuals and attending vendor class to assure upgrade is performed correctly
		Organize vendor information to ensure availability for installation requirements
		Research supplier database to determine which piece of equipment to purchase
		Get as much info as possible on problem areas assoc. with installation of or upgrading of equipment prior to working on
Analyzing and Solving Problems	3.25	Analyze past problem history to justify upgrade or removal
		Review equipment installation and upgrade documents to determine sequence of activities
		Identify equipment operation anomalies during testing
		Analyze installation needs in order to troubleshoot possible problems
		Put proper people on the job, have vendors there to look at failed equipment and make suggestions to correct
Making Decisions and Judgments	3.29	Decide if equipment modifications and upgrades are functioning to specifications
		Coordinate maintenance activities with engineering activities to schedule equipment upgrade activities and assist with post-upgrade evaluation
		Decide when to move equipment in order to minimize machine downtime
		Determine performance expectations for a new piece of equipment
		Determine if appropriate resources are available
		Determine if project is complete and successful

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Organizing and Planning	3.54	Organize, plan and coordinate supplier maintenance activities
		Meet with planning and manufacturing to schedule preventive downtime
		Organize work team and plan work time to efficiently execute installation and upgrades
		Develop an installation plan that does not impact the production schedule
		Have materials/tools/prints/manuals available before modification
		Have back up plan if modification fails
Using Social Skills	2.88	Discuss needs for special tool or training that will facilitate equipment updating
		Contact the supplier in a friendly and courteous manner to minimize installation problems
		Provide input to management as to requirements for equipment upgrade
		Coordinate with all appropriate people to plan and execute the equipment installation
Adaptability	2.92	Change training/work methods to stay up-to-date with customizing and upgrading
		Alter the installation process, work around unforeseen shortages
		Develop installation team plan with alternate members that can be contacted if needed
		Be adaptable to last minute changes in installation layout
Working in Teams	3.46	Provide all installation data to process engineers on the server so they can bring the process up quicker
		Work on a cross-functional team to develop an installation plan
		Coordinate on-site vendor representative participation with other employees' roles
		Meet with vendor, operators, to share information
		Team up with other employees to develop plan to do installation properly
Leading Others	2.96	Assure vendors follow company's policies during installation and customization
		Give timely and accurate feedback to work group during installation or repair of equipment
		Help locate parts and needed tools; Help plan the job for a safe and efficient change
		Get all info together from vendors; Provide to employees; Ask for suggestions; Get agreement on the process to follow
		Give your input/suggestions to others- maintenance vendors as best method to upgrade

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Building Consensus	3.27	Create agreement by promoting mutual goals when change is necessary
		Create positive environment during stressful situations such as late installations or late repairs
		Foster agreement in advance in order to be receptive and responsive to new equipment transition
		Maintenance and vendors share their suggestions and come up with the best way to implement customization or upgrading; Always get the production workers involved in decision making
Self and Career Development	3.16	Research the latest tools in order to remain current
		Attend relevant tradeshows and vendor-specific new equipment training
		Apply current knowledge and skills to new workplace methods
		Attend training on proper equipment moving techniques
		Get all info you can from vendor and tech people
Speaking	3.34	Provide feedback on equipment installation/repair to avert problems with design or use
		Provide information of latest technology affecting a particular area
		Present plans for an upgrade tool kit in order to show yield improvement
		Talk with the stakeholders during equipment roll out process in order to ensure consistency in production run
		Present training information to upgrade team members on customization procedures
Listening	3.60	Listen to vendors' instructions and history of installation at other companies/plants
		Listen to vendors in order to clarify expectations of upgraded equipment
		Listen to the supplier's concerns for proper equipment installation
		Listen to engineers, operators, supervisors to determine if equipment may need upgrades
		Listen to equipment vendor's suggestions to help make new installation easier
Writing	3.58	Document testing procedures/results that vary from design
		Record updates or changes that will be needed the next time similar or same equipment is changed
		Communicate by email with vendor on questions regarding installation
		Create detailed new equipment integration procedure to include training and "break in" record
		Develop "process flow" documents for equipment installation or modification activities
Reading	4.22	Read and understand proper installation and upgrade
		Reading OEM procedures for proper equipment installation, such as proper anchoring of machine
		Read, understand, and follow vendor requirements and safety procedures

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Math	4.00	Calculate information from blueprint and equipment data sheets for proper installation and use
		Let numbers from calculations show importance of changes (furnish tools to calculate with)
		Calculate square footage of a machine and determine if it will fit in the designated area
		Estimate resource requirements to install, customize or upgrade
		Perform necessary calculations to ensure tools comply with specs
Science	3.37	Use positive metal identification to ensure proper placement of piping alloys
		Understand the physics behind the process in order to suggest and comprehend upgrading tools
		Identify, describe, and explain HASCOM requirements for new equipment
		Apply concepts common to mechanical fluid, electrical and thermal systems to the installation or upgrades of equipment
		Identify physical requirements of molding equipment

MIR7

Critical Work Function: Maintain equipment, tools and workstations.

