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FEDERAL WAGE SYSTEM JOB GRADING STANDARD FOR ELECTRONIC INDUSTRIAL CONTROLS MECHANIC, 2606

Workforce Compensation and Performance Service

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ELECTRONIC INDUSTRIAL CONTROLS MECHANIC, 2606

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WORK COVERED

This standard covers nonsupervisory work involved in the installation, maintenance, troubleshooting, repair, and calibration of electronic controls and indicating and recording systems used on industrial machinery or engines, in automated materials storage and handling systems, in aircraft engine and similar test facilities, or in energy monitoring and control systems. This work requires knowledge of the practical application of electronics theories and circuits that are applicable to power, timing, motion control, indicating devices, and pulse and counting mechanisms, including special purpose digital computers (microprocessors) dedicated to control functions, as well as a knowledge of industrial equipment operation and processes.

WORK NOT COVERED

This standard does not cover work that primarily involves:

- Maintenance, repair, calibration, and certification of electronic test, measurement, and reference equipment used for precise measurement of electrical and electronic values. (See Electronic Measurement Equipment Mechanic Series, 2602.)

- Fabrication, overhaul, modification, installation, maintenance, troubleshooting and/or repair of ground, airborne, and marine electronic equipment, such as: radio; radar; sonar; cryptographic; industrial x ray; marine, aeronautical and space navigation aid; TV receiver; surveillance; and similar devices. (See Electronics Mechanic Series, 2604.)

- Installation, maintenance, and repair of electronic digital computers and peripheral equipment, such as computers for scientific, engineering or administrative computation and record keeping. (See Electronic Digital Computer Mechanic Series, 2608.)

- Maintenance, repair, installation, and calibration of integrated electronic systems. (See Electronic Integrated Systems Mechanic Series, 2610.)

- Installation and maintenance of electronic equipment when this is an integral part of the engineering testing, analysis, alignment, and performance evaluation of complex electronic systems, or when the employee is responsible for solving engineering problems of site selection, systems integration, and modification of the equipment to adapt to novel site characteristics. (See Electronics Technician Series, GS-0856.) (Note: The Introduction to the 2600 family contains a detailed discussion of the differences between electronics mechanic and electronics technician work.)

- Troubleshooting, testing, repair, overhaul, modification and maintenance of electrical equipment, such as welders, motor generator sets, AC and DC motors where the primary knowledge and skill is of electrical circuitry and electrical principles. (See Electrical Equipment Repairing Series, 2854.)

- Installation, modification, and repair of electrical systems in aircraft, watercraft, buildings, and mobile or transportable vans and vehicles that provide power to or carry signals between electronics equipment, where the primary knowledge and skill is of electrical circuitry and electrical principles and formula. (See the Electrical Installation and Maintenance Family, 2800.)

- Dismantling, repair, relocation, modification, maintenance, alignment, overhaul, and installation of fixed and semifixed production machinery, equipment, and systems such as various standard and numerically controlled machine tools, woodworking and metalworking machines used in the production of goods when the work requires primarily a practical knowledge of the mechanical, hydraulic, and pneumatic systems and components of diverse industrial production machinery and their attachments. (See Production Machinery Mechanic Series, 5350.)

- Dismantling, repair, alignment, overhaul, and installation of general nonproduction industrial plant machinery, equipment, and systems such as bridge cranes, towveyor/conveyor and pneumatic tube systems, sandblasting machines, and other industrial plant support machinery and equipment, when the work requires primarily a practical knowledge of the mechanical, hydraulic, and pneumatic systems and components. (See Industrial Equipment Mechanic Series, 5352.)

TITLES

Jobs covered by this standard that are graded below grade 10 (other than Helper and Intermediate jobs) are to be titled *Electronic Industrial Controls Worker*.

Jobs covered by this standard at grade 10 or above are to be titled *Electronic Industrial Controls Mechanic*.

GRADE LEVELS

This standard describes work at grades 8, 10, 11, and 12. It does not cover all possible grade levels for this occupation. If jobs differ substantially from the level of skill, knowledge, and other work requirements described for grade levels in the standard, they may be graded above or below these grades, based on the application of sound job grading principles.

HELPER AND INTERMEDIATE JOBS

Helper and intermediate jobs in this series are graded by the Office of Personnel Management Job Grading Standards for Trades Helper and Intermediate jobs. (Grade 10 or 11 in this standard, whichever is representative of the principal level of work of the activity, is to be used as the "journey level grade" in applying the Intermediate Job Grading Table. ***Grade 12 is not a journey level***.)

