

# Federal Wage System Job Grading Standard for Instrument Mechanic, 3359

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## WORK COVERED

This standard is for grading nonsupervisory jobs involved in installing, aligning, modifying, troubleshooting, repairing, overhauling, testing, and calibrating a variety of instruments containing electric, mechanical, pneumatic, hydraulic, and/or electronic components, assemblies, and controls. The work includes using both manual and automated test equipment such as pneumatic, hydraulic, or vacuum test stands or computer controlled electronic test consoles to test, align, and calibrate instruments. The work also includes maintaining, repairing, and calibrating precision instruments and standards such as dial indicators, concentricity gauges, sine bars, micrometers, and plug and ring gauges. The work requires knowledge and application of electrical and mechanical principles; knowledge of pneumatic and/or hydraulic mechanisms; and, in some work situations, knowledge of electronic principles and theory.

This standard cancels and supersedes the Job Grading Standard for Instrument Mechanic, 3359, issued in September 1974.

## WORK NOT COVERED

This standard does not cover work that primarily involves:

- Work involved in repairing, troubleshooting, calibrating, and testing electronic digital computers and peripheral equipment. (See the [Electronic Digital Computer Mechanic Series, 2608.](#))
- Work involved in maintaining, repairing, and calibrating electronic test, measurement, and reference equipment used for measuring a variety of electronic values, quantities, and relationships such as voltage, resistance, capacitance, frequency, and inductance. (See [Job Grading Standard for Electronics Measurement Equipment Mechanic Series, 2602.](#))
- Work involved in installing, maintaining, troubleshooting, repairing, and calibrating electronic controls and indicating and recording systems used on industrial machinery or engines, in automated materials storage and handling systems, in aircraft engines, or in energy monitoring and control utility systems. (See [Job Grading Standard for Electronic Industrial Controls Mechanic Series, 2606.](#))
- Work involved in installing, maintaining, troubleshooting, overhauling, and repairing electronic systems and equipment. (See [Job Grading Standard for Electronics Mechanic Series, 2604.](#))
- Work involved in troubleshooting, overhauling, modifying, maintaining, and testing optical instruments. (See [Job Grading Standard for Optical Instrument Repairing, 3306.](#))

## TITLES

Jobs covered by this standard at grade 10 and above are titled *Instrument Mechanic*.

Jobs graded by this standard below grade 10 (other than helper and intermediate jobs) are titled *Instrument Worker*.

## GRADE LEVELS

This standard does not describe all possible grades at which jobs might be classified. If jobs differ *substantially* from the skills, knowledge, or other work requirements described in the standard, they may be graded either above or below the grade levels described based on sound job grading methods.

## HELPER AND INTERMEDIATE JOBS

Helper jobs are graded by the [Job Grading Standard for Trade Helper Jobs](#). The grade 8 level described in this standard DOES NOT apply to jobs that are part of a planned program of training and development of skills for advancement to a higher grade. Such trainee jobs are covered by the [Job Grading Standard for Intermediate Jobs](#). Grade 10 in this standard is to be used as the *Ajourney level* in applying the Intermediate Job Grading Table.

## NOTES TO USERS

Ongoing technological advancements in the field of electronics will continue to have an impact upon electrical components and devices commonly found in the instruments covered by this standard. As a consequence, work within this occupation may require knowledge of electronic principles ranging from a practical understanding to a knowledge of general electronic theory. For example, when electromechanical controls have been replaced by electronic-based devices, they may be so limited in scope of operation and complexity of design that adjustment and repair can be done in accordance with detailed instructions for which little electronics knowledge is required. Typically, such work would be graded by the [Job Grading Standard for Electronics Mechanic, 2604](#), at or below grade 8. In other cases, the overall complexity of the electronic-based device may be greater, but the electronics knowledge generally does not exceed the grade 10 level as described in the Electronics Mechanic standard. That is, the electronic devices worked on are generally a part of a self-contained and functionally independent unit that would not exceed the level of complexity described at the grade 10 in that standard.

In accordance with the Federal Wage System mixed job grading policy, if both the nonelectronics and electronics work are at the same grade and the nonelectronics work is paramount, the job would continue to be classified to the 3359 series. When electronics knowledge is paramount or the electronics work is at a higher grade than the nonelectronics

work, the job should normally be placed in the [2600, Electronic Equipment Installation and Maintenance Family](#).