Critical work functions *describe the major responsibilities involved in carrying out a concentration*

Concentrations *are the major areas of front-line work covering families of related jobs. Separate standards were identified for each concentration.*

Key Activities **Key activities** *are the duties and tasks involved in carrying out a critical work function*	Performance Indicators **Performance indicators** *correlate to the key activities. The performance indicators provide information on how to determine when someone is performing each key activity competently*
Perform preventive maintenance and routine repair	Preventive maintenance schedule is prepared and checked as appropriate. Preventive maintenance is performed to schedule. Preventive maintenance is documented completely and in a timely manner. Repair needs are communicated to the correct parties using the right procedures and forms. Any necessary repair work is checked through follow-up. Necessary supplies are available to do the preventive maintenance. Preventive maintenance schedule, documentation, equipment needs and outstanding repairs are communicated effectively from shift-to-shift, to team members, to managers and to others as required. All safety procedures are followed when doing repairs.
Monitor equipment to ensure it is operating correctly	Current equipment performance is regularly compared to optimal equipment operations. Abnormal equipment conditions are investigated. Abnormal equipment conditions are corrected in a timely manner. Equipment is monitored to ensure that the corrective action solved the problem. Documentation of equipment repair history is complete, up-to-date and accurate.
Provide training to maintain equipment	Training is conducted in an effective and appropriate manner. Preventive maintenance training materials are documented and available. Training conducted is documented correctly and training records are updated and easily available. Training is relevant to equipment, tools, materials, and processes at the workstation. Cross- training is provided when appropriate. Training and training documentation meet all company and regulatory requirements.
Perform all house-keeping to maintain production schedule	Tools are stored in proper location. Materials are kept in a safe manner. Unsafe conditions are identified and reported promptly. Corrective action is taken to correct unsafe conditions. Workstation is clean and clear of safety hazards. Scheduled housekeeping inspections are passed. Workstation is organized to maximize efficiency. All appropriate safety equipment is present and in proper working order.

Knowledge and Skills

Describes what a worker needs to know or be able to do to perform the critical work function

ACADEMIC AND EMPLOYABILITY SKILLS

Skill	Overall Complexity Rating for Workers	Overall Complexity Rating for Supervisors	Complexity Dimension	Complexity Subdimension	Complexity Subdimension Rating for Workers
Math	**NA**	**L**	Complexity of mathematics content	Number sense and computation	**NA**
				Geometry, measurement, and spatial sense	**NA**
				Complexity of data analysis, statistics, and probability	**NA**
				Functions and algebraic thinking	**NA**
				Complexity of representation and communication	**NA**
			Complexity of problem solving	Mathematical methods	**NA**
				Mathematical reasoning	**NA**
				Mathematical tools	**NA**
Science	**NA**	**L**	Complexity of scientific inquiry	Design	**NA**
				Use of evidence	**NA**
			Complexity of understanding the nature of science	Unifying concepts and processes	**NA**
			Complexity of core scientific content	Physical science	**NA**
				Life science	**NA**
				Earth and space science	**NA**
			Complexity of applied science	Science and technology	**NA**
				Science in personal and social perspective	**NA**
Reading	**M**	**M**	Complexity of text		**M**
			Complexity of reading skills		**M**
			Complexity of reading purpose		**M**
Writing	**L**	**L**	Complexity of text	Complexity of text	**M**
			Complexity of writing product	Type of product	**M**
				Organization	**L**
				Elaboration	**M**
			Complexity of writing process	Writing development	**L**
				To inform	**M**
				To persuade	**L**
Listening	**L**	**M**	Complexity of communication	Content complexity	**M**
				Demands on attention	**M**
				Communication indirectness	**L**
			Barriers to communication	Limitations on interaction	**L**
				Distractions	**M**
Speaking	**L**	**M**	Complexity of communication	Content complexity	**M**
				Tact and sensitivity required	**L**
				Communication indirectness	**L**
			Context demands	Diversity of audience	**M**
				Constraints on preparation	**M**
				Distractions	**M**
				Listener resistance	**L**
Using Information and Com-munications Technology	**M**	**L**	Complexity of technology application	Complexity of equipment or technology	**M**
				Complexity of applications	**M**
				Training time constraints	**M**
			Frequency of technology change	New learning required	**M**
Gathering and Analyzing Information	**M**	**M**	Difficulty of information gathering	Amount of information	**M**
				Number and variety of sources	**M**
				Resourcefulness needed	**M**
			Complexity of analysis	Complexity of information and analysis	**M**
				Need to evaluate source information	**M**
				Lack of analysis guidelines	**L**

