

# Federal Wage System Job Grading Standard for Optical Instrument Repairing, 3306

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## WORK COVERED

This standard covers nonsupervisory work involved in troubleshooting, overhauling, modifying, maintaining, and testing optical instruments such as binoculars, telescopes, cameras, sextants, gun sights, periscopes, and cinetheodolites. These jobs primarily require knowledge and application of optical principles, procedures, and materials and, in addition, knowledge of mechanical and electrical methods of mounting and controlling optical systems.

## WORK NOT COVERED

This standard does not cover work primarily involving:

- Blocking, grinding, etching, polishing, coating, cementing, silvering, assembling, and inspecting optical glass for use in optical instruments. (See [Lens and Crystal Work Family, 4000](#)).
- Troubleshooting, overhauling, modifying, repairing, aligning and calibrating mechanical and electromechanical instruments and instrument systems. (See [Instrument Mechanic Series, 3359](#)).
- Planning and fabricating prototype optical instruments in support of scientific, engineering, or medical research personnel. (See [Instrument Maker Series, 3314](#).)

## TITLES

Jobs graded by this standard at Grade 10 and above are to be titled *Optical Instrument Repairer*.

Jobs graded by this standard below Grade 10 (other than Helper and Intermediate jobs) are to be titled *Optical Instrument Worker*.

## GRADE LEVELS

This standard does not describe all possible grade levels for this occupation. If jobs differ substantially from the skill, knowledge, and other work requirements described for the jobs in the standard, they must be graded at levels other than those described, based on the application of sound job grading methods.

## HELPER AND INTERMEDIATE JOBS

Helper and intermediate optical instrument repairer jobs are covered by [Job Grading Standards for Trades Helper](#) and [Intermediate Jobs](#). (Grade 10 in this standard is to be used as the Journey level in applying the Intermediate Job Grading Table.)

The Grade 8 level in this standard covers continuing jobs that involve the more routine maintenance and repair tasks. It is not descriptive of jobs that are part of a planned program of training and development of skills for advancement to a higher grade; such jobs are covered by the job grading standard for Intermediate Jobs.

## OPTICAL INSTRUMENT WORKER, GRADE 8

*Duties:* The optical instrument worker does the more routine repair and adjustment. The worker checks, overhauls, repairs, collimates, and tests such optical equipment as marine sextants, wide-angle observation periscopes, theodolites, compasses binoculars, straight tube and elbow telescopes, and individual lens/prism assemblies of more complex instruments. Using well-proven methods and procedures the worker:

- Disassembles the equipment. Inspects such parts as gears and drives for broken and worn parts; shafts for play, binding and catching; and glass for leaks. Replaces broken or worn parts. Adds or removes shims to obtain proper clearances.
- Checks prisms, filters, and lenses for broken or chipped edges and silvering. Inspects chamber bubbles of leveling devices to insure proper reducing and enlarging. Makes circuit tests of auxiliary systems and replaces such defective parts as wiring, switches, and rheostats of illuminating circuits. Cleans optical glass elements with swab of lens paper wrapped around stick and saturated with acetone or alcohol. Overhauls mechanical elements such as mounts and shutters, adjusting eccentricity of azimuth or altitude scales, and replacing worn parts. Overhauls and fills various types of cells and bubble assemblies. Inspects fit of bearings using micrometers and adjusts or replaces them.
- Sets up collimators, attaching test fixtures and using transits to zero collimator tubes in accordance with specific procedures. Inspects trails of equipment on collimating tubes and adjusts prisms to correct trails. Adjusts arcs of scales to proper readings by adjusting rods, arms, worms, or sector gears. Overhauls, collimates, and focuses lens systems of repaired items and correlates with mechanical movements, shimming, scraping, or otherwise adjusting parts to bring them within prescribed tolerances.
- May perform related duties such as: Overhaul, repair, troubleshoot, and adjust liquid filled compasses. Cement and coat optical lenses. Test photographic and visual optics for resolution powers, aberrations, focal distances, and deviation of prism angles.