In some work situations, work that was formerly covered by the 3359 series is now covered by a series in the Electronic Equipment Installation and Maintenance Family, 2600. For example, electrical, mechanical, and pneumatic utility control systems have been replaced by electronic centralized environmental monitoring and control systems (EMCS). Typically, journey level work on this entire system, i.e., computer, pneumatic, hydraulic, electronics, electrical, and/or mechanical systems, would be covered by the [2606](#) series.

For a detailed discussion of the impact of technological development in electronics and a discussion of computer-controlled automatic test equipment (ATE), refer to the [Introduction to Electronic Equipment Installation and Maintenance Family, 2600](#).

## **INSTRUMENT MECHANIC, GRADE 8**

*General:* Grade 8 instrument workers perform work involved in routine repair and checkout of electrical, mechanical, pneumatic, hydraulic, or electronic components, assemblies, and devices that require only limited or minor adjustments and where problem analysis is repetitive. Examples of components serviced are pressure and vacuum gauges, quantity and directional indicators, transducers, regulators, and synchro and gear assemblies. Workers at this level repair devices that have little or no interaction between components that would complicate repair and test procedures. They visually examine disassembled components for broken parts, worn surfaces, heat discoloration, and other damaged conditions using magnifying mirror lamps, or microscopes. They use soldering devices, vacuum ovens, gas torches, purging equipment, and induction heaters to unseal, seal, and purge hermetically sealed components with gas. They check for leaks with leak detectors and use meggers to test for electrical shorts and grounds. Grade 8 workers solder and unsolder wires and components, fabricate or repair electrical wiring assemblies, and clean parts with Freon and isopropyl alcohol, vapor degreasers, and/or ultrasonic cleaners. They check electronic devices for electrical tolerances using such equipment as multimeters, signal generators, and transistor testers. They take resistance, impedance, and capacitance readings and compare the results to stated values. They replace defective components on printed circuit cards or entire cards as directed by higher level personnel.

Grade 8 instrument workers disassemble instruments to test, locate, repair, or replace defective parts such as dials, pointers, jewels, bearings, slip rings, tension springs, coils, magnets, relays, resistors, capacitors, diodes, potentiometers, gears, and valves. They may also assist higher grade workers in troubleshooting and performing operational checks on systems and equipment of moderate and higher levels of complexity with full responsibility vested with higher grade personnel.

In some work situations, grade 8 instrument workers may also assist higher grade workers in the setup and operation of computerized automatic test equipment (ATE) to determine the depth of repair for a variety of instruments, and assist in the final checkout of these instruments to determine if repair was correctly made.

*Skill and Knowledge:* Grade 8 instrument workers have a working knowledge of electrical, mechanical, hydraulic, and/or pneumatic principles; an understanding of the basic principles underlying electronics; and the skill to repair and maintain a variety of limited function electrical, electronic, mechanical, hydraulic, or pneumatic components and devices. They have skill to disassemble items and perform detailed visual examinations to detect worn or damaged parts such as broken wires, cracked insulation, worn gears, cracked solder joints, and defective contacts, pivots, springs, or similar deficiencies. They have skill to lubricate parts as required and remove dirt and corrosion with appropriate solvents. They have knowledge to determine when standard parts and components can be cleaned and reinstalled or must be replaced with new or reconditioned parts. Some work at this level requires skill in removing imperfections from seating or sealing surfaces with abrasives and by polishing surfaces. Grade 8 instrument workers have skill in soldering wire connections and components and repairing wiring assemblies.

They have knowledge of how much heat delicate instruments and components can withstand before causing damage to internal parts. They have skill in using electrical test equipment such as ohmmeters, voltmeters, continuity testers, meggers, and test panels to test and adjust electrical quantities and perform final checks on repaired items in accordance with diagrams, instructions, and test procedures that detail the steps to be followed. They use a working knowledge of electronics to test items such as resistors, capacitors, transistors, potentiometers, diodes, relays, and transformers. Workers at this level have skill in using standard measuring devices such as micrometers, dial indicators, and feeler gauges to maintain accurate dimensions and close tolerances.