ACADEMIC AND EMPLOYABILITY SKILLS

Skill	Overall Complexity Rating for Workers	Overall Complexity Rating for Supervisors	Complexity Dimension	Complexity Subdimension	Complexity Subdimension Rating for Workers
Analyzing and Solving Problems	**M**	**M**	Problem complexity	Problem uniqueness or difficulty	**M**
				Number and range of problems	**M**
			Solution complexity	Number and complexity of possible solutions	**M**
Making Decisions and Judgments	**L**	**L**	Degree of judgment or inference required	Lack of guidance or precedents	**L**
				Integration difficulty	**M**
				Quantity or ambiguity of risks and consequences	**M**
			Individual decision-making responsibility	Accountability and autonomy	**M**
				Absence or ambiguity of rules or policy constraints	**L**
Organizing and Planning	**L**	**M**	Complexity of plans	Goal complexity or ambiguity	**L**
				Flexibility required	**M**
				Resource coordination required	**M**
				Scope and effects of planning	**M**
			Constraints on planning	Lack of guidelines	**L**
				Lack of feedback	**L**
				Constraints on resource availability	**M**
Using Social Skills	**L**	**M**	Complexity of social interactions	Diversity	**M**
				Structure or protocol required	**M**
				Tact and sensitivity required	**L**
Adaptability	**L**	**L**	Degree of adaptability required	Frequency of change	**M**
			Difficulty of adapting	Unpredictability of change	**M**
				Lack of support for change	**L**
Working in Teams	**L**	**M**	Degree of collaboration required	Task interdependence	**M**
			Team member heterogeneity	Team diversity	**M**
			Goal or role ambiguity	Lack of clarity or support for team goals	**L**
				Lack of clarity or stability of responsibilities	**L**
Leading Others	**NA**	**M**	Work challenges	Challenges to goal attainment	**NA**
				Work structuring requirements	**NA**
				Scope and complexity of leadership responsibility	**NA**
			People challenges	Coaching or monitoring needs	**NA**
				Conflict management needs	**NA**
Building Consensus	**NA**	**L**	Consensus process inhibitors	Number and diversity of stakeholders	**NA**
				Ambiguity of goals	**NA**
				Lack of organizational support, incentives, or consensus leadership	**NA**
				High consensus standard	**NA**
			Difficulty of issues requiring consensus	Complexity of issues	**NA**
				Contentiousness of issues	**NA**
				Lack of opportunities for agreement	**NA**
Self and Career Develop-ment	**NA**	**L**	Need for learning and development	Self and career development requirements	**NA**
			Limitations on learning and development opportunities	Time, resource, or support constraints	**NA**
				Application constraints	**NA**

Overall complexity ratings: The *overall* level of complexity required in a skill in order to perform the critical work function. *Scale*: H=high complexity; M=moderate complexity; and L=low complexity. Two separate ratings are provided: one for *workers* (entry-level up to first-line supervisors) and the other for *supervisors* (first-line supervisors). In some cases, the overall complexity rating was **NA (Non-Applicable)**. This means that this skill was deemed not to be needed to perform this given critical work function, so no complexity rating was assigned.

Complexity Subdimension ratings: These are complexity level ratings for individual aspects of the particular skill. *Scale*: H=high complexity; M=moderate complexity; and L=low complexity. At this time, these ratings are provided for workers only. In some cases, the subdimension complexity rating was **NA (Non-Applicable)**. This means that this *particular dimension* of the skill was deemed not to be needed to perform this given critical work function, so no complexity rating was assigned.

Knowledge and Skills

Describes what a worker needs to know or be able to do to perform the critical work function

OCCUPATIONAL AND TECHNICAL KNOWLEDGE AND SKILLS

These are the technical knowledge and skills needed to perform the critical work function.