*Skill and Knowledge:*

- Ability to overhaul, repair, collimate, and test optical equipment such as the examples above, containing primarily optical and mechanical components, characterized by few adjustments and little interaction between the various components which would complicate alignment or calibration procedures.
- Ability to test and make troubleshooting analyses of equipment, such as checking for alignment of binocular optical paths and determining corrective adjustments or locating fogged prisms caused by defective optical cement.
- Knowledge and application of basic optical theory and the theory of mechanical motion and gearing in the fitting, focusing, and collimating of optical and mechanical components and the use of test instruments such as collimating test stands.
- Ability to understand and apply instructions and specifications which explain the precise steps and procedures to be performed. Ability to interpret blueprints and diagrams of uncomplicated optical paths and mechanical linkages.
- Ability to use the hand and power tools common to an optical shop, and measuring instruments such as calipers and micrometers in order to fit parts and make mechanical adjustments. Ability to use collimators to optically align assemblies such as right-angle eye pieces, reticle groups, or complete units such as telescopes.
- Ability to apply visual-motor skills in repairing, adjusting, collimating, and aligning uncomplicated optical equipment with use of general and specialized test devices and hand tools.

*Responsibility:* Work is assigned through work orders and oral instructions from a supervisor. The supervisor spot checks work in progress and completed work for acceptability. Judgments and decisions are guided by detailed technical specifications and well established shop practices. Receives assistance from supervisor or higher grade employee when commonly used work practices or specifications do not cover the situation.

*Physical Effort:* Normally works with small, light items not in excess of 5 kilograms (10 pounds), but occasionally handles items which weigh up to 18 kilograms (40 pounds). Works in sitting position for extended periods of time. Occasional assignments involve standing, bending, and stooping in cramped or awkward positions. Close eye and hand coordination is required in fitting and repairing parts.

*Working Conditions:* Work is performed in well-lighted, heated, and ventilated areas. May be required to work in clean room conditions where special clean room garments including head coverings, shoe coverings, and gloves are required. Subject to cuts and bruises, and abrasions from operating hand and power tools. May occasionally be required to perform some tasks outside, normally in good weather.

## OPTICAL INSTRUMENT REPAIR, GRADE 10

*Duties:* The Grade 10 optical instrument repairer tests, adjusts, troubleshoots, modifies, aligns, and repairs a wide variety of optical devices, subassemblies and components. Typical assignments deal with the optical systems and supporting mechanical and electrical systems of equipment such as astrotrackers, autocollimators, target acquisition, fire control, and infrared night vision devices.

The repairer:

- Examines equipment to determine sensitivity and accuracy of light transmission, electrical servo controls and readouts, optical and mechanical alignment, etc. Pinpoints malfunctions of equipment by functional tests. Determines when degradation of lenses, prisms, mirrors, and other elements requires repair or replacement.
- Disassembles optical systems. Cleans, cements, and mounts lens and prism elements. Collimates lens systems and makes necessary alignments and measurements. Performs diopter, field flatness, resolution, and other tests as required. Assembles, adjusts, and tests reticle assemblies and components. Reassembles and purges lens systems and performs leak and fog (immersion) tests. Finishes tests and corrects optical elements to meet specification requirements using optical flats, test plates, interferometer, collimators, and other equipment as required.
- Repairs mechanical elements. Uses special fixtures and dial indicators to test elements for alignment, parallelism, and concentricity. Adjusts gears for minimum backlash and striction. Tests striction to insure gear starting and running voltages are within specifications. Attaches shutters, filters, and similar auxiliary units. Manually operates assemblies to determine by observations and feel whether equipment has proper freedom of travel.
- Repairs electrical controls and assemblies. Tests motors, brakes, servos, synchros, resolvers, and rate generators for resistance and continuity. Checks and adjusts phase relationships of synchros and servos of electrical controls and readouts. Peaks output of photo tubes and electrical amplifiers.

