AN/PSQ-20A
NIGHT VISION DEVICE (NVD)

TERMINAL LEARNING OBJECTIVE:

Action: Operate the NVD system.

Condition: Given student handouts, TM 11-5855-335-10, NVD system and taught in a classroom environment.

Standard: In accordance with this lesson material and TM 11-5855-335-10, students will demonstrate the skills taught to effectively operate the NVD system.

ADMINISTRATION

- Safety Requirements: General
- Specific Safety Hazards:
  - –Optical Material: The thermal lens contains a small amount of germanium. Do not touch, ingest, or inhale particles of a broken lens.
  - –Lithium Battery: May release flammable or noxious gas if crushed, punctured, or otherwise mutilated if brought into contact with water. Gas may cause a fire or injury to personnel.
- Risk Assessment: Low
- Environmental Considerations: It is the responsibility of all Soldiers and DA civilians to protect the environment from damage, IAW TC 3-34.489 Appendix A and FM 3-100.4, in all considerations during military operations.
- Evaluation: At the end of this lesson you will be required to take a 20 question written exam with a passing score of 14 or higher.

Agenda

- FUSED OPERATION
- CHARACTERISTICS
- PUT INTO OPERATION
- MOUNTING
- OPERATIONS IN ADVERSE CONDITIONS
- PMCS AND TROUBLESHOOTING
- PREPERATION FOR STORAGE

ELO A Fused Operation

ACTION: Discuss basic concepts of Fused Operation.

CONDITION: Given student handout(s) and taught in a classroom environment.

STANDARD: In accordance with the lesson materials, students will demonstrate a basic understanding of the principles of combining thermal and image intensifier imaging which influence image optimization for target detection and recognition.

Fused Operation

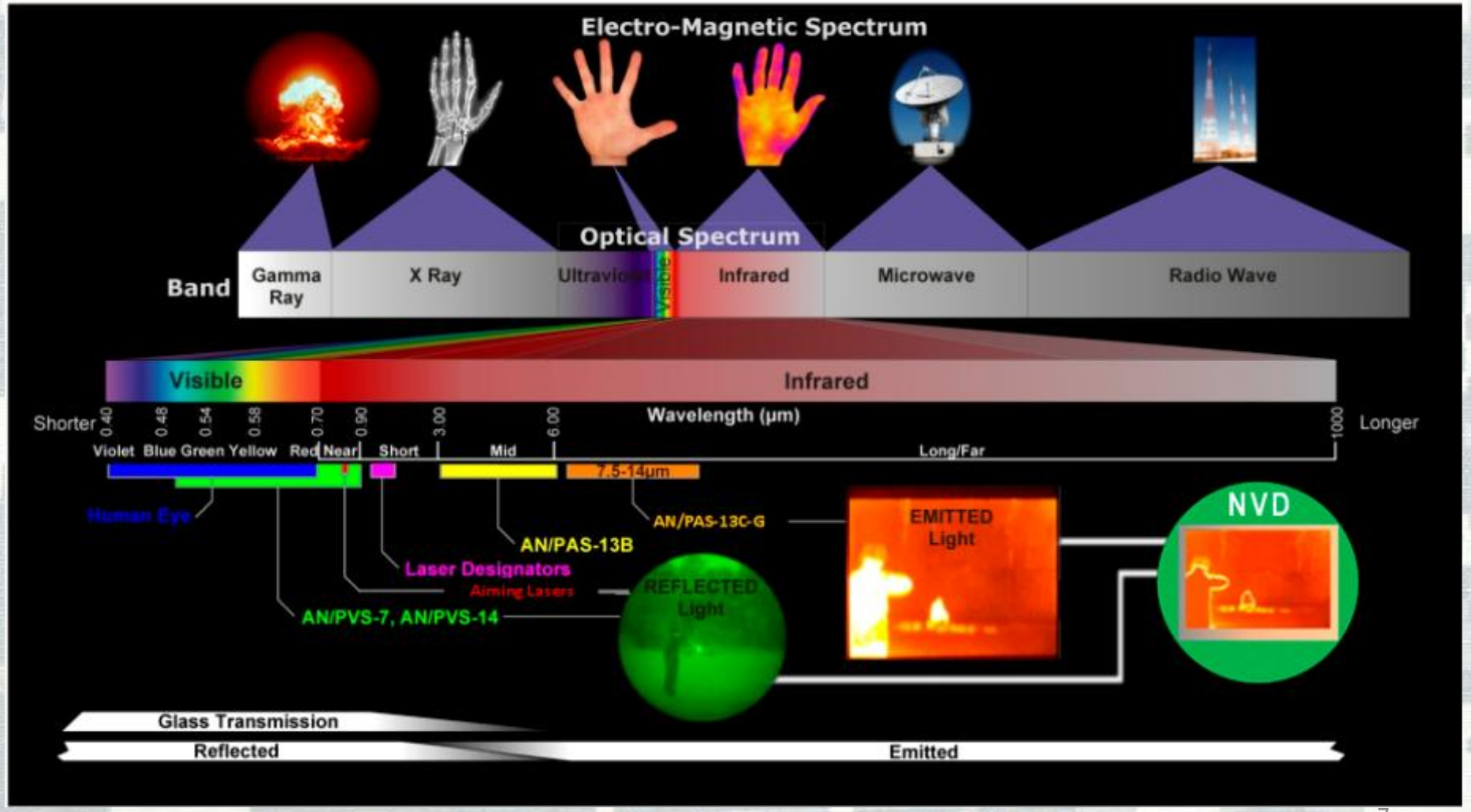
WHY A FUSED SYSTEM?

This Night Vision Device combines Thermal and I^2 technology to provide a fused image. It will give the following benefits to the soldier:

- Greater situational awareness
- Expanded viewing capability from daylight conditions to total darkness and through most battlefield obscurants such as fog and smoke
- Rapid cueing to dangers (Thermal) without losing the ability to see detail (I^2)
- No need for multiple devices

Fused Operation

Thermal Imaging Systems cannot "see" through glass

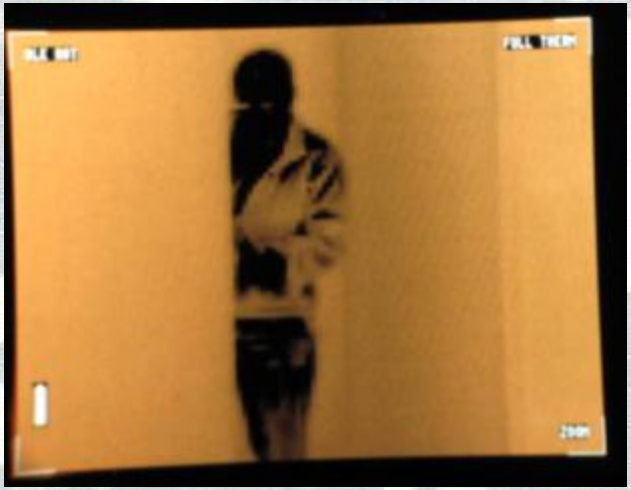


Fused Operation – I^2

The I^2 system collects, amplifies and displays reflected light in low light conditions. The I^2 system can be used with an illuminator for short-range scenes that might be at or near total darkness.

Fused Operation - Thermal

- The Thermal imaging system collects and displays the scenes thermal energy in white hot or black hot. Thermal works in all light conditions including daylight, total darkness, most smoke, fog, dust, haze and other conditions of limited visibility.



Fused Operation - Thermal

- **EXPOSURE - AMOUNT OF EXPOSURE to:**
  - **Radiation - Sun, human beings/animals**
  - **Conduction - Earths core, man made machinery**
  - **Convection - Wind (hot or cold)**

- **ABSORPTION - AMOUNT OF ENERGY ABSORBED DUE TO EXPOSURE**
  - **Some materials absorb the energy they are exposed to very well**
  - **Some materials reflect most of the energy they are exposed to**
  - **Exposure time directly affects the amount of energy absorbed**

- **EMISSIVITY - RATE AN OBJECT RELEASES ABSORBED ENERGY**
  - **Some objects emit absorbed energy slowly - low thermal signature**
  - **Some objects emit absorbed energy quickly – high thermal signature**

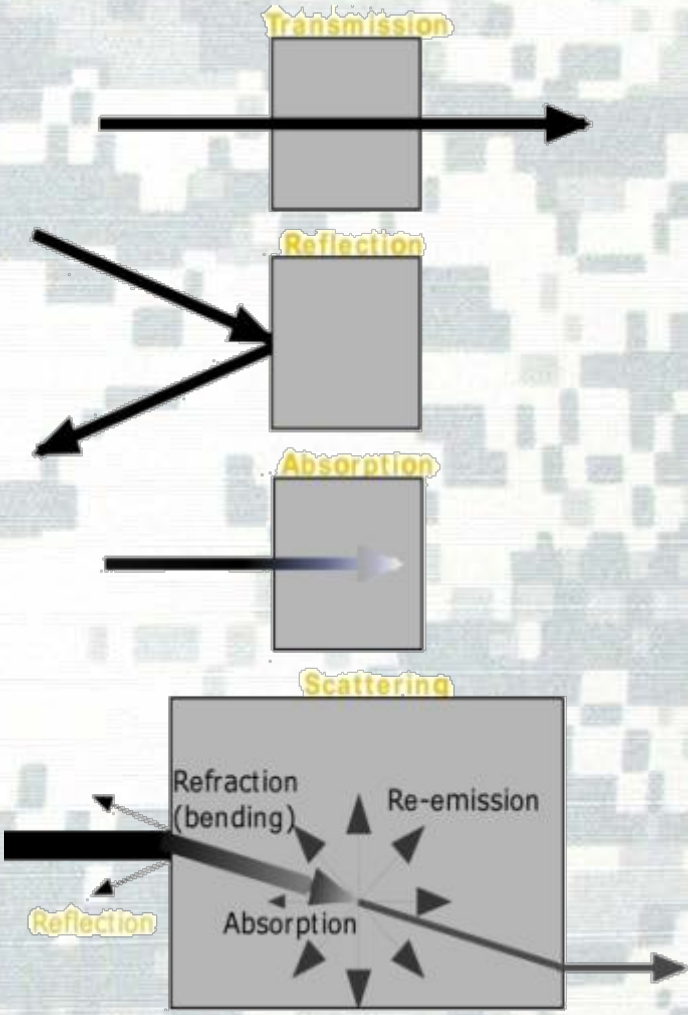
Absolute zero (-459.6° Fahrenheit) is the lowest possible temperature, at which point the atoms of a substance transmit no thermal energy - they are completely at rest.