Skill Category	Specific Knowledge and Skills	Specific Knowledge and Skills
Maintenance Process	A. Knowledge of equipment to be maintained and monitored to ensure it operates correctly. B. Skill in troubleshooting to identify a problem with equipment. C. Skill in following preventive maintenance schedules. D. Knowledge of job specific guidelines or collective bargaining agreement that affect maintenance. E. Skill in repairing and maintaining machines or tools. F. Knowledge of the moving parts of equipment.	G. Skill in recognizing wear and tear on equipment components. H. Knowledge of the equipment instrumentation to correctly diagnosis equipment system status. I. Knowledge of the procedures for logging repairs and work order requests. J. Knowledge of the most common causes of failure of equipment to diagnosis problem quickly. K. Knowledge of what the equipment alarms mean. L. Skill in making on-process adjustments during production.
Maintenance Tools and Equipment	A. Knowledge of materials management to know what is recyclable and what is not. B. Skill in using appropriate maintenance tools to maintain machines.	C. Knowledge of how to use monitoring or diagnostic devices to find out when equipment is operating correctly.
Documentation of Maintenance	A. Knowledge of statistical methods charts to ensure that equipment is producing a quality product. B. Knowledge of forms and procedures for correctly documenting processes (e.g., preventative maintenance forms). C. Knowledge of diagrams, schematics, manuals, and specifications to understand how to repair equipment.	D. Skill in documenting repairs, replacement parts, problems and corrective actions to maintain log to determine patterns of operation. E. Skill in reviewing maintenance log/checklist to ensure that recommended preventative procedures are followed.
Safety	A. Knowledge of set-up to verify machine safety. B. Knowledge of safety procedures to prevent accidents. C. Knowledge of how to use and store hazardous materials and chemicals (e.g., compliance with MSDS) D. Knowledge of Lock out/Tag out policies and procedures.	E. Skill in visually inspecting equipment to ensure safety compliance before operating. F. Skill in identifying and reporting unsafe work conditions. G. Knowledge of materials management to know what is recyclable and what is not.
Training	A. Skill in delivering training. B. Knowledge of how to plan, prepare, and present structured on-the-job-training.	C. Skill in conducting training on the use of safety equipment, such as fire extinguisher, eye-flush bottles, and first aid kits. D. Knowledge of the certification/license requirements to operate specific equipment.

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Critical Work Function: Maintain equipment, tools and workstations

Knowledge/skill	Mean Importance	Examples
Using Information and Communication Technology	3.43	Use Time Management System to schedule preventive maintenance based on production hours
		Enter data into scheduled maintenance program using the computer
		Use PC to document history of maintenance
		Access documentation and log books electronically to determine maintenance schedules and procedures
		Use an automated system to monitor machine parameters to ensure quality output
Gathering and Analyzing Information	3.25	Gather information regarding improper working equipment to be fixed and communicate to supervisors
		Perform a walk-through equipment inspection to monitor equipment
		Use maintenance instruction books and schedule logs to maintain machinery
		Review machine maintenance schedules to ensure machine is available when needed
		Review records of parts suppliers who can get stock parts in the least amount of down time
Analyzing and Solving Problems	3.63	Identify specific areas of problematic machinery to troubleshoot for problems
		Identify specific parts or assemblies that require above average maintenance
		Analyze machine repair logs to help determine the cause of equipment problems
		Evaluate equipment to ensure that it is in good working order before the start of each day
		Visually inspect tools and equipment for possible wear and inform supervisor of needed repairs
Making Decisions and Judgments	3.59	Determine if equipment is operating properly
		Determine availability of equipment retooling to fulfill production requirements
		Determine preventive maintenance schedule in accordance with production schedule
		Determine if equipment maintenance will impact production schedule
Organizing and Planning	3.28	Organize work area to improve efficiency
		Plan training activities to minimize production downtime
Using Social Skills	3.38	Establish rapport with maintenance workers so they will want to come to your area quickly when needed
		Communicate with workers in a positive way in order to convince them of the need for regular, scheduled preventive maintenance
		Provide tactful feedback to co-workers on housekeeping of the work area
		Interact with trainees in a friendly manner to provide training

