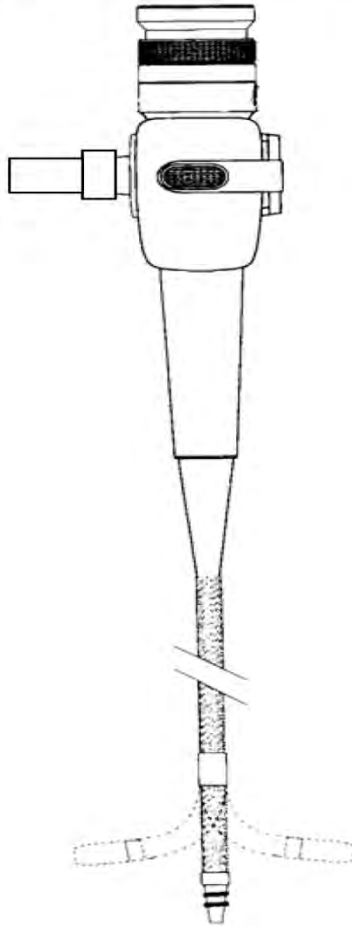


INDUSTRIAL BORESCOPE

Operator's Guide





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Introduction

Thank you for purchasing a Hawkeye Blue Flexible Borescope. We value your business and appreciate you choosing us as your remote visual inspection provider.

Gradient Lens Corporation's mission is to address the special needs of industrial remote visual inspection users. We want to be ***YOUR EYE INSIDE***. Headquarters are in Rochester, New York.

Our family of Hawkeye Blue Flexible Borescopes includes articulating models ranging in diameter from 2.5mm to 8.0mm. Where possible, image guides incorporate ultra-thin fiber technology, to provide the highest quality imaging and use wear resistant metallic outer braids for increased durability.

By following the use and care instruction in this guide, you will be rewarded with years of dependable, trouble-free service. Please read these instructions completely before use.



Warnings and Precautions

The following precautions will help you to use your Hawkeye Blue flexible borescope safely and prolong its life.

Do not bend or twist the articulating section at the end of the insertion tube by hand. Always use the articulation controls to move the tip.

Whenever inserting or withdrawing the Hawkeye Blue flexible borescope, first adjust the articulation controls to the relaxed neutral position to straighten the tip. Ensure the articulation lock is released, so the tip is free to bend as needed.

Never apply excessive force when inserting or withdrawing the Hawkeye Blue flexible borescope. The flexible bending section is vulnerable to tension and compression forces and may be damaged.

Never try to force articulation knobs beyond their mechanical stops.

Protect the Hawkeye Blue flexible borescope from unnecessary moisture, heat, dust and shock.

Never leave the Hawkeye Blue flexible borescope unattended when it is connected to an operating light source.

Do not leave the Hawkeye Blue flexible borescope connected to an operating light source for extended periods of non-inspection time.

Never use the instrument to observe within a human or animal body.

Never insert the Hawkeye Blue flexible borescope into areas of live voltage.

Use only recommended accessories; other components may lead to unpredictable performance.

System Description

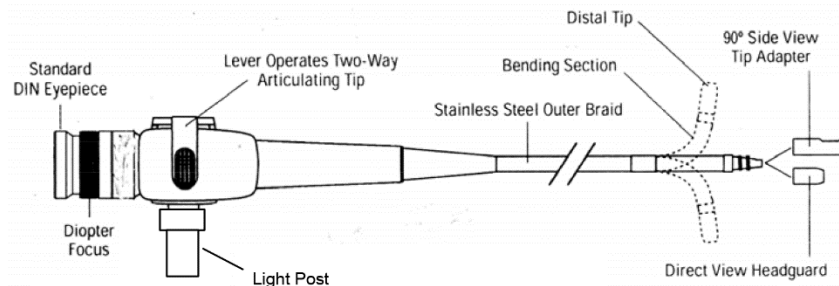
Generally speaking, Hawkeye Blue flexible borescopes consist of two separate and different fiberoptic bundles running through a protective insertion tube that has viewing optics on the distal end and an eyepiece on the other. One fiber bundle is designed to carry light to the viewing tip and is called the *Illumination Bundle*. In most cases a *Light Guide* is used to carry light from the *Light Source* to the Hawkeye Blue flexible borescope, the NOVA light sources can be directly connected for portable operation. The other fiber bundle is designed to carry an image from the viewing tip to the eyepiece and is called the *Imaging Bundle* or *Image Guide*. One end of each bundle terminates in the distal tip with the purpose of illuminating and capturing an image, while the opposite ends terminate separately, the Imaging Bundle near the eyepiece and the Illumination Bundle in the light guide connector. Imaging performance is primarily dependent on the quality of the imaging bundle fibers, eyepiece and objective lens sets.