*Responsibility:* Grade 8 instrument workers receive work assignments from their supervisor or higher grade worker. Detailed instructions and specific maintenance and repair procedures are provided for all items serviced. They work independently on routine and repetitive work assignments. Decisions and judgments are controlled through established work procedures and detailed instructions. Routine work assignments are typically carried out with little or no review in progress. They receive detailed instructions from their supervisor on new or unusual assignments. All work is subject to review in progress and upon completion for conformance to standards and job specifications.

*Physical Effort:* Grade 8 instrument workers make repairs that often require them to work in sitting positions for extended periods of time. Some work requires long periods of standing, walking, bending, and reaching. They frequently lift, handle, and carry items and equipment that weigh up to 18 kilograms (40 pounds). They are sometimes required to lift and move items weighing in excess of 23 kilograms (50 pounds) with the help of weight handling equipment or with assistance from other workers.

*Working Conditions:* Grade 8 instrument workers typically work in well lighted, heated, and ventilated areas. They may be required to work in clean room conditions where special garments including head coverings, shoe coverings, and gloves are required. Also, they may be required to use protective equipment such as hard hats, safety glasses and shoes, face shields, ear plugs, and respirators. The work involves the use of cleaning solvents and lubricants that may expose

workers to unpleasant fumes. They are exposed to the possibility of electrical shock; burns from hot solder, soldering irons, and electrical sparks; and cuts, bruises, and abrasions from operating power tools and equipment.

## **INSTRUMENT MECHANIC, GRADE 10**

*General:* In comparison with grade 8 workers who perform standard repair and checkout of limited function components and devices, grade 10 instrument mechanics troubleshoot, repair, overhaul, modify, test, calibrate, and install instruments and equipment of multiple component design. The items serviced at this level have interdependent electrical, mechanical, pneumatic, hydraulic, and/or electronic units and devices that detect, measure, record, indicate or regulate velocity, pressure, displacement, weight, temperature, torque, resistance, voltage, and similar values and relationships. They repair and maintain integrated groupings of equipment such as utility pneumatic controllers, transmitters, and cumulators; navigational, gyroscopic, and accelerometer units; or fuel quantity and flow, pressure, temperature, altitude, speed, and air flow indicating devices. They also repair and maintain precision measurement instruments and equipment such as multimeters, voltmeters, dial indicators, tachometers, frequency meters, insulation testers, power supplies, and a variety of other devices of similar complexity, that are used as working or reference measurement standards. They perform pretests to determine the extent and location of malfunctions and to isolate defective components. They simulate operating conditions on malfunctioning equipment, energize system components, and conduct operational checks, including tests of input and output from or to related system components. They check the electrical characteristics and values of circuits and component parts. They check mechanical parts for damage, proper operation, and wear. They repair or replace faulty parts and adjust all moving parts and electrical devices for alignment within the simulated system. They occasionally assist engineering personnel in modifying existing procedures for new instruments. They use a variety of test equipment such as volt-ohm meters, transistor testers, digital meters, oscilloscopes, bearing analyzers, phase and null meters, galvanometers, and computerized automatic test equipment.

Instrument mechanics at this level usually service components of standard design that are either self-contained and functionally independent or are serviced while separated from other equipment with which they are designed to operate, e.g., instrument panels. They work from equipment manuals containing operating instructions, theory of operation, schematics, wiring diagrams, and parts lists. They follow wiring plans, blueprints, and specifications covering individual components, and test and calibrate components in accordance with specific performance instructions. They may be required to remove, install, and checkout equipment in aircraft, ships, tanks, or similar equipment in field locations.

Grade 10 instrument mechanics set up and operate computer controlled automatic test equipment to test, troubleshoot, and repair gyroscopic and accelerometer instruments. They use appropriate cabling and interfacing to install instruments on test systems. They analyze wave forms, voltage, current, power amplitudes, indicator and counter readouts, and other electronic/ electrical presentations to determine the serviceability of the instruments. They perform final tests and calibrations after the required repairs have been accomplished. In some work situations, they

assist in the development of diagnostic programs and program information necessary for computerized analysis of gyroscopes, accelerometers, and other similar devices.