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Adaptability	3.22	Revise workstation equipment to meet new job requirements
		Change to new equipment and retrain on new methods and procedures in order to meet the new challenge
		Use a different machine tool to compensate for an unexpected tool breakage
		Change schedules to adapt to production needs, while not sacrificing equipment efficiency
Working in Teams	3.07	Team with fellow employees to accomplish better housekeeping and schedule improvements
		Work with maintenance personnel on problem solving/troubleshooting
		Team with new employees to cross-train maintenance jobs
		Work with co-workers to resolve production issues
Leading Others	2.70	Influence others by example to maintain clean and neat workplace
		Inspire production workers to maintain proper tooling storage in order to eliminate searching
		Train others on the routine for maintaining equipment
		Influence others to perform preventive maintenance and repairs
Building Consensus	2.45	Work with team members to determine the training needed to achieve measurable improvements in productivity and quality
		Persuade others to ensure equipment is operating correctly and good housekeeping is maintained
		Facilitate agreement on machine maintenance schedule in order to minimize production impact
		Resolve team member conflicts over work station organization in order to create uniform set-up
		Create agreement on the format of maintenance logs to ensure consistency
Self and Career Development	2.66	Acquire new skills necessary to operate high technology equipment
		Acquire training in set-up and maintenance to improve your worth as an employee
		Attend training on new machines to improve skill base
		Learn new skills related to all parts of the production process
Speaking	2.97	Suggest how a co-worker can improve work station efficiency
		Express concerns to management about equipment conditions
		Provide feedback on machine condition in order to evaluate optimum usage
		Notify maintenance to let them know about a machine problem
		Communicate to co-workers about a maintenance plan for a new process
Listening	3.11	Receive maintenance instructions and understand them
		Listen to the sound a machine makes to determine if it functions correctly
		Listen to directions given in the correct operation of the equipment

		Listen to details of vendor-suggested maintenance program for their equipment
		Listen to machine operator in order to understand what part of the process is causing the most downtime
		Listen to concerns of maintenance staff with regard to preventive maintenance schedules and production schedules
Writing	3.55	Write out repair order requests
		Write reports on troubleshooting results on new equipment
		Write comprehensive safety standards for unique tools and machines
		Document maintenance and repair history of equipment
		Complete shift-to-shift logs
Reading	4.04	Read maintenance manuals in order to troubleshoot problems
		Read equipment manuals to determine proper preventive maintenance procedures, lubricants and replacement parts
		Read machine manuals in order to set up equipment and troubleshoot
		Read and understand all gauges on equipment
		Review maintenance schedule in order to assure upkeep
		Review procedures for programming diagnostics on computer drive machine equipment
Math	2.79	Determine volume of coolant and oils
		Measure liquid quantities
		Estimate repair time for equipment
		Measure torque specifications and spec tolerances to properly maintain and use equipment
		Calculate scheduled down-times for machine maintenance
Science	2.76	Understand the mechanical principles of machinery
		Knowledge of the chemical with which you are working
		Understanding of chemicals so as to properly store dangerous materials and chemicals
		Understanding why an ESD strap must be correctly grounded at the workstation

MIR8

Critical Work Function: Maintain a safe and productive work area.

Critical work functions *describe the major responsibilities involved in carrying out a concentration*

Concentrations *are the major areas of front-line work covering families of related jobs. Separate standards were identified for each concentration.*

Key Activities **Key activities** *are the duties and tasks involved in carrying out a critical work function*	Performance Indicators **Performance indicators** *correlate to the key activities. The performance indicators provide information on how to determine when someone is performing each key activity competently*
Perform environmental and safety inspections	Potential hazards in the work are identified, reported, monitored. Corrective action is taken to correct potential hazards. Health, safety and environmental documentation and policies are thoroughly and regularly reviewed. Inspections meet all relevant, health, safety, and environmental laws and regulations. Inspections are done according to company schedule and procedures. Inspections are documented. Inspection records are stored correctly.
Perform emergency drills and participate in emergency response teams	Training and certification on relevant emergency and first aid procedures is complete and up to date. Emergency response complies with company and regulatory policies and procedures. Emergency drills and incidents are documented promptly according to company and regulatory procedures.
Identify unsafe conditions and take corrective action	Conditions that present a threat to health, safety and the environment are identified, reported, and documented promptly. Corrective actions are identified. Appropriate parties are consulted about corrective actions. Corrective actions are taken promptly according to company procedures. Ongoing safety concerns are tracked and reported until corrective action is taken.
Provide safety orientation to other employees	Orientation covers all topics and procedures needed to facilitate employee safety. Orientation makes clear the need and processes for employees to raise safety concerns, ask questions, and receive additional training. Orientation is documented according to company requirements. Orientation meets all relevant laws, policies, and regulations. Safety training is delivered regularly.