NOTES TO USERS

For discussion of such factors as impact of solid state technology on the occupation, equipment complexity versus complexity of work assigned, and guides for deciding if work is general schedule or wage grade, refer to the Introduction to the Electronic Equipment Installation and Maintenance Family, 2600.

Definitions: Certain general terms may have different meanings to different users of this standard. For the purpose of this standard, the following terms are defined as:

Part. The lowest subunit of electronics devices, the basic detachable segments or pieces from which contiguous subassemblies are constructed. That unit that usually must be soldered, connected, wired, attached to a pressboard or similar receptacle. Representative examples include: transistor, thermistor, diode, resistor, capacitor, vacuum tube, rectifier, switch, IC chip, blank pressboard, etc.

Subassembly. A structural unit of interconnected parts comprising a circuit to perform a singular phase of an electronics function. Representative examples include: power supply regulator circuit, signal amplifier strip, memory circuits of a remote vehicle guidance unit, etc.

Assembly. A grouping of circuits and/or subassemblies normally interconnected to a chassis or modular pressboard forming a complete unit capable of performing an electronics function. An assembly cannot normally be removed as an intact end item from the chassis or pressboard. Representative examples include: regulated power supply module, power output circuits of an electron beam welder, or microprocessor unit of an analog to digital converter.

Component. A grouping of assemblies and/or circuit modules that performs a full electronics function and is normally regarded as an end item or detachable operational module. Each unit is normally capable of performing a complete linear or operational electronics function as a secondary or supporting constituent element of a complex electronics system. Representative examples include: digital control unit or field interface device of an environmental monitoring and control system; wire guidance unit of an automatic warehousing system; NC machine tape reader, command generator or data display; etc.

System. A grouping of advanced electronics assemblies and major components that frequently performs two or more substantially unrelated electronics functions where each is dependent on the interaction of one segment to another in the performance of an orderly working totality. The components usually involve the presence of numerous and complex integrated circuitry and overall systems operability is affected by the interface of the components and their collective reliability. Malfunction diagnosis and repair require a full-systems approach since functional problems in one portion of the system can emanate from a seemingly unrelated source within the overall system. A representative example is the electronic control portion of a numerically controlled

machine including tape reader, dial input and other input devices, master timer, command generator, discriminator, servo drives, and tool position and speed sensors.

Adaptive Control versus Electronic Integrated Control Systems: Adaptive control is a refinement of numerical control that adapts the metal cutting operation of a numerically controlled machine to the actual condition of the cutting tool and stock, such as stock hardness variations, air gaps in the work piece, and dulling rate of the tool. Transducers on the machine detect tool deflection, vibration, and temperature and torque on the spindle. The signals from the transducers are analyzed by a special adaptive control program and corrections are made to spindle speed and feed rate. Although these transducers are sensors providing feedback to a logic unit, this does not meet the criteria for an electronic integrated system, i.e., where the output of a number of sensor subsystems is integrated in a logic subsystem. The transducers and microprocessor or the adaptive control unit do not compare at all in scope, operation, of complexity of theory and design to "a number of sensor subsystems" such as target tracking radar or gyro or inertial sensing unit, that are part of an electronic integrated system.

2606-8 ELECTRONIC INDUSTRIAL CONTROLS WORKER, GRADE 8 2606-8

General: Grade 8 Electronic Industrial Controls Workers apply standardized, specific procedures and techniques to perform fabrication, installation, modification, overhaul, maintenance and repair of electronic equipment of limited complexity such as subassemblies, printed circuit cards, and chassis. Examples of typical work assignments at this level:

- Receives defective circuit cards or chassis, such as servos, tool position sensors, power supplies, oscillators, or other assemblies that are of limited design and functional complexity Makes visual check and repairs obvious damage. Applies test signal and checks out circuit. Locates and repairs malfunctions.

- Works as a team member in the installation, repair, and maintenance of complete numerical control, environmental monitoring and control, or similar systems by performing more simple and routine tasks, such as identifying, checking, and connecting power and signal cables, replacing defective parts and assemblies that have been identified by higher grade mechanics, or monitoring system operation by following operating and testing procedures for the system and associated test equipment, and identifying and reporting improper operating indications.