All objects above absolute zero emit thermal

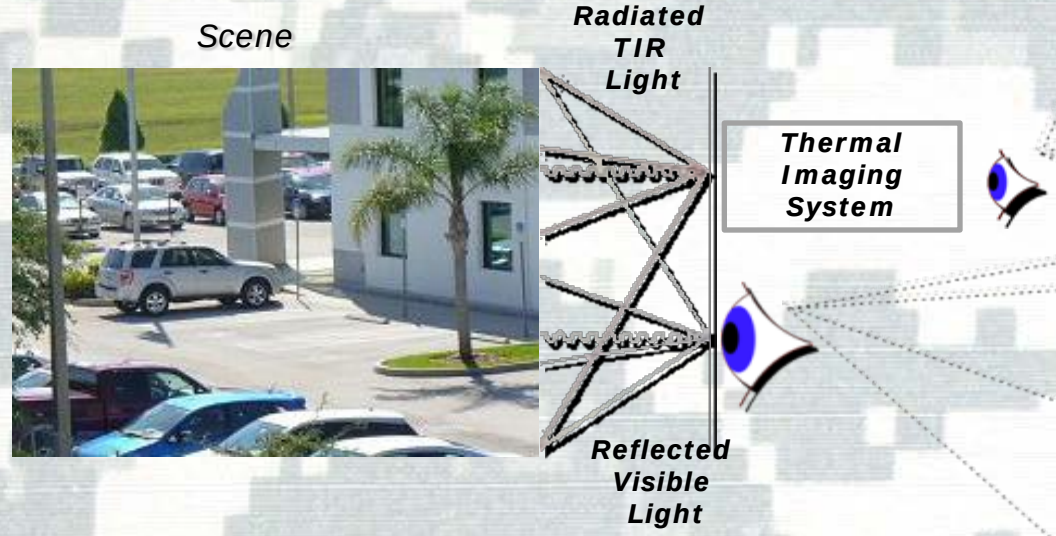
Fused Operation - Thermal

All matter (solid, gas, liquid) will exhibit, to varying degrees, the following properties when light shines on them:

- **Transmission**
  - **Degree to which light passes through a medium**
  - **Few good Thermal Infrared (TIR) transmitters, e.g. Germanium**
- **Reflection**
  - **Degree to which light bounces off of a medium**
  - **Good TIR reflectors include**
    - **Metals**
    - **Glass**
    - **Water**
- **Absorption**
  - **Degree to which light is absorbed by a medium**
  - **Many good TIR absorbers**
  - **<u>Water and Water vapor have greatest impact</u>**
  - **Smoke and Dust (dirty battlefield)**
- **Scattering**
  - **Light travels straight in a vacuum**
  - **Light traveling through or between mediums may be bent or deflected due to:**
    - **Reflection**
    - **Absorption & re-emission**
    - **Refraction (bending)**



Fused Operation - Thermal

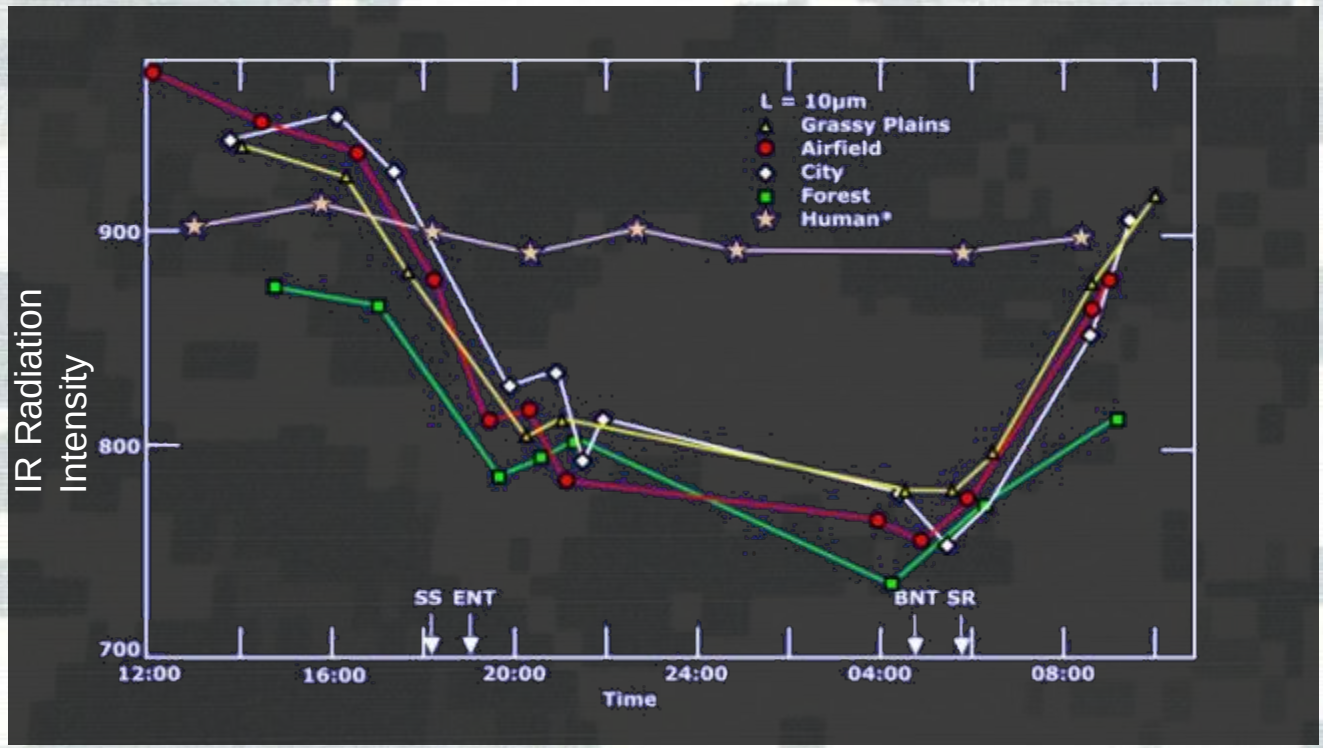


Visible Image

Thermal – receives TIR energy radiated from a scene and:

- Senses differences in apparent temperatures of the scene
- Converts the differences to a visible image

Fused Operation - Thermal



Diurnal TIR radiance variations
SS= Sunset, SR = Sunrise
ENT=end of nautical twilight, BNT=beginning of nautical twilight

- **Scene objects heat and cool at different rates throughout the day and year.**
- **As a result:**
  - **TIR scene contrast varies.**
  - **Scene objects relative temperatures may invert.**
- **Periods will exist in these cycles where minimal TIR contrast exists (crossover points).**

Fused Operation - Atmospheric Turbulence

Twinkling or shimmering (Mirage)

- Affects line-of-sight through air near heated surfaces (such as air above a road heated by sunlight).
- Affects stability and clarity of image (may cause image to appear to move or be unfocused).
- To avoid atmospheric turbulence move to a higher position or, if possible, wait for temperatures to cool.

Fused Operation - Signatures (1 of 2)

- Thermal imagers reveal temperature differences between objects and these differences lead to thermal cues
  - Engines burn fuel, produce heat of the vehicle and the nearby surroundings (ground)
  - Friction, produces heat and creates warm footprints and tire tracks
  - Shadows reduce sunlight absorption and can show recent presence of objects

Shiny = Poor emissivity!

Fused Operation - Signatures (2 of 2)

Suicide Vest – Thermal/Visible Images

Western Male w/PVC Pipe

Western Female w/Metal Pipe

Middle Eastern Female w/PVC Pipe

Fused Operation – Pros and Cons

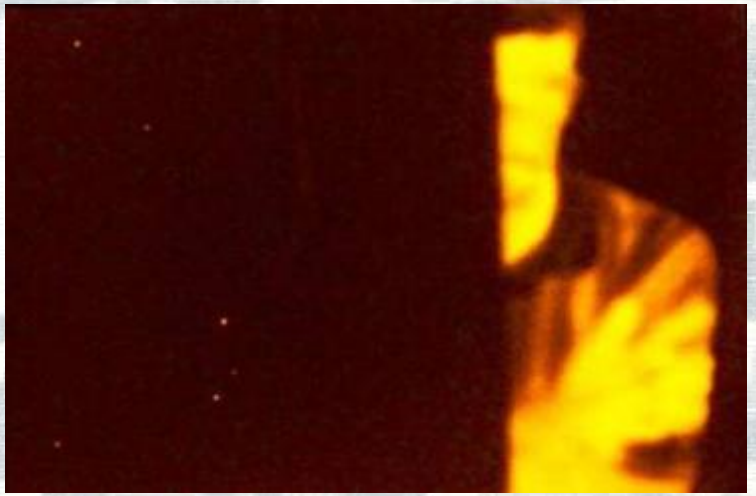
PROS AND CONS OF I^2 AND THERMAL

I^2

- Will see through glass
- Requires reflected light

THERMAL

- Will not see through glass
- Reflects the images on the near side of the glass (like a mirror)
- Does not require reflected light



Fused Operation

With the AN/PSQ-20

The images from I^2 or Thermal can be viewed independently or can be combined into a single, fused image.

Fused – I^2 and Thermal images are optically overlaid as a single displayed image.

I^2 Only

Fused

Thermal Only

Check on Learning

Q: What advantage's does image intensifier provide over thermal?
A: It can see through glass

Q: What advantage does Thermal have over Image Intensifier?
A: Can be used in total darkness?