The optical equipment repairer may perform related duties such as removing or installing and checking optical equipment in aircraft, ships, or other user locations.

### *Skill and Knowledge:*

- Ability to test, overhaul, repair, align, and collimate a variety of complex optical equipment, containing a number of optical, mechanical, and electrical systems. For example:  
  
Remove astrotracker telescope. Test prism mounts for elevation accuracy using collimators and simulators.

Make alignment and focus adjustments. Mount telescope on test fixtures, attach and align reticles, and test altitude and bearing accuracy. Repair mechanical mounts and gear drives and electrical control and indicating servos and synchros. Align them to meet established operating specifications.

- Ability to trace and correct malfunctions of complex equipment composed of optical, mechanical, and electrical units, such as infrared telescopes, where it is necessary to determine first if the malfunction is in the optical, mechanical, or electrical portion, then locate the problem. Characteristic of equipment of this complexity are optical, mechanical, or electrical systems which are self-contained so that troubleshooting is not complicated by feedback of error information from the defective systems into other systems being checked.
- Ability to apply visual-motor skills to make precise adjustments to complex equipment such as adjusting the optical and mechanical elements in a panoramic periscope where very close alignment is needed, especially from the upper right angle prism through the rotating prism to the lower prism in order to minimize distortion and assure accurate positioning of the image at any azimuth.
- Ability to apply knowledge of optical theory and construction principles to a wide variety of complex optical equipment, in order to disassemble, inspect parts, and determine whether repairs or replacements should be made; repair and/or replace parts; reassemble them, calibrating, collimating, and adjusting by use of necessary hand and power tools and test equipment. Knowledge of standard shop practices for work on servomechanisms and other electrical controls and indicators as well as complicated lens and prism assemblies and mechanical mounts and controls.
- Ability to use a variety of processing, measuring, and testing equipment such as spectrometer, optical lens bench, autocollimator, transit, interferometer, optical flats, and blocking and grinding tools. Ability to make all adjustments on complex, well-proven equipment to operating tolerances, including mounting complete units and synchronizing mechanical and electrical servo control and readout units.
- Ability to interpret and apply technical manuals, blueprints and work orders, on his own, in making repairs, in collimating, and in calibrating a variety of complex optical equipment such as metasopes, panoramic periscopes, and astrotrackers.

*Responsibility:* A supervisor or leader assigns work orally or through work orders. The repairer selects tools, decides on methods and techniques to use, and carries out work from start to finish with little check during progress. Independently determines the nature of the trouble and extent of repair required. However, technical advice and assistance are available on unusual or very difficult problems.

Utilizes and follows technical manuals, blueprints, sketches, and work orders in performing the work. Occasionally encounters problems which require the repairer to modify guidelines and standard practices in order to obtain necessary tolerances, required test results, and compatibility of related working parts. Must exercise care when performing assigned duties so as not to damage delicate parts and materials. Final work product is reviewed for compliance with trade practices, directives, and operating 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](#).

## OPTICAL INSTRUMENT REPAIRER, GRADE 11

*Duties:* The Grade 11 Optical Instrument Repairer tests, adjusts, troubleshoots, modifies, aligns, and repairs the most complex optical devices such as stereoscopic and coincidence rangerfinders, submarine periscopes, optical tracking cinetheodolites, and available light night vision instruments. The optical devices repaired are characterized by optical and mechanical, electrical, or electronic systems with interrelated functions so that the repairer must deal with all aspects of the integrated assembly to successfully complete work on any of the components. In addition, many of the devices repaired, modified, and aligned are atypical i.e., they are prototype devices or are of such complexity and accuracy that the major components are custom fitted to each other to cancel inherent errors. As a result, repair and calibration procedures may be unavailable or of only general applicability and the repairer must develop and evaluate the detailed procedures and techniques to use on the specific unit.