Below is a description of the functional components of the Hawkeye Blue Flexible borescopes.

Imaging System

The imaging system includes the eyepiece optics, the fiberoptic imaging bundle, and the objective lens set at the distal tip.

The eyepiece magnifies the image carried back by the imaging bundle for viewing by the human eye. On most models the eyepiece includes a diopter focus adjustment so different



users can adjust the lens set to their particular vision prescription and use the Hawkeye Blue flexible borescope without glasses. All Hawkeye Blue Flexible borescope eyepieces are of standard DIN design and therefore compatible with standard eyepiece attachments such as camera couplers.

The imaging bundle is a continuous strand of flexible glass fibers that carry the image from the distal tip back to the eyepiece. The high-resolution image of the Hawkeye Blue Flexible borescopes is due primarily to the extremely small diameter and high light transmission efficiency of our imaging fibers.

The distal lens set is a combination of precision micro lenses that capture images and focus them into the small imaging bundle. Many Hawkeye Blue Flexible borescope models are equipped with a special distal section that accepts an additional lens set that changes the direction of view from forward to side. This side view tip adapter enables the same scope to be used as either a forward viewing scope or side viewing scope. A direct, forward viewing tip is provided with the Hawkeye Blue flexible borescope. The side-viewing tip is available as an optional accessory on 4mm diameter and larger models.



Illumination System

Hawkeye Blue flexible borescope models use an internal fiberoptic bundle up to the scope body and then connect to an external light guide that extends to the light source. This design allows the Hawkeye Blue flexible borescopes to be used with any of Gradient Lens Corporation's NOVA or Luxxor light sources. Using the NOVA light provides a completely portable solution, preferred by many over being tied to a wall power source. For video viewing, the Luxxor light source is usually required.

Articulation System

Articulation refers to the ability of the operator to "steer" the Hawkeye Blue flexible borescope tip. Hawkeye Blue Flexible borescopes are either 4-way articulating with a set of knob controls, 2-way articulating with a lever control, or non-articulating.

Articulation is accomplished by a set of steel cables that extend from the distal section back to the scope body, and an articulating collar assembly in the bending section. The cables push and pull the articulating collars together or apart in order to "steer" the viewing tip in a desired direction. The operator uses the knob or lever control on the scope body to push and pull the right cables. Both articulation controls devices include a locking mechanism should the operator want the tip to stay where pointed instead of returning toward the neutral forward direction.

Flexible Borescope Handpiece

The handpiece, or body, is the control section of the Hawkeye Blue flexible borescope and is designed to facilitate one hand operation of the articulation controls while looking in the Eyepiece. This leaves the operator's other hand free to push, pull and rotate the flexible insertion tube. Both hands work together to position the distal section and point the viewing tip toward the area to be inspected.

Insertion Tube

The insertion tube is most of the working length of the Hawkeye Blue flexible borescope and is constructed to be durable and flexible at the same time. Its flexibility allows it to be snaked through equipment bends in order to get to areas not accessible by rigid Borescopes or other inspection instruments. Its durable construction protects the optical fiber bundles and houses the articulation cables. All models have a stainless steel mono-coil at their center for resistance to accidental crushing, and most incorporate a steel/Tungsten outer braid to resist damage while sliding over harsh surfaces.

Bending Section

The bending, or articulation, section connects the insertion tube to the distal viewing section and houses the articulating collar assembly. This is most flexible part of the scope, allowing the tip to be pointed in almost any direction. Its need for flexibility however makes it the most vulnerable part of the scope, and it cannot tolerate the same rough handling as the insertion tube. Its steel/Tungsten outer braid does provide protection from sliding over rough surfaces.

Distal Section

The distal section houses the termination points of both the illumination fiber bundle and imaging bundle. The distal section also contains the precision micro lenses that focus images into the imaging bundle. All of these components are positioned in the careful orientation so as to provide the highest possible imaging performance. Scope models are available with forward viewing tips, side viewing tips, and interchangeable tips that use both forward and side viewing tip adapters.



SYSTEM SET-UP

Setup consists only of installing the desired tip adapter (for models Equipped for interchangeable tips), focusing the eyepiece to your eye, making a few checks to ensure the Hawkeye Blue flexible borescope is operating properly, and attaching a light source or light guide to the light post.