Knowledge and Skills

Describes what a worker needs to know or be able to do to perform the critical work function

ACADEMIC AND EMPLOYABILITY SKILLS

Skill	Overall Complexity Rating for Workers	Overall Complexity Rating for Supervisors	Complexity Dimension	Complexity Subdimension	Complexity Subdimension Rating for Workers
Math	**NA**	**L**	Complexity of mathematics content	Number sense and computation	**NA**
				Geometry, measurement, and spatial sense	**NA**
				Complexity of data analysis, statistics, and probability	**NA**
				Functions and algebraic thinking	**NA**
				Complexity of representation and communication	**NA**
			Complexity of problem solving	Mathematical methods	**NA**
				Mathematical reasoning	**NA**
				Mathematical tools	**NA**
Science	**L**	**L**	Complexity of scientific inquiry	Design	**L**
				Use of evidence	**L**
			Complexity of understanding the nature of science	Unifying concepts and processes	**L**
			Complexity of core scientific content	Physical science	**M**
				Life science	**NA**
				Earth and space science	**NA**
			Complexity of applied science	Science and technology	**L**
				Science in personal and social perspective	**NA**
Reading	**M**	**M**	Complexity of text		**M**
			Complexity of reading skills		**M**
			Complexity of reading purpose		**M**
Writing	**L**	**M**	Complexity of text	Complexity of text	**M**
			Complexity of writing product	Type of product	**M**
				Organization	**M**
				Elaboration	**M**
			Complexity of writing process	Writing development	**L**
				To inform	**M**
				To persuade	**L**
Listening	**M**	**M**	Complexity of communication	Content complexity	**M**
				Demands on attention	**M**
				Communication indirectness	**L**
			Barriers to communication	Limitations on interaction	**M**
				Distractions	**M**
Speaking	**M**	**M**	Complexity of communication	Content complexity	**M**
				Tact and sensitivity required	**M**
				Communication indirectness	**L**
			Context demands	Diversity of audience	**M**
				Constraints on preparation	**M**
				Distractions	**M**
				Listener resistance	**M**
Using Information and Com-munications Technology	**L**	**L**	Complexity of technology application	Complexity of equipment or technology	**L**
				Complexity of applications	**L**
				Training time constraints	**M**
			Frequency of technology change	New learning required	**M**
Gathering and Analyzing Information	**M**	**M**	Difficulty of information gathering	Amount of information	**M**
				Number and variety of sources	**M**
				Resourcefulness needed	**M**
			Complexity of analysis	Complexity of information and analysis	**M**
				Need to evaluate source information	**M**
				Lack of analysis guidelines	**M**

ACADEMIC AND EMPLOYABILITY SKILLS

Skill	Overall Complexity Rating for Workers	Overall Complexity Rating for Supervisors	Complexity Dimension	Complexity Subdimension	Complexity Subdimension Rating for Workers
Analyzing and Solving Problems	**M**	**M**	Problem complexity	Problem uniqueness or difficulty	**M**
				Number and range of problems	**M**
			Solution complexity	Number and complexity of possible solutions	**M**
Making Decisions and Judgments	**M**	**L**	Degree of judgment or inference required	Lack of guidance or precedents	**M**
				Integration difficulty	**M**
				Quantity or ambiguity of risks and consequences	**M**
			Individual decision-making responsibility	Accountability and autonomy	**M**
				Absence or ambiguity of rules or policy constraints	**L**
Organizing and Planning	**L**	**M**	Complexity of plans	Goal complexity or ambiguity	**L**
				Flexibility required	**M**
				Resource coordination required	**M**
				Scope and effects of planning	**M**
			Constraints on planning	Lack of guidelines	**L**
				Lack of feedback	**L**
				Constraints on resource availability	**M**
Using Social Skills	**M**	**M**	Complexity of social interactions	Diversity	**M**
				Structure or protocol required	**M**
				Tact and sensitivity required	**M**
Adaptability	**L**	**L**	Degree of adaptability required	Frequency of change	**M**
			Difficulty of adapting	Unpredictability of change	**M**
				Lack of support for change	**L**
Working in Teams	**L**	**M**	Degree of collaboration required	Task interdependence	**L**
			Team member heterogeneity	Team diversity	**L**
			Goal or role ambiguity	Lack of clarity or support for team goals	**L**
				Lack of clarity or stability of responsibilities	**L**
Leading Others	**L**	**M**	Work challenges	Challenges to goal attainment	**L**
				Work structuring requirements	**M**
				Scope and complexity of leadership responsibility	**NA**
			People challenges	Coaching or monitoring needs	**NA**
				Conflict management needs	**M**
Building Consensus	**L**	**L**	Consensus process inhibitors	Number and diversity of stakeholders	**L**
				Ambiguity of goals	**L**
				Lack of organizational support, incentives, or consensus leadership	**L**
				High consensus standard	**M**
			Difficulty of issues requiring consensus	Complexity of issues	**L**
				Contentiousness of issues	**M**
				Lack of opportunities for agreement	**M**
Self and Career Develop-ment	**NA**	**L**	Need for learning and development	Self and career development requirements	**NA**
			Limitations on learning and development opportunities	Time, resource, or support constraints	**NA**
				Application constraints	**NA**