Q: What's the advantage in having both I^2 and Thermal?
A: Provides for better situation awareness for any given area of interest in any condition.

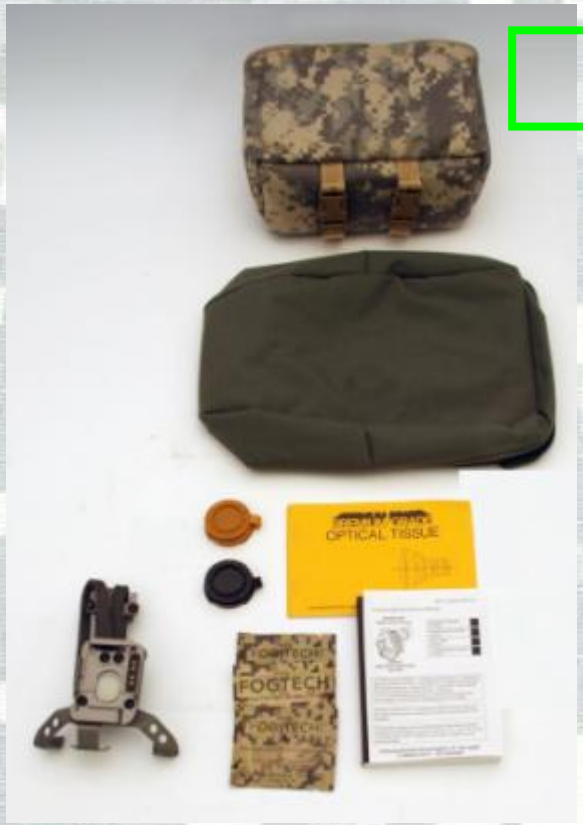
ENABLING LEARNING OBJECTIVE B

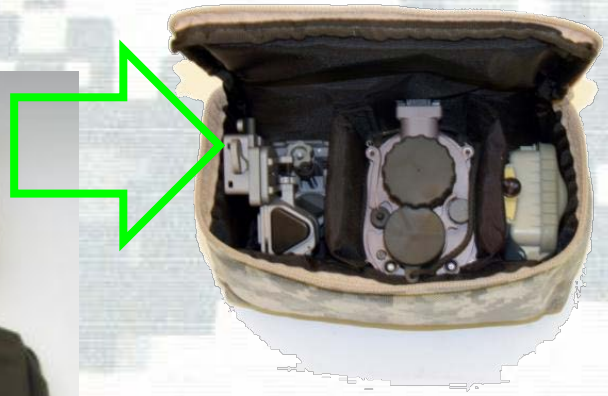
Action: Overview the characteristics of the NVD system.

Conditions: Given student handout(s) and taught in a classroom environment.

Standards: In accordance with the lesson materials, students will view the characteristics of the NVD system.

CHARACTERISTICS





In the Carrying Case you will have:

- NVD system
- Battery pack
- Helmet mount (Rhino)
- QRC

In the Green Shipping & Storage Case you will have:

- Carrying Case
- HMWA
- LIF & Sacrificial Window
- Demist Towelette
- Lens paper
- Operator TM

CHARACTERISTICS

- **WEIGHT: 2 LBS**
- **BATTERIES: 3 L91 AA LITHIUM (1.5V ea.)**
  - **BATTERY LIFE (23° C/74° F) ≥15 HRS**
    - **»7.5 HRS FUSED OR THERMAL ONLY**
    - **»FOLLOWED BY 7.5 HRS I^2**
- **WATER RESISTANT TO 1M FOR 30 MIN.**

USING ALKALINE AA BATTERIES SIGNIFICANTLY REDUCES OPERATIONAL TIME

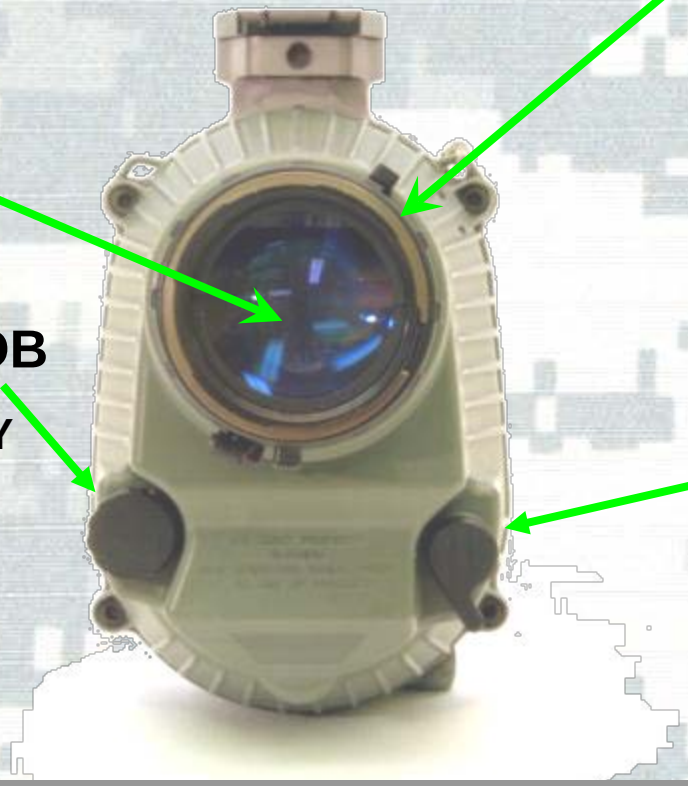
CHARACTERISTICS

FIELD OF VIEW

- 40° (I^2)
- 30° (THERMAL)
- USE SCANNING TECHNIQUE TO MAINTAIN AWARENESS OF YOUR SURROUNDINGS

CHARACTERISTICS

IMAGING SYSTEM REAR



THE NVD POWER KNOBS ARE MULTI-FUNCTIONAL

CHARACTERISTICS

IMAGING SYSTEM FRONT

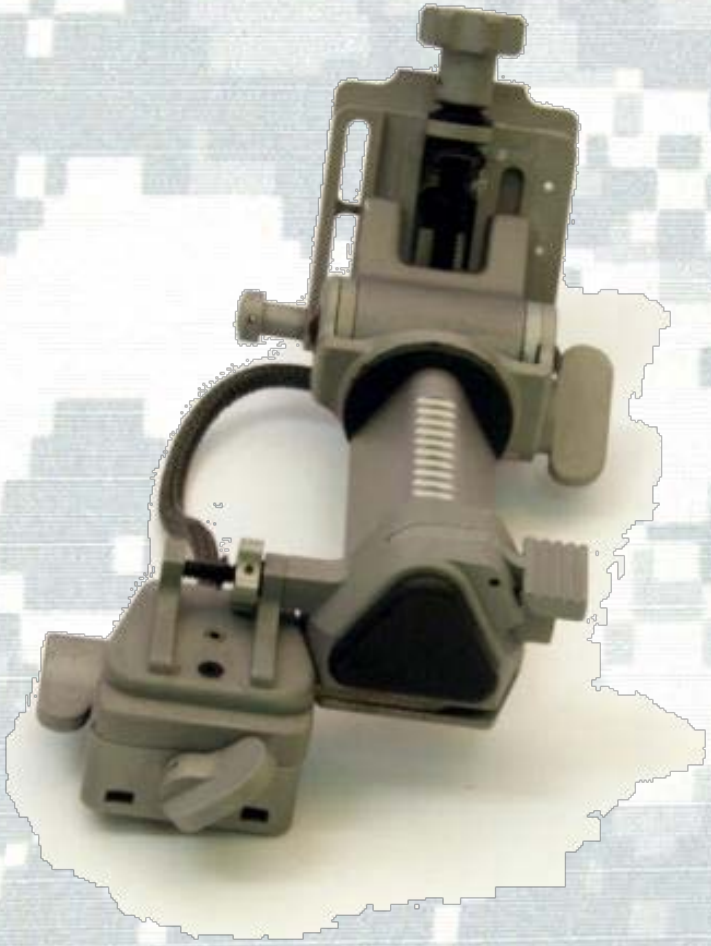
WARNING: THERMAL OBJECTIVE LENS IS MADE OF GERMANIUM

CHARACTERISTICS

HELMET MOUNT (RHINO)

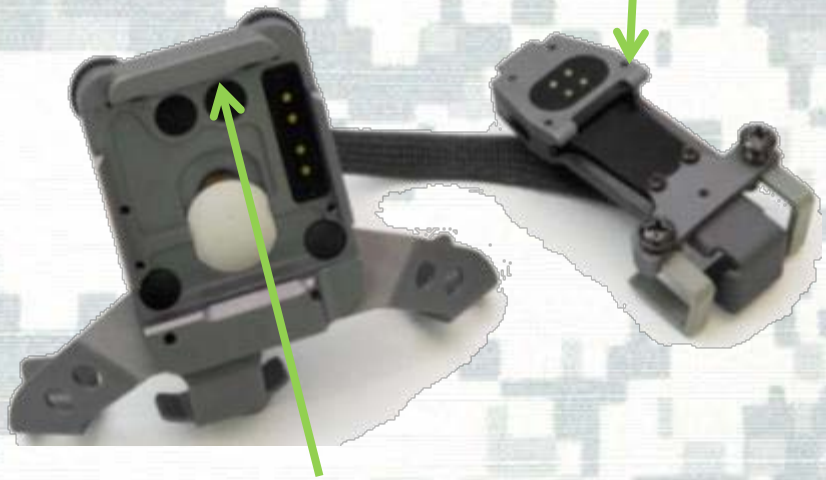
"Rhino" Adjustable for:

- Height
- Left or Right eye
- Eye Relief
- Tilt
- Horizontal



CHARACTERISTICS

HELMET MOUNT WIRING ASSEMBLY (HMWA)



Top of the Helmet Mount Bracket

WARNING: Ensure the pads in the front and rear cover the HMWA hooks.