To Change the Tip Adapter

1. Unscrew the tip until it clears both sets of threads. Store in tip adapter case.
2. Screw on the new tip until it completely clears the first set of threads.
3. Rotate the tip on the scope until the keyed flat finds the flat on the scope Distal section.
4. Slide the tip down to the second set of threads and screw on until finger tight.

DO NOT USE ANY TOOLS OTHER THAN YOUR HAND TO TIGHTEN THE TIP OR DAMAGE MAY RESULT!

Focus the Eyepiece

To focus the eyepiece optics for your eye, simply rotate the focus knob while looking into the eyepiece. The viewing tip of the Hawkeye Blue flexible borescope should be pointed at a small object with sharply defined edges. Typed text on white paper is a recommended target for this adjustment.

Check Operation

Before using the Hawkeye Blue flexible borescope it is a good practice to check for any visible damage as well as operation of the tip articulation and clarity of the image. Look for any sign of penetration or crushing of the insertion tube, bending neck or distal section that might indicate damage to the imaging system, or other damage that might compromise performance. Check for adequate tip articulation by rotating the control knobs or moving the control lever. Look through the eyepiece to ensure the Hawkeye Blue flexible borescope is providing a good image (connect light guide to a light source for this check). If damage is found or performance inadequate, return the scope to the Service Center for evaluation and repair.

Plug Into a Light Source:

Insert the light guide connector into the light guide socket of a Gradient Lens Corporation Luxxor, NOVA or other compatible light source. Turn the light source on, wait about 30 seconds for the lamp to reach peak intensity, and check to ensure a bright light is projected from the viewing tip of the Hawkeye Blue flexible borescope. The Hawkeye Blue flexible borescope is now ready to use.



User Care & Maintenance

User maintenance on a Hawkeye Blue flexible borescope can be summed up in two parts: Keeping the scope clean, and storing it properly when not being used. Care of the Hawkeye Blue flexible borescope during use is also important and will affect frequency of repair.

Cleaning the Hawkeye Blue Flexible Borescope:

After each use, clean and dry the Hawkeye Blue flexible borescope to prevent corrosion and long-term exposure to residue materials.

1. Clean the insertion tube with soapy water, then rinse and dry.
2. Clean the glass surfaces in the viewing tip, light guide connector and eyepiece with a soft cloth and an alcohol/water solution. Common household glass cleaners will work as well (Windex, etc.)
3. Clean the Hawkeye Blue flexible borescope body with a damp cloth. Do Not Immerse the Body in water, IT IS NOT WATERTIGHT.

Packing and Storing the Hawkeye Blue flexible borescope:

When Packing the Hawkeye Blue flexible borescope, take care to:

- Ensure all articulation locks are released
- If equipped with a detachable tip adapter, secure in its protective case
- Secure entire scope length in storage cut-out before closing case lid
- If stored outside of case, do not coil the tube in a smaller diameter than is designed into case storage section

CAUTION! *Do not let case lid fall on insertion tube!*

Store the system in its carrying case away from water, high humidity, high temperature, direct sunlight, dust, salinity, chemicals, x-rays, vibration and shock.

User Tips for longer scope life

Do not move or twist the bending section at the end of the insertion tube by hand

When inserting or withdrawing the scope, articulate the tip to the relaxed forward position and ensure the friction lock is released.

Never apply excessive force when inserting or withdrawing the tube. The tip may be caught, and strong tensile force can damage the bending neck.

Do not let case lid fall on insertion tube.

Do not run over the insertion tube with cart or vehicle wheels.

Never try to force articulation knobs beyond the mechanical stops.

Protect the borescope from unnecessary moisture, heat dust and shock.

Do not leave the borescope connected to an operating light source for long periods of non-inspection time.

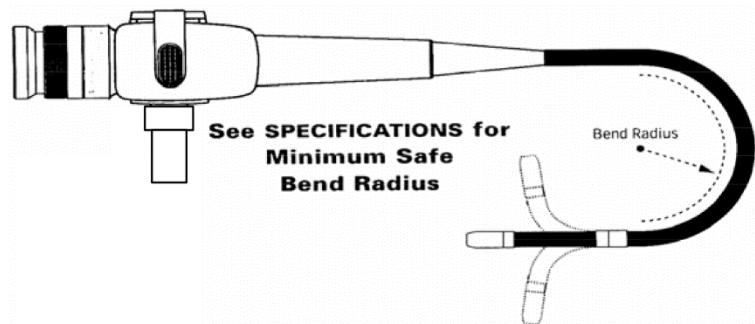
Clean the flexible borescope after every use.