- Constructs individual chassis and components of electronic equipment in accordance with detailed schematics, layout diagrams, and assembly instructions. Tests work by checking circuit continuity, resistance and impedance, and similar values as specified in assembly instructions.

Grade 8 Electronic Industrial Controls Workers determine the work sequence on routine repetitive assignments.

Skill and Knowledge: Grade 8 Electronic Industrial Controls Workers require knowledge of construction practices of electronic equipment in order to recognize types and sizes of resistors, capacitors, wiring, transistors, etc., and follow signal paths through printed circuit and wired circuitry, recognizing actual circuit configurations that are shown in schematics and diagrams. They exercise skill in removing and replacing specified parts, following standard methods.

Grade 8 workers need knowledge of standardized shop practices and procedures, such as soldering procedures for construction or repair of printed circuit boards and mechanical and electrical placement and hookup of parts and subassemblies in larger chassis and consoles, as well as familiarity with basic test equipment operation, such as voltmeters, ohmmeters, signal generators, and oscilloscopes, in order to follow specified checkout procedures and compare readings with specified values. They require knowledge of electrical and electronic theory such as the electromagnetic basis of alternating current and inductive and capacitive reactance, series and parallel tuned circuits, impedance matching, and operation of vacuum tubes and transistors and exhibit skill in applying such knowledge to follow the testing procedures for chassis or circuit boards with one or a few types of circuit such as an amplifier strip, discriminator, power supply, etc.

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At this level, works are skilled in reading schematics of uncomplicated assemblies, such as power supplies, audio amplifiers, and switching panels to determine value, polarity, and location in the circuit of defective parts, determine proper test points for measuring values of parts, voltages, etc., and in applying precise instructions and specifications describing fabrication, test or repair procedures to be followed. Skill in the use of the usual handtools of the electronics trade, such as drills, chassis punches, wrenches, soldering irons, and microsoldering, units is needed to remove and replace circuit parts where accurate positioning, appearance, mechanical strength, and electrical integrity are important. Knowledge of common testing procedures is required, such as use of vacuum tube voltmeters to prevent loading of high impedance circuits when testing for operating voltages and use of signal generators and oscilloscopes to visually trace the progression of a signal through a discriminator and amplifier section.

Responsibility: Grade 8 Electronic Industrial Controls Workers receive detailed oral instructions and written work orders from the supervisor or a higher grade employee. On routine assignments, they independently determine work methods and the use of tools and test equipment. Judgments and decisions at this level are guided by clearly described procedures and instructions, and the work consists of recurring steps involved in the disassembly, repair, replacement, and test of parts, subassemblies, and assemblies. The work is spot-checked during the progress of the task or work order and the supervisor or higher grade worker is usually available for any necessary assistance. Completed work is checked for compliance with instructions, specifications, and standardized shop practices and procedures. New assignments are performed under close review.

Physical Effort: Work assignments require moderate physical effort. Employees frequently lift, carry, or otherwise handle items weighing up to 18 kilograms (40 pounds). Occasionally they handle items greater than 18 kilograms. Assistance is usually available with heavy items. They work in a sitting position for extended periods. Frequent standing, walking, bending, crouching, reaching, and stooping is required. Occasionally, climbing and work in high places may be required.

Working Conditions: Work is usually performed inside in well lighted, heated, and ventilated areas. When equipment is fixed in place, it is sometimes necessary to work in warehouse or industrial areas exposed to loud noises, heat or cold, fumes, etc. Employees are subject to injuries, such as electric shock, cuts and bruises, as well as burns caused by electrical energy or soldering irons.

2606-10 ELECTRONIC INDUSTRIAL CONTROLS MECHANIC, GRADE 10 2606-10

General: In comparison with grade 8 workers who perform limited, routine, or closely controlled tasks, Electronic Industrial Controls Mechanics, grade 10, perform the overhaul, installation, maintenance, modification, and repair of various types of electronically controlled industrial equipment that is characterized by moderate complexity of design, construction, and function. They apply knowledge of electronic theory and circuits and basic logic circuits to power, timing, and motion controls, indicating and counting mechanisms, and similar devices that are found in boiler combustion control systems; materials handling equipment, such as digital weighers, laser readers, electronic counters, and automatic/manual controls of fork lifts or other warehouse vehicles; in process controls, such as those sensing, recording, and dispensing chemicals to maintain a desired mixture; or production equipment, such as ultrasonic cleaners, electron beam welders, and profile follower milling machines and less complex numerically controlled machines, such as punch presses, lathes, boring machines, and drills, that have single or dual axes and point-to-point control.