*Skill and Knowledge:* Grade 10 instrument mechanics apply a thorough knowledge of electrical, mechanical, pneumatic, and/or hydraulic principles and theory and a working knowledge of electronic principles and theory to troubleshoot, repair, overhaul, modify, test, and calibrate instruments and equipment encompassing electrical, electronic, mechanical, hydraulic, and/or pneumatic subassemblies, components, and related devices such as transmitters, gyroscopes, accelerometers, indicators, servomechanisms, and amplifiers. They evaluate and may perform functional tests on items to determine the extent of repair required. They perform complete and partial teardowns of the instruments and clean parts and examine for wear, foreign matter, damage, and similar conditions. They check gears for backlash and alignment, and synchros and resolvers for accuracy and phasing. They replace bearings and bent or binding shafts and adjust slip rings. They repair and assemble pressure and fluid control valves, and perform electrical sensitivity adjustments. They apply a working knowledge of electronics including AC and DC, amplification, power supplying, transistors, semi-conductor theory, and servomechanism principles to test electronic circuitry and repair or replace items such as circuit cards, integrated chips, resistors, capacitors, transistors, diodes, relays, and transformers.

Instrument mechanics at this level have skill in interpreting and applying the requirements in technical orders, manufacturers' handbooks and repair manuals, blueprints, schematics, shop procedures, maintenance check lists, engineering instructions, and similar documents while repairing, testing, and calibrating complex instruments and equipment. They have skill in the use of a microscope to check critical surfaces and dimensions; in tracing faulty wiring, components, or circuitry for hard-to-locate defects and problems; and in analyzing fault indications obtained during testing to determine the type and location of the malfunction and in accomplishing the necessary repairs. They have skill in the use of measurement devices such as vernier calipers, height gauges, comparators, and surface gauges to maintain and control such parameters as concentricity, spring loading, gear mesh, end play, run out, torque, and alignment. They also have skill in the use of test equipment such as manometers, oscilloscopes, and ammeters to adjust, measure, and analyze such characteristics as pressure, flow, vacuum, wave forms, and power amplitudes.

Grade 10 instrument mechanics apply a thorough knowledge of mechanical motion and gearing principles in order to make all adjustments for alignment, parallelism, and concentricity, and to connect, mesh, and align surfaces, assemblies, and parts with one another. They have skill in making precise adjustments to instruments such as adjusting the null and phase of synchros; adjusting the tension and end play of gears and shafts; positioning cams; and adjusting pivotal and actuation points. They apply a knowledge of standard shop mathematics to accomplish initial operational checks and the calibration and final testing of all instruments and equipment. Grade 10 instrument mechanics have skill in the set-up and operation of software-controlled automatic test equipment in both manual or automatic mode to run existing or new and/or extensively modified (e.g., not fully "debugged") diagnostic programs to test and calibrate gyroscopes and accelerometers.

Instrument mechanics at this level must be able to assist engineering personnel in developing, debugging, or modifying diagnostic programs by recommending changes where necessary and identifying and investigating apparent contradictions between test specifications or test requirement documents and test programs.

*Responsibility:* Grade 10 instrument mechanics receive work assignments from the supervisor that are usually accompanied by appropriate blueprints, schematics, technical data, and engineering instructions. In some work situations, blueprints, schematics, or technical data may be incomplete or absent. As compared to the predetermined methods and procedures at the grade 8 level for routine work assignments, grade 10 instrument mechanics make more independent decisions and judgments regarding troubleshooting techniques, and modification and repair procedures. They independently plan the sequence of work and determine the processes, methods, procedures, parts, materials, test equipment, and technical data to use in completing assignments. The supervisor provides technical assistance on unusual or difficult problems. Completed work is either self-certified or inspected by the supervisor and/or quality control personnel. Grade 10 instrument mechanics also are responsible for providing technical assistance to lower grade workers, and may be required to certify the work products of lower grade workers.

*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](#).

## **INSTRUMENT MECHANIC, GRADE 11**

*General:* In comparison with grade 10 mechanics who service items of multiple component design that detect, measure, record, indicate, or regulate values and relationships, grade 11 instrument mechanics troubleshoot, repair, overhaul, modify, test, calibrate, and install the most complex instruments and equipment that are combined and interrelated with other devices, and are designed to perform multiple functions such as differentiation, data integration, data conversion, and data translation functions. The devices repaired and maintained are characterized by electrical, mechanical, pneumatic, hydraulic, and/or electronics systems with interrelated functions so that the mechanics at this level must deal with all aspects of the integrated assembly to successfully complete work on any of the components. Items serviced are characterized by a variety of data sensing units, computing assemblies, actuating mechanisms, display indicators, and related controls that are collectively combined and integrated into a complete unit of information gathering devices. They maintain, repair, and calibrate such major items as gyro magnetic compass systems, displacement gyro platform systems, or mechanical, pneumatic, hydraulic, and electrical/electronic precision measurement test consoles. They troubleshoot the various items and instruments under simulated or actual operating conditions; trace sources of trouble and identify defects by following signal flow through subassemblies and components; and make adjustments or repairs that are often complicated by the need to consider the interaction of functionally related subsystems in isolating malfunctions or achieving critical