CHARACTERISTICS

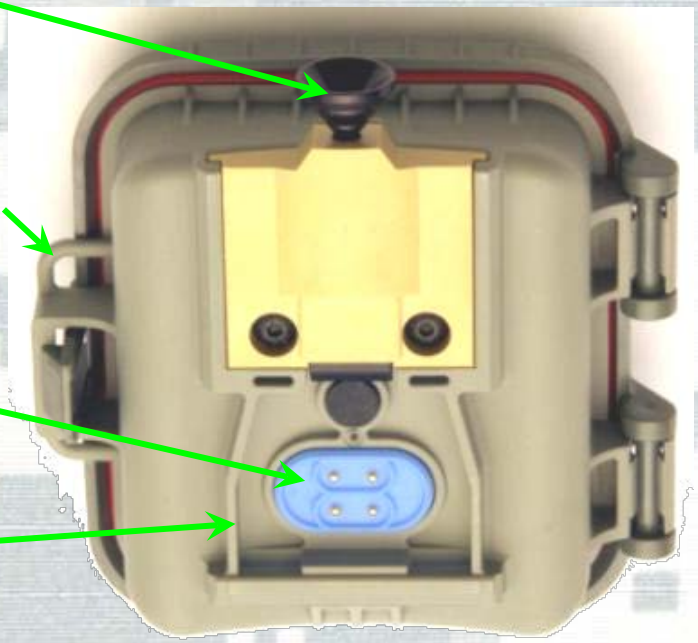
BATTERY PACK ASSEMBLY

BATTERY PACK RELEASE

LANYARD LOOP

SPRING LOADED CONTACTS

HOTSHOE RECIEVER



BATTERY PACK COVER LATCH

NOTE: RECOMENDED 3 L91 AA LITHIUM BATTERIES

Check on Learning

Question: What type of batteries are recommended?

Answer: L91 AA Lithium Batteries.

Question: Where can you find the I^2 knob?

Answer: In the front of the Imaging System at the center right.

Question: Where can you find the Thermal knob?

Answer: At the rear of the Imaging System on the bottom left.

ENABLING LEARNING OBJECTIVE C

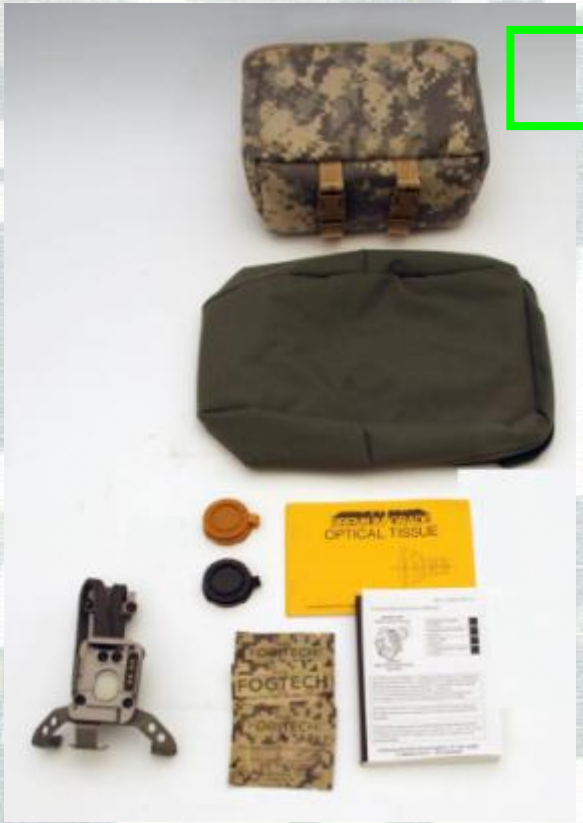
Action: Put NVD system into operation.

Conditions: Given student handout(s), NVD system, and taught in a classroom environment.

Standards: In accordance with the lesson materials, students will demonstrate a basic understanding of how to put the NVD system into operation.

PUT INTO OPERATION

INVENTORY



In the Carrying Case you will have:

- NVD system
- Battery pack
- Helmet mount (Rhino)
- QRC

In the Green Shipping & Storage Case you will have:

- Carrying Case
- HMWA
- LIF & Sacrificial Window
- Demist Towelette
- Lens paper
- Operator TM

Operator Action:
Take NVD system out of carrying case

PUT INTO OPERATION

IMAGING SYSTEM

- Eyecup comes installed.

- Eyecup will protect the eye from lasers and conceal green glow.

Operator Action:
Take off eyecup and reinstall

PUT INTO OPERATION

BATTERY INSTALLATION

INSERT BATTERIES (-) END FIRST, (+) END UP.
THEY ALL GO ONE WAY

INSERT THE CENTER BATTERY LAST

TO REMOVE BATTERIES, PRESS THE (-) END OF THE TWO OUTSIDE BATTERIES AND THEN PULL OUT BATTERIES

Operator Action:
Place batteries into battery pack

PUT INTO OPERATION

INSTALL BATTERY PACK

- Place wide part of battery pack hotshoe receiver over front of imaging system hotshoe.
- Engage hooks and rotate down until the latch clicks into place.
- Gently pull to ensure it is secure.

Operator Action:
Install battery pack onto NVD system

PUT INTO OPERATION

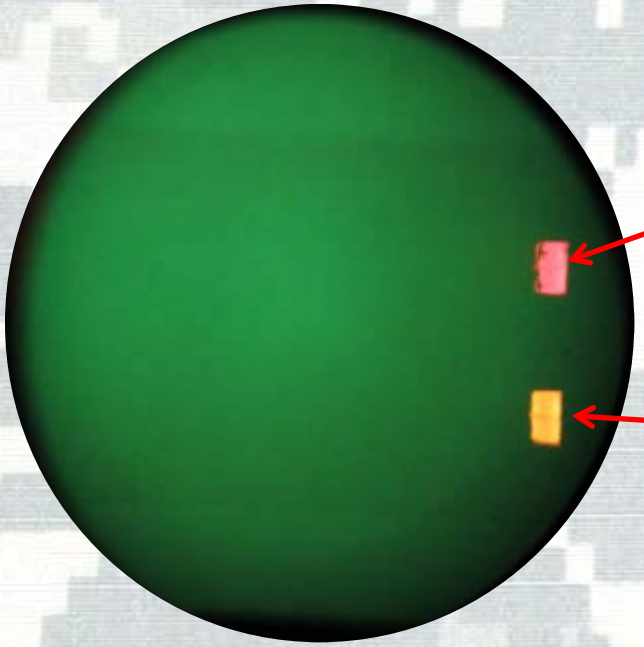
I^2 OPERATION

- I^2 ON / OFF / GAIN
  (Rotate)
- IR ILLUMINATOR LEVER
- HIGH LIGHT CUTOFF

Operator Action:
- Turn on I^2 and adjust the gain
- Operate the IR Illuminator

PUT INTO OPERATION

I^2 INDICATORS



IR ILLUMINATOR ON

I^2 Low Battery

NOTE: IF YELLOW LED IS PRESENT, REPLACE BATTERIES WITHIN 30 MINUTES

PUT INTO OPERATION

I^2 DIOPTER FOCUS

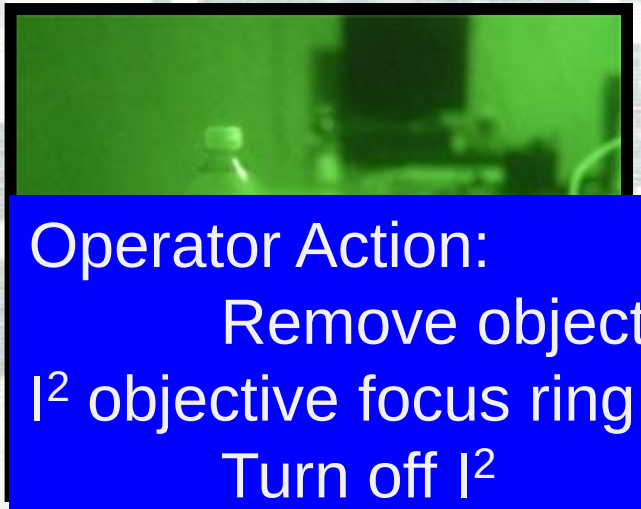
- Leave the objective lens cover on.
- Find an object and rotate the diopter focus until it is in clear view.
- You should adjust through “best” focus and then back.

Operator Action:
Adjust diopter focus ring

PUT INTO OPERATION

I^2 OBJECTIVE FOCUS

- With the objective focus ring you can adjust from 25cm to Infinity.
- Find a close object and rotate the objective focus ring until it is in clear view.
- Find a far object and rotate the objective focus ring until it is in clear view.