Operating the Flexible Borescope

To effectively perform a Hawkeye Blue flexible borescope inspection, you must be familiar with the internal design of the equipment you are inspecting and also be familiar with the operation of the Hawkeye Blue flexible borescope. Inside the equipment your vision will be limited, so you must be able to visualize the location of the Hawkeye Blue flexible borescope and its orientation to the area to be inspected.

Holding the Hawkeye Blue Flexible Borescope:

Hold the Hawkeye Blue flexible borescope body in one hand in a way that is comfortable and allows you to both look into the eyepiece and actuate the articulation control. Use the other hand to hold the insertion tube and guide it toward the inspection area. Be sure not to bend the insertion tube or bending section in a tighter bend radius than noted in the specifications. This will cause damage to the imaging and illumination fibers.



Inserting the Hawkeye Blue Flexible Borescope:

Before inserting the Hawkeye Blue flexible borescope into equipment, ensure that the bending section is straight and the articulation lock is not engaged. The tip should move freely when the articulation controls are moved. With the tip in the forward neutral position, slowly begin to insert the scope into the equipment. Look into the eyepiece to see where the scope is pointed as you guide the tip to the inspection area. If a bend must be negotiated, articulate the tip in the direction of the bend so as to keep the tip from buckling. If the scope is hindered while maneuvering around objects or bends, rotate the tube back and forth while moving it forward. This kind of movement helps to overcome snags on equipment edges. Continue guiding the scope forward until the target area is visible in the eyepiece.

Withdrawing the Hawkeye Blue Flexible Borescope

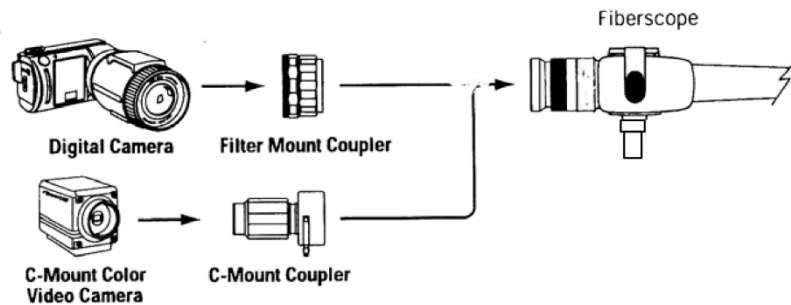
When the inspection is completed, carefully withdraw the Hawkeye Blue flexible borescope. *Be sure to release all articulation locks prior to withdrawal in order to prevent damage to the articulation system.* Move the articulation controls back and forth to ensure they are in the loose neutral position and the tip is free to bend as needed during withdrawal. Pull out the scope slowly, and be ready to catch the viewing tip when it exits to prevent slapping and possible damage to the tip optics. If the scope snags on equipment edges, try rotating the tube back and forth.

Using Cameras with the Hawkeye Blue Flexible Borescope

Borescope video cameras and digital cameras can be used with Hawkeye Blue flexible borescopes to document inspection images on videotape or digital camera storage devices. Speak with your Gradient Lens Corporation Sales Representative to determine which is best for you. Each requires an optical coupler to attach the camera to the Hawkeye Blue flexible borescope eyepiece. The right coupler depends on the camera being used.

Borescope Video Cameras usually have a standard “c-mount” fitting which requires a c-mount coupler. These couplers can have different focal lengths, which determine the screen magnification of the Hawkeye Blue flexible borescope image, which in turn can impact image brightness. The right coupler will depend on the diameter scope being used and the available light on the target surface. You may want to have more than one of these couplers to optimize performance on each inspection.

Digital Cameras must have a similar lens thread in order to be used with Hawkeye Blue flexible borescopes. Have the thread diameter available when selecting the threaded coupler.



See the User Guides for the Hawkeye Video Camera and Digital Camera for more information about using these to document your inspections.



Troubleshooting

The following troubleshooting hints should help you to solve some performance problems on site. If a problem is not solved using these suggestions, call the Service Center at the number listed under the SERVICE section and arrange to return your Hawkeye Blue flexible borescope for evaluation and repair. **NEVER attempt to disassemble the Hawkeye Blue flexible borescope.**

If Image Is Not Clear and Sharp...