Skill and Knowledge: Grade 10 mechanics apply knowledge of electrical and electronic block diagrams, wiring diagrams, and schematics in order to understand the construction and operation of the industrial controls and troubleshoot malfunctions. When assignments include digital devices, they apply knowledge of simple logic diagrams to follow the signal and determine appropriate voltage conditions. They must know electronics theory, including transistor and solid state diode theory, operation of pulse forming networks, voltage and current comparison networks such as the Wheatstone Bridge or other balancing networks, and basic electron tube theory. They must know simple logic circuitry, such as gates, latches, and flip flops as found in common integrated circuits. They must be skilled in the selection and use of the proper test equipment in order to prevent loading of circuits and damage to delicate parts. The mechanics must have a good general knowledge of pneumatic, hydraulic, mechanical, and electrical systems and of the operation or industrial processes performed by the equipment in order to be able to test and evaluate the operation of repaired equipment.

Responsibility: In comparison to grade 8 Electronic Industrial Controls Workers, who receive detailed oral and written instructions, grade 10 mechanics work from oral or written instructions that provide a general statement of the problem. They refer to manufacturers' handbooks, technical manuals, schematics, block diagrams and, occasionally, logic diagrams that are complete and specific except in the case of items of limited complexity, such as fuel flow test benches or engine thrust detectors, where most of the equipment is quite similar and knowledge of one make or model is easily adapted to other makes and models. They determine work sequence, select test instruments, locate the malfunction, and complete the repairs. They make operational tests of equipment to assure proper operation. Work is spot checked by the supervisor or other higher graded employee to assure compliance with directives, specifications, and accepted trade practices.

Physical Effort: Physical effort is the same as that described at the grade 8 level.

Working Conditions: Working conditions are the same as those described at the grade 8 level.

2606-11 ELECTRONIC INDUSTRIAL CONTROLS MECHANIC, GRADE 11 2606-11

General: Unlike grade 10 Electronic Industrial Controls Mechanics, who work on equipment of only moderate complexity, grade 11 mechanics work on highly complex systems of electronic sensing and control. This includes multiple axis numerically controlled (NC) machine tools with continuous path or contouring control capability, such as machining centers and omnia mills; nuclear plant controls; and computer controlled warehousing/stock-handling equipment and centralized environmental monitoring and control systems (EMCS) that use special purpose, dedicated computers to store operating parameters and initiate adjustments. Mechanics at this level require a thorough knowledge of logic circuits, of electronic amplification and control circuits, and of complex electrical, mechanical, hydraulic, and/or pneumatic systems. In addition, they must be well grounded in the industrial or environmental control processes to be accomplished by the equipment on which they work in order to properly test and coordinate the various portions of the system.

Skill and Knowledge: Grade 11 Electronic Industrial Controls Mechanics use greater scope and depth of knowledge than is required at the grade 10 level due to the greater complexity of the systems to be repaired. They must be skilled in the interpretation of engineering drawings that combine electrical and electronic schematics, logic diagrams, and mechanical drawings in order to trace signal flow throughout the system while troubleshooting malfunctions of complex systems, such as an NC machining center with adaptive control where the signal must be traced in digital logic form from the part program in the tape reader through the central processor, in electrical and mechanical form through the machining center to the tool, in electrical and then digital form to the adaptive control micro-processor and then as a digital input to modify the commands from the central processor. They must know the characteristic voltage, current, and signal shape of the input and output of a wide variety of microprocessors, integrated and discrete solid state circuits, and high power vacuum tube or transistor applications in order to recognize indications of improper operation and differentiate them from temporary anomalies introduced by the testing itself. They must be skilled in the interpretation of installation and repair instructions that frequently describe only general applications for the various components rather than their interface with the other components of the specific system, since the various components are often produced by many manufacturers with differing design philosophies such as the case when new NC control units are retrofitted onto older NC machines or EMCS controls are connected through customized interface devices to electrical, mechanic&, pneumatic, or hydraulic controls of components that vary greatly in operating theories and operating tolerances as a result of differing age, purpose, and manufacturers' practices. Data conversion and processing units are an integral feature of electronic controls at this level. To troubleshoot these, mechanics use Boolean algebra to construct truth tables and logic equations for analysis of logic circuits and the ability to program simple test instructions in the tape language or on an input console to check out particular circuits or functions.