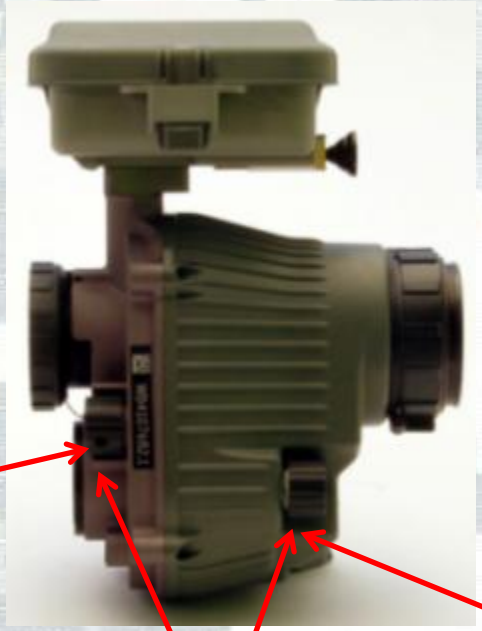
Operator Action:

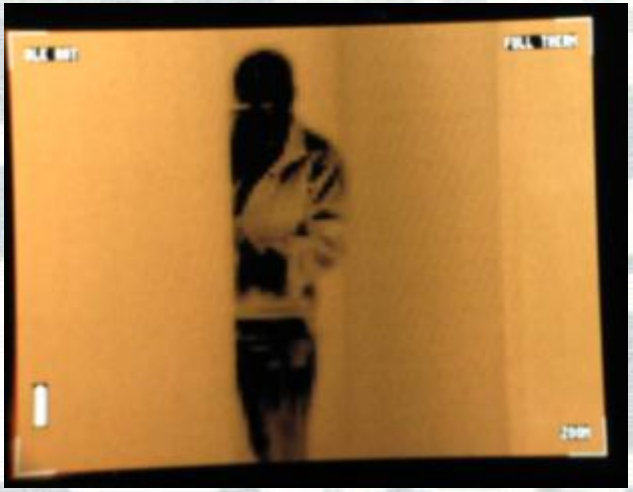
Remove objective lens cover and adjust I^2 objective focus ring to near and far objects

Turn off I^2

PUT INTO OPERATION

THERMAL OPERATION





3X
(PRESS)

- THERMAL ON / OFF (Rotate)
- DISPLAY BRIGHTNESS (Rotate)
- POLARITY (PRESS)

CALIBRATE
(PRESS BOTH TOGETHER)

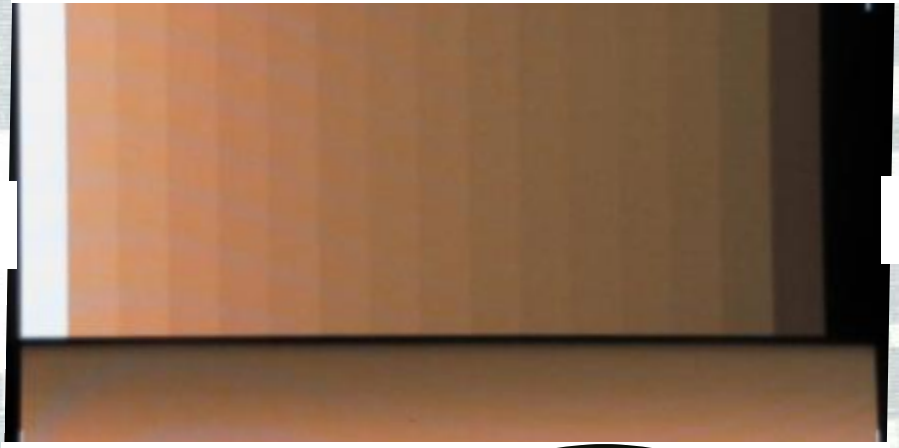
PUT INTO OPERATION

THERMAL START-UP SCREEN

White identifies the hottest object and black is the coldest.

This reverses for Black Hot.

Everything in between is a shade of amber.



Operator Action:
Turn on thermal operation

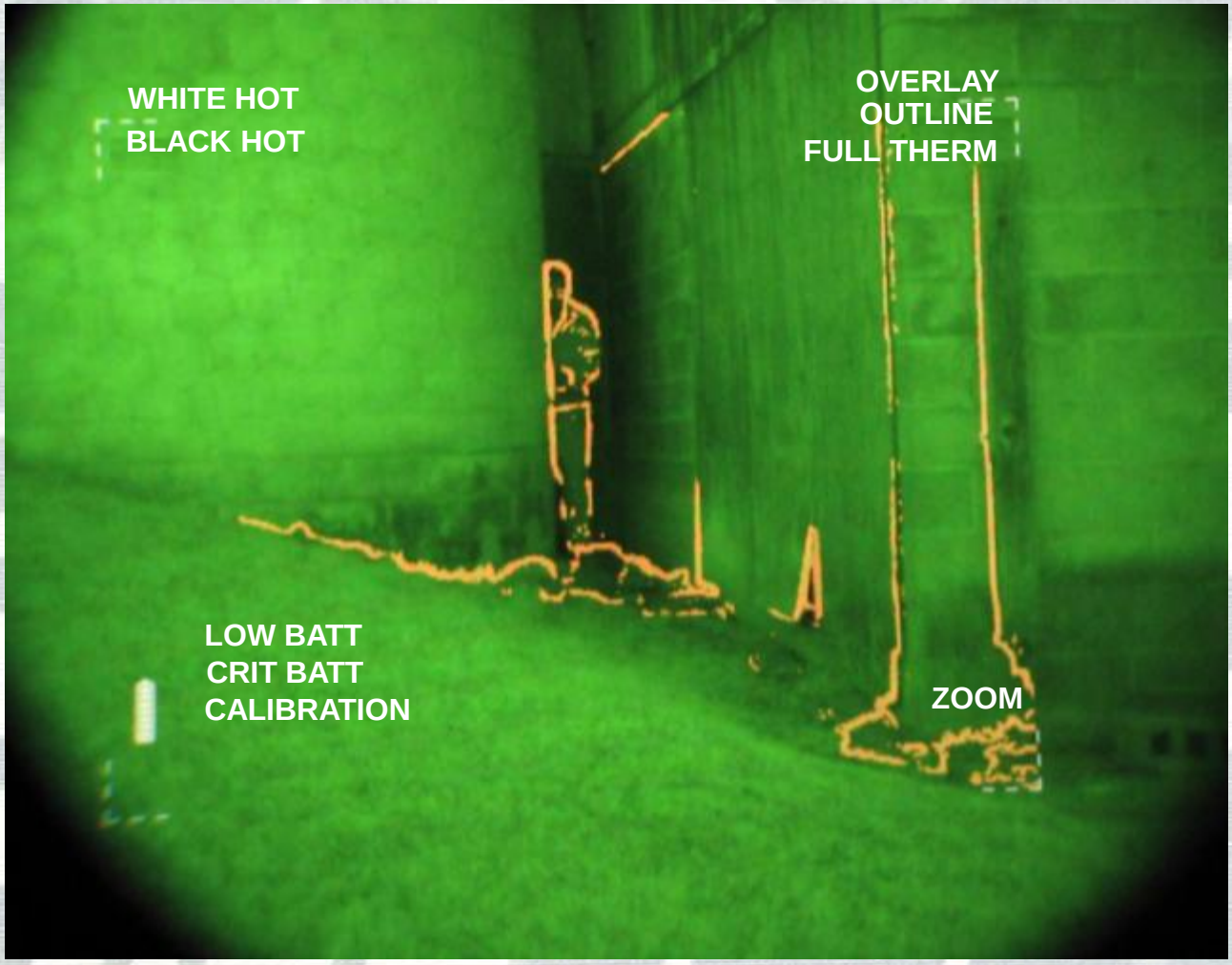
PUT INTO OPERATION

THERMAL DIOPTER FOCUS

- Leave the objective lens cover on.
- Look at the symbology displayed for the thermal image and adjust the diopter focus ring for clarity.
- You should adjust through “best” focus and then back.
- The symbology will remain on for 10 seconds push any thermal control to see it again.

Operator Action:
Adjust diopter focus ring

PUT INTO OPERATION



NOTE: NOT ALL INDICATORS ARE DISPLAYED AT THE SAME TIME

PUT INTO OPERATION

FUSED IMAGE

I^2 and Thermal images align at 45m.

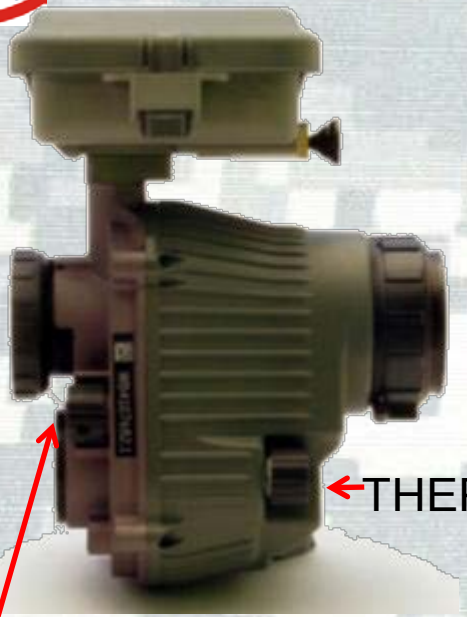
The operator can adjust either knob to set preferred brightness.

Operator Action:

Keep thermal on and turn on I^2

PUT INTO OPERATION

FUSED IMAGERY

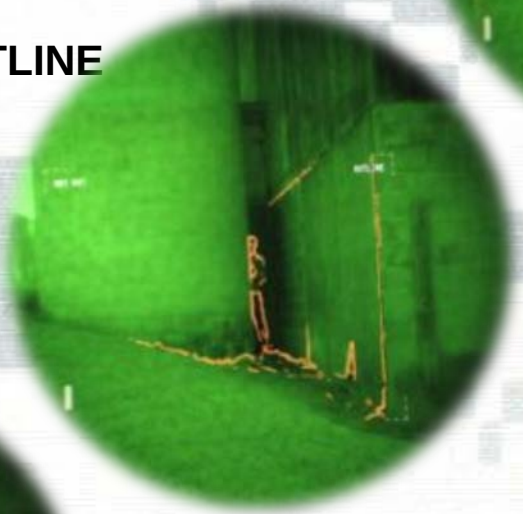


THERMAL - On

I^2 & Thermal
Mode Selection

1. OVERLAY

2. OUTLINE



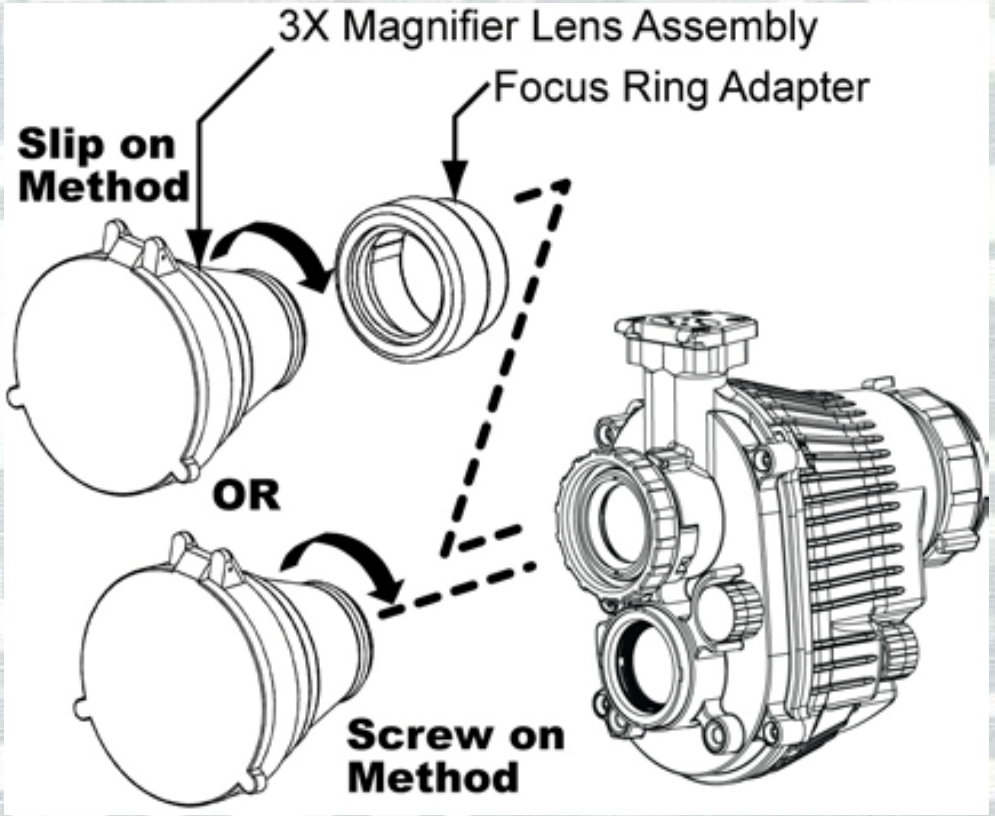
3. FULL THERMAL

Operator Action:
Use the I^2 button to cycle through the modes

PUT INTO OPERATION

INSTALLING A 3X MAGNIFIER

- Standard 3X Magnifier can attach to I^2 Objective.
- For quick use install with focus ring adapter
- For long observations the 3X Magnifier can replace LIF



Operator Action:
Turn off NVD system and remove battery pack

Check on Learning

Question: If the I^2 yellow Low Battery Indicator appears, what should you do?

Answer: Change batteries within 30 minutes.

Question: How do you recalibrate the Thermal sensor?

Answer: Simultaneously press both the Thermal & I^2 power knobs together.

Question: What does the red LED on the right side of your I^2 scene mean?

Answer: The IR Illuminator is on.

ENABLING LEARNING OBJECTIVE D

Action: Place Helmet Mount Wiring Assembly (HMWA) onto helmet and NVD system onto HMWA.

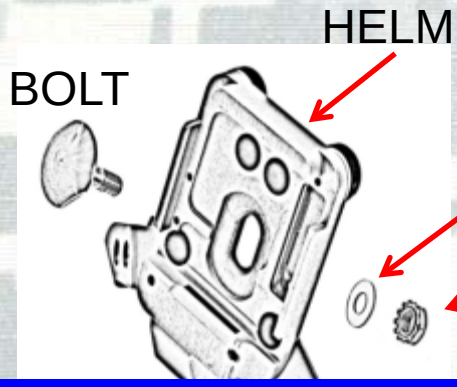
Conditions: Given student handout(s), NVD system and taught in a classroom environment.

Standards: In accordance with the lesson materials, students will mount the Helmet Mount Wiring Assembly onto their helmet.

MOUNTING

HELMET MOUNT WIRING ASSEMBLY (HMWA)

- Ensure the rear bracket is flush to ACH brim and tighten with cross-tip screwdriver in multi-tool.
- Place the plate on the front of the helmet & line up the hole with the oval opening in the plate.
- Insert the bolt through the Front Plate.
- Place the washer and nut on the threaded bolt and tighten.
- Keep the front plate tight to the brim of the helmet.



Operator Action:
Secure HMWA to helmet

MOUNTING

HELMET MOUNT WIRING ASSEMBLY (HMWA)

- Fold excess cable into “S”.
- Check that the pads in the helmet cover the cable.
- The pads should be placed to protect the head from contact with the HMWA hooks.
- Always check that the HMWA is tight before use.

Operator Action:
Fold excess cable and replace pads

MOUNTING

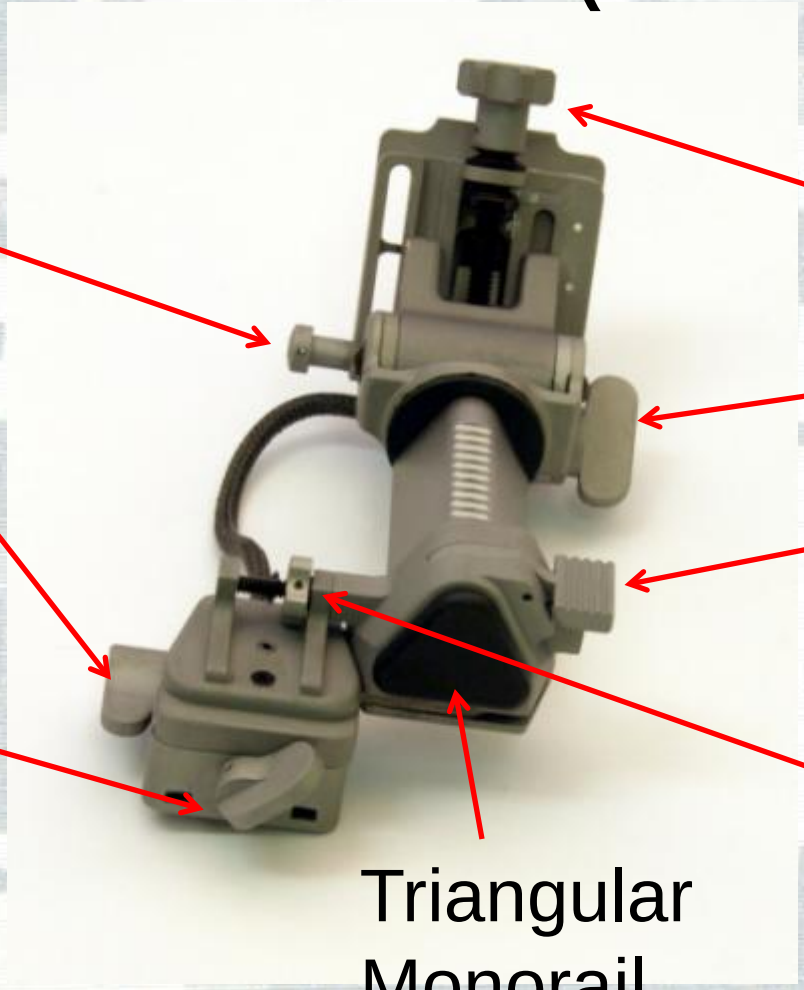
BATTERY PACK TO HELMET

- Place the battery pack hotshoe receiver over HMWA hotshoe as shown.
- Rotate forward until it locks in place.
- Gently pull to ensure it is locked.

Operator Action:
Secure battery pack to HMWA

MOUNTING

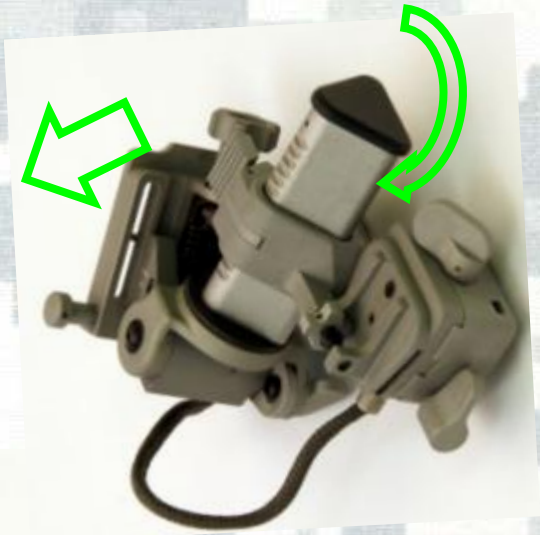
HELMET MOUNT (RHINO)



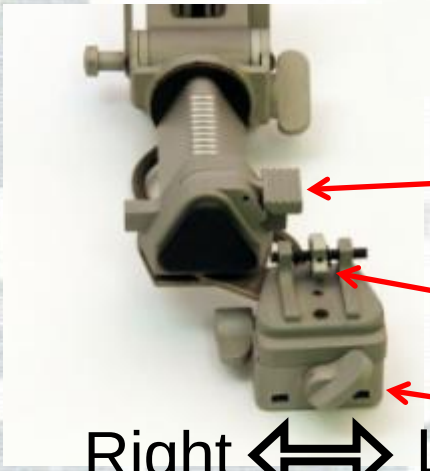
MOUNTING

HELMET MOUNT (RHINO)

- After removing the Rhino from the carrying case you can unfold it by pulling and turning the triangular monorail.



- Select right or left eye by
  - Push the Fore & Aft adjust lever to move the carriage to the end of the rail.
  - Loosen the Eye Shift Lock Nut.
  - Pull the Swing Arm out and away from the Triangular Monorail.
  - Rotate to t
  - Tighten the
    Nut.



Operator Action:
Unfold rhino and select preferred eye

MOUNTING

HELMET MOUNT ASSEMBLY

- Place the top edge of the helmet mount under the “keeper” on the Helmet Mount Bracket.
- Rotate the bottoms together till you hear the latch engage.
- Gently pull to ensure it is locked in place.