Overall complexity ratings: The *overall* level of complexity required in a skill in order to perform the critical work function. *Scale*: H=high complexity; M=moderate complexity; and L=low complexity. Two separate ratings are provided: one for *workers* (entry-level up to first-line supervisors) and the other for s*upervisors* (first-line supervisors). In some cases, the overall complexity rating was **NA (Non-Applicable)**. This means that this skill was deemed not to be needed to perform this given critical work function, so no complexity rating was assigned.
Complexity Subdimension ratings: These are complexity level ratings for individual aspects of the particular skill. *Scale*: H=high complexity; M=moderate complexity; and L=low complexity. At this time, these ratings are provided for workers only. In some cases, the subdimension complexity rating was **NA (Non-Applicable)**. This means that this *particular dimension* of the skill was deemed not to be needed to perform this given critical work function, so no complexity rating was assigned.

Knowledge and Skills

Describes what a worker needs to know or be able to do to perform the critical work function

OCCUPATIONAL AND TECHNICAL KNOWLEDGE AND SKILLS

These are the technical knowledge and skills needed to perform the critical work function.

Skill Category	Specific Knowledge and Skills	Specific Knowledge and Skills
Safety Procedures	A. Knowledge of how to locate and use Material Safety Data Sheets (MSDS). B. Knowledge of company first aid or first response procedures. C. Knowledge of material handling techniques to safely move materials. D. Knowledge of how to be proactive in responding to a safety concern and document occurrences. E. Knowledge of emergency exits. F. Knowledge of various emergency alarms and procedures.	G. Knowledge of clean-up procedures for spills. H. Knowledge of Lock Out/Tag Out requirements. I. Knowledge of how to inspect work area and report possible safety risks. J. Knowledge of machine functions to determine if all safeguards are operational. K. Knowledge of safety procedures in case of smoke or chemical inhalation. L. Knowledge of procedures for handling hazardous materials.
Personal Safety	A. Skill in identifying and reporting unsafe conditions. B. Knowledge of safety issues related to hazardous materials. C. Knowledge of housekeeping needed to maintain a safe work environment.	D. Skill in determining if all safety guards are in place prior to machine operation. E. Knowledge of clothing and personal protective equipment (PPE) that should be worn to ensure safety.
Safety Policies and Regulations	A. Knowledge of basic filing procedures to properly store inspection records. B. Knowledge of safety requirements and environmental regulations related to performing inspections. C. Knowledge of policies and procedures needed to perform audits and train employees about hazardous conditions.	D. Knowledge of company safety standards for handling potential hazards. E. Knowledge of how to safely store, identify, and use hazardous materials and pressurized vessels. F. Knowledge of OSHA and other health and safety requirements as applied to the workplace.
Corrective Action	A. Knowledge of what constitutes an unsafe condition to be able to take corrective actions.	B. Knowledge of required corrective action procedures. C. Knowledge of accident documentation procedures.
Safety Training	A. Skill in developing and/or delivering safety training per guidelines.	B. Knowledge of health and safety education requirements.