The repairer:

- Performs independently the troubleshooting, testing, repairing, collimating, and calibrating of the most complex optical devices, such as examples above. Plans the complete jobs. Determines and orders necessary replacement parts. Develops step-by-step overhaul procedures substituting locally available test equipment and standards for those called for in published procedures.
- When repairing one-of-a-kind or obsolescent equipment, devises modifications to standard parts to fit the system or plans and fabricates replacement parts.
- Visits user locations to provide assistance such as on-the-spot modification or troubleshooting and repair of malfunctions. The repairer may perform related duties such as installing periscopes and aligning flexure systems of submarines; installing and synchronizing rangerfinders, gun sights and other optical devices in turrets and aligning them with the guns; or acceptance testing new optical/photographic equipment, instrumenting the setups, and operating the equipment to provide data.

*Skill and Knowledge:*

- Ability to repair, align, and adjust the most complex optical equipment, for example: Equipment using advanced technology such as starlight scopes where electronic, optical and mechanical systems have a very close interface and all systems must be operating precisely to specifications in order to achieve satisfactory operation of the unit; or equipment such as submarine periscopes where the optical systems perform multiple operations such as various combinations of navigation, range finding, infrared scanning, or fire control. Some positions may require ability to perform the repairs needed by special purpose, modified, or obsolescent equipment for which blueprints and technical data are inaccurate and incomplete and replacement parts must be modified or constructed, based on practical knowledge of the requirements of optical systems.
- Ability to apply broad practical knowledge of optical equipment theory and repair practices to the most complex optical devices, including knowledge of electrical and electronic applications to optical equipment, in order to repair interrelated systems where satisfactory performance is obtained only by simultaneous adjustments in, for example, optical and electronic or optical, mechanical, and electrical systems of the device; or in order to devise and evaluate detailed changes to approved repair procedures and techniques which are needed due to lack of repair parts, changed test equipment, or introduction of modified equipment without complete documentation.
- Ability to interpret technical manuals, blueprints, sketches, and work orders in locating answers for complicated mechanical, electrical, and optical problems in the most complex equipment such as rangefinders, optical tracking cinetheodolites, or prototype or special purpose devices for which there are no operating precedents at the activity since equipment is unfamiliar or greatly modified. Ability to develop modifications to guidelines and standard procedures to adapt to equipment or specification changes.
- Ability to independently use all usual types of optical measuring and testing equipment, electronic testing equipment such as oscilloscopes and VTVM, and special purpose collimators and test consoles to perform diversified work on the most complex devices or on unusual equipment where there is no work history or data available as guidelines. Ability to set up, perform, and interpret results of the work, on the basis of broad general experience in the use of similar tools and equipment.
- Ability to apply visual-motor skills to make extremely precise adjustments required by the most complex optical devices due to the multiplier effect of an extensive optical system and mechanical mounting and control systems, or requirement for absolute accuracy of alignment such as required by starlight scopes which need the maximum light and the most accurate image possible in the optical stages in order to amplify and present an intelligible output image from the electronic stages.

Ability to trace and correct malfunctions in the most complex equipment such as rangerfinders or submarine periscopes where troubleshooting is made difficult due to the extensive optical systems performing multiple functions which are interrelated since they use many components in common, or available light night vision devices where optical and electronic systems are interrelated and malfunctions may result from the sum of a number of minor deficiencies in both areas rather than one or two more easily identifiable defects.

*Responsibility:* Receives assignments in the form of work orders and oral discussions. Works in accordance with available drawings, technical orders, or mission specifications. Independently solves problems which require modification of guidelines and standard practices. Is responsible for knowing and judging the effects that changes and adjustments will have on the related integral devices of the optical instrument and assuring that the completed instruments are aligned and functioning properly.

Completed work is subject to spot check for compliance with trade practices. Supervisor provides technical assistance and advice on unusually difficult problems.

*Physical Effort:* Physical effort is the same as that described at the [Grade 8 level](#).

*Working Conditions:* Working conditions at this grade are the same as those described at the [Grade 8 level](#).