Operator Action:
Install rhino into HMWA

MOUNTING

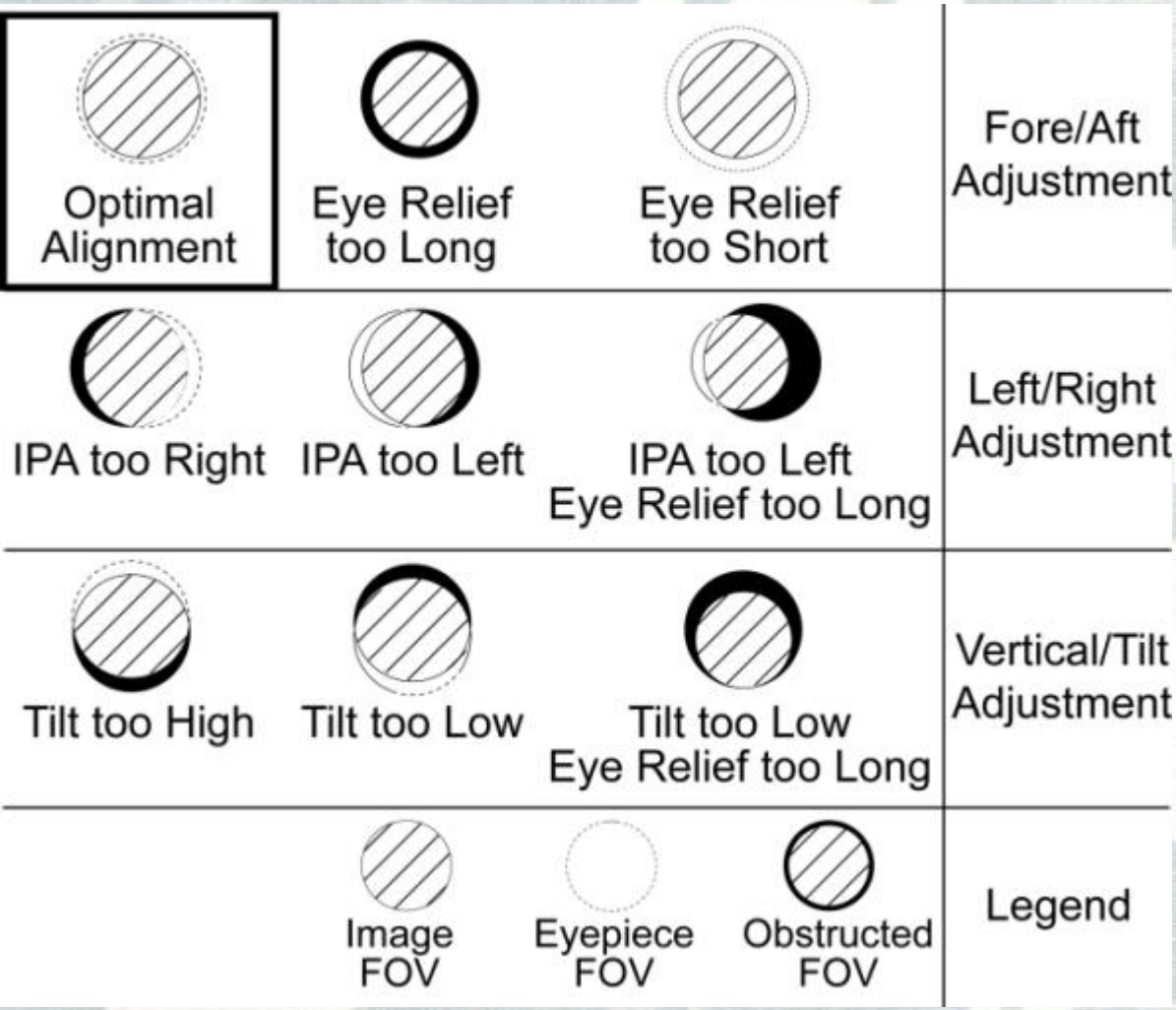
IMAGING SYSTEM TO RHINO

- Insert the front of the hotshoe into the mount and rotate up until the latch engages.
- Press up on the latch to ensure it is locked.

Operator Action:
Install NVD system to rhino

MOUNTING

CHECK YOUR EYE POSITION



From WP 0014 Operator TM

MOUNTING

ALIGN TO YOUR EYE

1. Vertical Adjustment
2. Tilt Adjustment
3. Interpupillary Adjustment
4. Eye Relief Adjustment

Operator Action:
Adjust NVD system to your eye

MOUNTING

STOWED POSITIONS: QUICK STOW TO THE LEFT OR RIGHT

- Grasp the NVD system and rotate to the side.

CAUTION: There is no power savings when in Thermal or Fused standby.

Operator Action:
Place NVD system into left or right stow

MOUNTING

STOWED POSITIONS: QUICK STOW UP

- Grasp the imaging system and rotate up.

CAUTION

You may damage the thermal and I^2 sensors if they are left pointing towards bright light sources like the sun without using the lens cover.

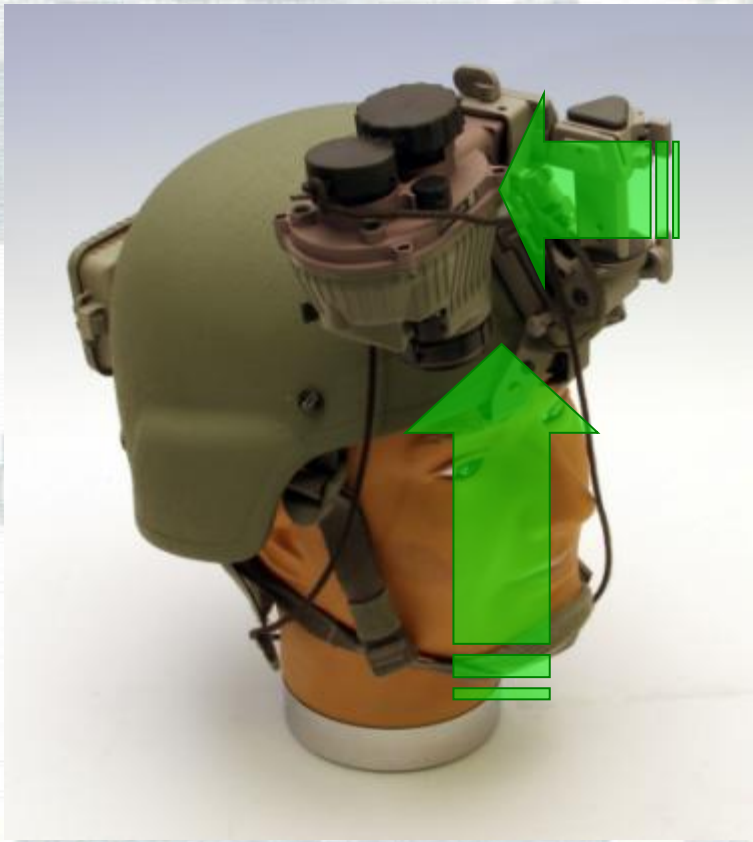
Operator Action:

Place NVD system into quick stow

MOUNTING

STOWED POSITIONS: FULL STOW

- Combines both motions.
- Move the NVD system to the side and then upward.
- Move NVD system forward for the tightest stow position.



Operator Action:
Place NVD system into full stow

MOUNTING

STOWED POSITIONS

- How the NVD system is stowed in use is up to the individual.
- Consider the height of the NVD system over the helmet when passing through doors or overhangs.
- When the NVD system is stowed the display and tube are dark. The NVD system is in standby mode and will continue to draw power until it is returned to operation, turned off, or the battery pack is disconnected.

Check on Learning

Demonstrate to the Instructor or the student next to you the location of:

- Vertical Adjust Knob
- Interpupillary Adjust Lever
- Tilt Lever
- Image Intensifier Power Knob
- Thermal Power Knob
- Thermal 3X button

Question: Where does the excess wiring from the HMWA go?

Answer: Folded into an S pattern underneath the center pads.

Question: How many stowed positions are there and what are they?

Answer: Three. Quick stow right/left, quick stow up, and full stow.

ENABLING LEARNING OBJECTIVE E

Action: Discuss how to operate the NVD system in adverse conditions.

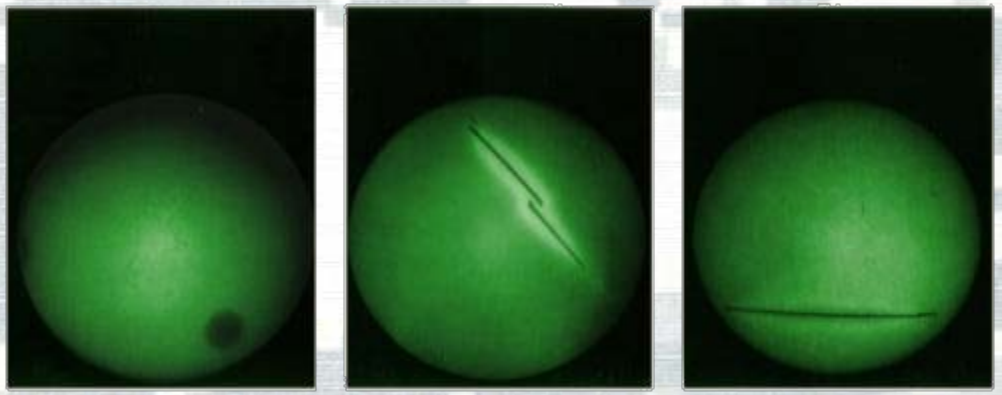
Conditions: Given student handout(s) and taught in a classroom environment.

Standards: In accordance with the lesson materials, students will demonstrate a basic understanding of what steps to take when operating the NVD system in adverse conditions.

OPERATION IN ADVERSE CONDITIONS

LASER THREAT ENVIRONMENTS

- Install the LIF into the I^2 objective lens to protect the I^2 tube from laser damage.
- Using the ridged side of the storage container as a wrench, hand tighten the LIF.
- Do not remove the LIF unless instructed by your unit CDR.
- Adjust the eyecup to properly protect the eye from lasers.



DAMAGE CAUSED TO THE I^2 TUBE IF THE LIF IS NOT INSTALLED.

OPERATION IN ADVERSE CONDITIONS

SACRIFICIAL WINDOW

- **Operation in dusty and sandy areas.**
  - **Install the sacrificial window to protect the objective lens.**
  - **Using the ridged side of the storage container as a wrench, hand tighten the sacrificial window.**
  - **LIF and sacrificial window cannot be used together.**

OPERATION IN ADVERSE CONDITIONS

DEMIST TOWELETTES

OPERATION IN RAINY OR HUMID CONDITIONS

- One application will last several days.