Maintenance, Installation and Repair
Academic and Employability Skill Examples

Critical Work Function: Maintain a safe and productive work area		
Knowledge/skill	**Mean Importance**	**Examples**
Using Information and Communication Technology	3.42	Input all safety and health training into data base to guarantee proper documentation
		Use computerized data collection to identify accident trends/areas that need to be evaluated for correction and elimination
		Use computers to access training programs
		Use PowerPoint presentations to conduct safety orientations
		Use computer to track safety training
Gathering and Analyzing Information	3.13	Gather, analyze and compare present safety conditions to past
		Visually inspect work area for possible safety hazards
		Collect information on safety audits and accident logs to identify improvement opportunities and corrective actions
		Gather information on who is in need of safety training
		Gather information from injury reports to determine repeated injuries from dangerous equipment in order to make corrections
Analyzing and Solving Problems	3.34	Identify safety issues to recommend corrective actions
		Select proper personnel protective equipment for the job to prevent injuries
		Analyze safety inspection reports to help implement a corrective action plan
		Identify areas or tasks where most injuries occur to suggest modifications to process, layout or job rotations in order to eliminate injuries
Making Decisions and Judgments	3.65	Decide on the list of priorities necessary for training of personnel in emergency response situations
		Determine that all safety equipment and guards are in place
		Identify unsafe conditions
		Determine if team members have the training and physical capabilities to safely complete assigned task
		Determine the frequency of safety training and drills
Organizing and Planning	3.47	Organize safety drills to ensure worker safety
		Plan and organize safety and environmental inspections in order to prevent accidents
		Plan the appropriate timing of emergency drills
		Plan emergency drills to prepare for threats to health or safety
Using Social Skills	3.55	Communicate to the production supervisor that a safety issues exists and critical process must be stopped until a remedy is found
		Interact with peers to share info on emergency drills/procedures

		Interact with new employees on importance of safe work environment in order to make a positive impact
		Give feedback to a co-worker in order to communicate a safer way to perform an operation or task
Adaptability	3.13	Change method of production to achieve safer outcomes
		Change to a new safety procedure in order to comply with new safety law requirements
		Change the production process to temporarily work around an unsafe area or condition
		Be able to respond to different types of emergencies
Working in Teams	3.58	Work with co-workers to identify and report unsafe conditions
		Work with all team members to conduct effective fire/safety/emergency drills
		Meet and discuss conditions that are thought to be unsafe in order to make everyone aware
Leading Others	3.55	Correct potential safety issues when discovered, to make co-workers aware of how issues should be addressed
		Encourage a more participative approach to safety issues
		Lead by example to show no repercussion of notification of possible unsafe conditions
		Lead others to work safely by emphasizing safe practices
		Build a common theme of "safety-first" among workers to ensure a safe work environment
Building Consensus	3.00	Explain how to correct an unsafe condition without offending the affected workers
		Review potential or existing safety concerns and build consensus by discussing potential actions needed to resolve them
		Facilitate agreement on safety procedures in order to assure entire team follows the agreed-upon process
		Create consensus upon emergency procedures and specific people's responsibilities
		Build consensus on what level of safety training is needed
Self and Career Development	2.93	Learn about hazardous material specs to prevent injury
		Attend in-house operator safety seminars
		Identify learning opportunities in environmental laws and technology to improve safety
		Acquire CPR and first-aid training
Speaking	3.48	Present safety policies and procedures to other employees in order to understand the importance of safety
		Express concerns to management about unsafe work environment
		Present accurate and cogent presentations to new hires and trainees in safety subjects
		Present safety training to co-workers when new work processes are implemented

		Discuss environmental issues with supervisor in order to avoid accidents and unsafe conditions
Listening	3.44	Listen to descriptions of safety policies and procedures in order to avoid accidents
		Listen to the concerns of the employee in order to identify ergonomics improvements needed
		Receive feedback from employees as it pertains to safety in a respectful and attentive way
		Listen to employees identifying potential safety hazards and take corrective actions
Writing	3.21	Post written warnings about unsafe conditions
		Write accurate accident injury reports
		Document clear procedures for safety practices
		Document equipment safety checks in safety log book
		Document safety incident and training orientation
		Document corrective actions regarding safety
Reading	3.63	Read warning labels to identify potentially hazardous materials
		Read information on emergency procedures
		Read MSDS forms to protect self and others
		Read company safety policies and procedures
		Read machinery and product instructions in order to safely use them
		Read safety and environmental standards to perform inspections
Math	2.31	Tabulate safety incidents
		Calculate the safe volumes of contamination
		Measure the distances needed to maintain safe tolerances in the workplace
		Measure content of lead in painted surfaces
		Calculate production quantities against accident rates to ensure that demand doesn't create unsafe workplace
Science	3.21	Understanding of how the body is impacted by ergonomics in order to make workstation more comfortable and safe
		Understanding of potential chemical hazards
		Knowledge of basic electrical systems to prevent electrocution