- Object may be out of focus. Try adjusting eyepiece diopter focus or moving the viewing tip further or closer to the object.
- If using a detachable tip adapter, the tip may not be properly attached. Detach tip adapter and reinstall.
- Lenses or glass windows may be dirty. Clean glass surfaces on viewing tip and eyepiece with alcohol and cotton swab (or soft cloth). Also clean detachable tips if being used.
- Light may be insufficient. Increase light source intensity or move viewing tip closer to object. Clean tip of light guide connector.
- If using a c-mount camera, and Moiré fringes appear (patterns of curved line distortion), try rotating the camera slightly with respect to the eyepiece.

If Articulation is Difficult

- Articulation locks may be fully or partially engaged. Release locks.
- Articulation cable movement may be hindered by bends in the insertion tube. Keep tube as straight as possible during inspection.
- Viewing tip movement may be blocked due to its position inside equipment. Try to reposition tip by rotating tube or moving tip forward or backward.
- **Do Not Apply Excessive Force** on articulation controls!

If Image Is Not Bright Enough...

- Light source intensity may be at a low setting. Turn to maximum intensity.
- Viewing tip may be too far from object. Move tip closer to object.
- If using a detachable tip adapter, the tip may not be properly attached. Detach tip adapter and reinstall.
- Lenses or glass windows may be dirty. Clean glass surfaces on viewing tip, light guide connector and eyepiece with alcohol and cotton swab (or soft cloth). Also clean detachable tips if being used.
- Light source lamp may have degraded performance. Install new lamp.
- Light source capacity may be insufficient for application. Try higher intensity light source.



SYSTEM SPECIFICATIONS

OPTICAL

Direction of View -Fixed Direct, Fixed Side, or Direct with Side View Tip Adapter

Field of View

| | |
|----------------------------|-----------------|
| Fixed Direct View Models | 45°, 60° or 90° |
| Fixed Side View Models | 45° |
| Interchangeable Tip Models | 45° |

Depth of Field

| | |
|----------------------|-------------------------|
| 2.5 mm dia. models | 3 mm (.118) to infinity |
| 3.3/4 mm dia. models | 5mm (.2in) to infinity |
| 5/6/8 mm dia. models | 8mm (.315) to infinity |

Distal Focus Fixed focus lens set

MECHANICAL

Tube Diameter Refer to Model Number (2.5,3.3, 4.0, 5.0, 6.0, 8.0, or 8.4mm)

Working Length Refer to Model Number

Insertion tube Bend Radius

| | |
|--------------------|--------|
| 2.5-6mm dia models | 1.25in |
| 8mm dia models | 1.5in |
| 13.6mm dia models | 2.0in |

Articulation

| | |
|----------------------|-------------------------------|
| 2.5mm dia models | 120° Up/Down |
| 3.2-6.0mm dia models | 120° Up/Down |
| 8.0mm + dia models | 120° Up/Down; 120° Right/Left |

Tube Construction Stainless steel monocoil inside watertight PVC and stainless steel braid (Tungsten braid optional).

ENVIRONMENTAL

Operating temperature 0° to 170° F (-18° to 77° C)

Watertight insertion tube up to 1 atm/1 bar (14.7psig); approx. 30ft water depth.

NOTE: The **handpiece** is splash proof only.

Fluid resistance (insertion tube) Water, 5% salt water. Selected scopes are resistant to; aviation fuel, gasoline, machine oil hydraulic fluids. Contact your Sales Representative for more information.



Warranty

Gradient Lens Corporation warrants the Hawkeye Blue Flexible Borescopes to be free of defects in material and workmanship and to perform in accordance with the manufacture's specifications when subject to normal use and service for a period of one year from the date of purchase. Gradient Lens Corporation will either repair or replace components found to be defective or at variance from the manufacture's specifications within this time at no cost to the customer. It shall be the purchaser's responsibility to return the instrument to the authorized service center.

This warranty does not cover breakage or failure due to tampering, misuse, neglect, accidents, improper installation, modification, shipping, or to improper maintenance, service and cleaning procedures. This warranty is also void if the instrument is not used in accordance with the manufacture's recommendations or if required service is performed by anyone other than a Gradient Lens Corporation authorized agent. No other express or implied warranty is given.

SERVICE

Should service of the equipment be required:

Call the Gradient Lens Corporation facility to obtain a return material authorization (RMA) and shipping directions.

Telephone: 585-235-2620

FAX: 585-235-6645

EMAIL: Service@GradientLens.com

Toll Free: 800-536-0790 (*in US only*)