tolerances and accuracies that require custom fitting major components and fabricating or finishing replacement parts.

Instrument mechanics at this level solve the most difficult problems in airborne, marine, tactical, test, and experimental applications. Many of the instrument devices are of unique design or systems configuration. They apply broad experience and a specialized knowledge of electrical, mechanical, pneumatic, and/or hydraulic theory and a working knowledge of electronics to diagnose, isolate, and repair malfunctions, and to achieve and maintain critical accuracies, sensitivity levels, and precise tolerances in aligning and adjusting complex instrument systems, components, and mechanisms. They work from manufacturers' technical information sources and operating instructions that may be vague or incomplete. In such instances, mechanics at this level are required to develop and improvise special techniques to test, repair, and calibrate the instruments.

*Skill and Knowledge:* Grade 11 instrument mechanics apply an extensive knowledge of electrical, mechanical, pneumatic, and/or hydraulic principles and theories, and a working knowledge of electronic principles, to repair, maintain, and calibrate the most complex instrument devices that perform differentiation, integration, and data translation functions. The devices serviced are characterized by interrelated systems and are designed to perform multiple functions so that troubleshooting is complicated by error indications from the interrelated assemblies. They have skill to isolate malfunctions in complex components and devices such as the gyro stabilized platform assembly in an aircraft inertial navigation unit (INU). They mount the INU on performance test fixtures and operate a test console to determine causes of malfunctions to one or a combination of defective components such as gyros, accelerometers, electronic modules, resolvers, or gimbal motors.

They repair or replace defective components and perform final operational tests and calibration on the INU. They have skill to interpret complex drawings, sketches, wiring diagrams, manufacturers' plans, engineering blueprints, and similar technical information. They have skill to modify and improve methods of testing and overhauling new instruments and devices that may require adapting tools and test equipment to special uses such as extending the range or sensitivity of diagnostic equipment, or fabricating tools to accommodate particular needs, or to perform standard operations more efficiently.

Instrument mechanics at this level must have a broad practical knowledge of construction and assembly techniques in order to make customized parts with complex configurations or assemble prototype devices with unusual angular relationships. They have skill in making precise repairs and alignments such as setting displacement outputs for mechanical ball-disc integrators or reworking spiral gears, differential gears, and antibacklashes. They have skill to align and calibrate special purpose test consoles that contain multifunctional items with critical mechanical and electronic tolerances and accuracies. They apply a comprehensive knowledge of testing and troubleshooting techniques and procedures to analyze, repair, and maintain electromechanical instrument systems where the equipment is interrelated and performs multiple functions or where performance specifications are met only by making simultaneous adjustments and alignments to interrelated system devices. At this level, instrument system malfunctions may result from the

interaction of a number of defects in several locations rather than one clearly identifiable defect in a single location.

*Responsibility:* Grade 11 instrument mechanics receive assignments from the supervisor concerning the priority of the systems or devices to be repaired. While guidelines such as blueprints, schematics, technical orders, manufacturers' handbooks, and engineering specifications are usually available, they are often vague or incomplete, and the mechanics may be required to identify and calculate the missing information. As compared to the work performed at the grade 10 level, grade 11 instrument mechanics make more independent judgments and decisions regarding methods and procedures for completing assignments that may involve extending the use of conventional tools and test equipment, and improvising fault analysis, repair, and calibration techniques. They are responsible for understanding the effect that particular repairs will have on interrelated system devices and interface equipment, and for making final tests and alignments to insure the accurate calibration and balanced operation of the entire instrument system. They are also responsible for recommending methods to improve equipment performance and more efficient maintenance procedures. The supervisor is available to provide advice on unusually difficult problems. Completed work is subject to spot checks by the supervisor for compliance with 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](#).