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Responsibility: Grade 11 Electronic Industrial Controls Mechanics receive work assignments from the supervisor in the form of written work orders and inspection reports and oral instructions. They work in accordance with available drawings, technical orders, or specifications. In comparison to the work performed by mechanics at the grade 10 level, work assignments at this level require more judgments and decisions regarding the methods and procedures for completing assignments that may involve extending the use of conventional tools and equipment, and improvising changes to techniques and procedures to reach specified parameters when aging of components or modification of circuits have changed operating conditions. The mechanics are responsible for knowing and judging the impact of repairs, i.e., the effects that changes and adjustments will have on the related integral devices of the equipment serviced. They are also responsible for making further tests and alignments to insure that the completed equipment is aligned and functioning properly.

The mechanics plan the work sequence and determine that equipment meets the requirements for serviceability, especially when working in remote user locations. They also are responsible for applying sound judgment in decisions that contribute toward greater operating life and efficient operations. The mechanics at this level must keep abreast of technological changes in the occupation, and provide technical guidance and assistance to lower grade employees.

Technical advice is available on unusually difficult problems. Completed work is spot checked for compliance with accepted trade practices and specifications.

Physical Effort: Physical effort is the same as that described at the grade 8 level.

Working Conditions: Working conditions are the same as those described at the grade 8 level.

2606-12 ELECTRONIC INDUSTRIAL CONTROLS MECHANIC, GRADE 12 2606-12

General: As compared to the maintenance and repair of highly complex complete operational control systems typical of work at the grade 11 level, Electronic Industrial Controls Mechanics, grade 12, work on new systems of similar great complexity. They serve as "lead workers" on teams to install and put into operation major electronic control systems that are new to the activity or that are major modifications of existing systems, so that there is little knowledge of the system problem areas and expertise in its repair. They troubleshoot and repair new systems during the operational tests and improvise procedures to cope with unforeseen defects. They construct interface devices and modifications to the equipment from sketches and verbal instructions in order to refine the new system operations. Assignments are characterized by application of advanced electronic theory and frequent technological changes in systems.

Skill and Knowledge: Grade 12 Electronic Industrial Controls Mechanics require extensive theoretical and practical knowledge of operation, capabilities, and limitations of electronic control equipment and systems as well as skill in applying this knowledge to understand new or extensively modified systems in order to improvise alignment, repair, and operating procedures that will be efficient, complete, and compatible with available resources. They must use ingenuity in the application of shop and trade practices to solve operating and repair problems, for example, to improvise troubleshooting procedures for an environmental control system in which a number of the major components were designed as independent systems with different engineering parameters and practices and that have been modified to accept central digital control. Mechanics at this level need practical knowledge of electronic theory and design and ability to use theoretical concepts to devise solutions for operating or repair problems on one-of-a-kind systems in which novel engineering approaches have created unforeseen problems. They exercise skill in interpreting electronic, electrical, and mechanical drawings, specifications, and schematics of complete custom systems such as a new automated warehouse materials handling system with numerous remote units and functions that must be coordinated or similar involved subunits that create and use many interlocking signals. They require skill in troubleshooting complex electronic systems characterized by unusual circuit arrangements and theories and lack of developed documentation.

Responsibility: In comparison to grade 11 Electronic Industrial Controls Mechanics who receive general assignments for work on proven and documented equipment, grade 12 Electronic Industrial Controls Mechanics exercise significantly more judgment and independence in determining the methods and techniques required to solve unusually complex installation and repair problems. For example, they independently judge the need for modification of test devices or work sequences, and for special or nonstandard trade techniques. They develop and submit for approval changes to detailed schematics, drawings, and maintenance procedures for use by lower grade employees.

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Grade 12 mechanics must keep abreast of technological changes in the occupation to understand new electronics theories and applications and provide technical guidance and assistance to lower grade employees.

They coordinate their efforts with technical and professional personnel on matters affecting installation or operating specifications and changes to equipment. The supervisor assigns work orally and through written instructions that outline the purpose of the work and possible approaches. Work is reviewed by occasional spot checks, review of documentation developed, and successful check out of the equipment.

Physical Effort: The physical effort required at this level is the same as that described at the grade 8 level.

Working Conditions: The working conditions at this level are the same as those described at the grade 8 level.