NOTE:

Towelettes are used on eyepiece lens only. Do not use on any objective lens. Towelettes leave a film that reduces the light entering the objective lenses.

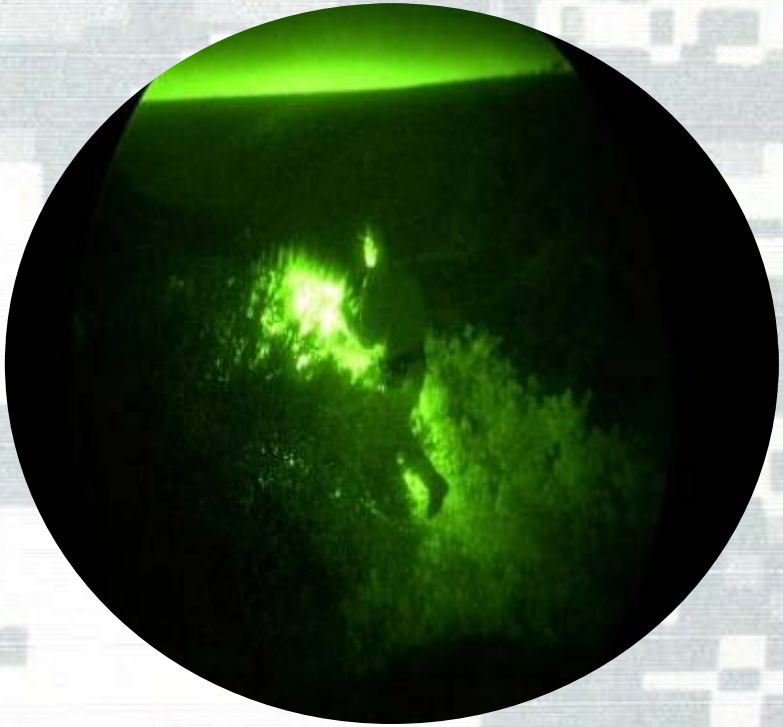
OPERATION IN SALT WATER AREAS

- **Rinse NVD system with fresh water if necessary and dry thoroughly.**
- **Clean lenses with lens paper (and water) if necessary.**

OPERATION IN ADVERSE CONDITIONS

EXTREME DARKNESS

- I^2 requires some ambient light to work.
- Sparkling or snowy image indicates that an I^2 device is operating at or near minimum illumination.
- In total darkness, the IR Illuminator or thermal sensor can be used.



OPERATION IN ADVERSE CONDITIONS

FOG AND SMOKE

- Thermal will see through most types of smoke and fog.
- I^2 night vision is degraded by fog or smoke.
  - Under most circumstances, I^2 visibility is similar to daytime unaided vision.
  - If supplemental IR illumination is used, it will be reflected back and could washout the image.

OPERATION IN ADVERSE CONDITIONS

HALO EFFECT (I^2 ONLY)

- Bright lights may cause a “halo,” which can obscure the area around a light source.
- Adjusting the brightness may reduce the halo effect.
- **THERE IS NO HALO EFFECT IN THERMAL**

Black Hot / Overlay

White Hot / Full

Outline

OPERATION IN ADVERSE CONDITIONS

RETAINING LANYARD FOR LOSS PREVENTION

If wrapping the Retaining Lanyard around you interferes with performing the mission you can untie the left side (without the cap) and tie it to your equipment.

There are two loops on the battery pack that are designed for security cord attachment points if necessary.

Check on Learning

Question: When should you remove the LIF and replace it with the sacrificial window?

Answer: In sandy or dusty conditions.

Question: Can the sacrificial window be used with the LIF?

Answer: No.

Question: When do you use the Demist Towelettes on the objective lenses?

Answer: Never.

ENABLING LEARNING OBJECTIVE F

Action: Perform PMCS and troubleshooting procedures on NVD system.

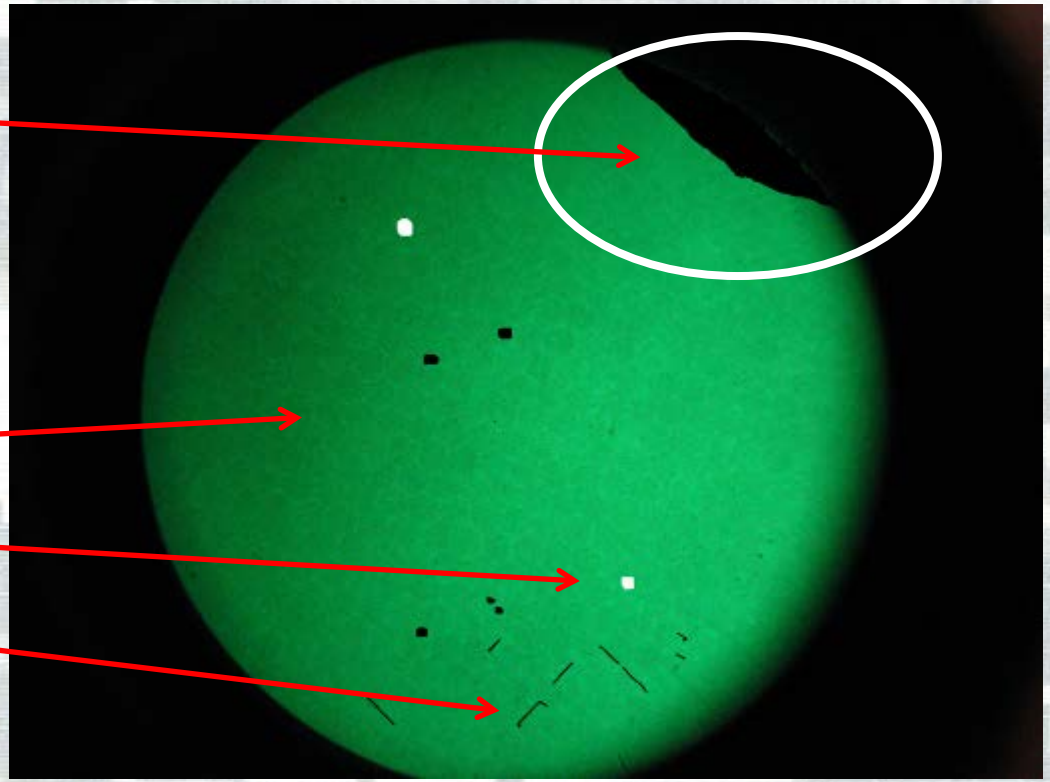
Conditions: Given student handout(s), NVD system, and taught in a classroom environment.

Standards: In accordance with the lesson materials, students will demonstrate the ability to perform a PMCS and troubleshoot the NVD system.

PMCS AND TROUBLESHOOTING

IMAGE INTENSIFIER DEFECTS

- Edge glow/shading indicates tube failure and should be reported to maintenance before use.
- Fixed pattern noise or honeycomb shaped pattern that interferes with image.
- Bright/dark spots
- Chicken wire

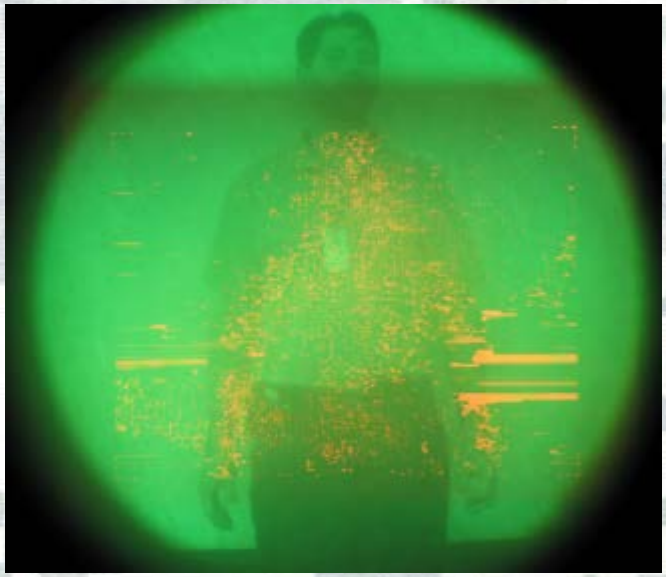


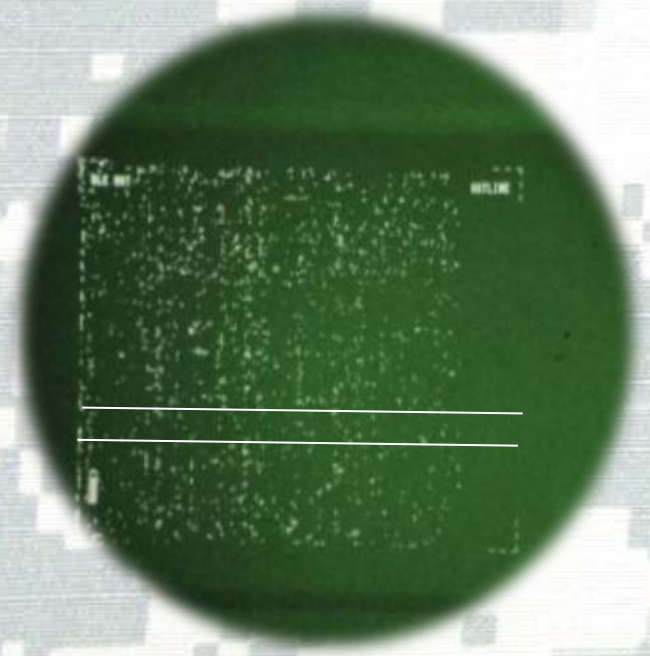
If fault is not edge glow/shading no action is required unless it interferes with your ability to perform the mission.

PMCS AND TROUBLESHOOTING

THERMAL DEFECTS

- Defective pixels
- Row/column outage
- Image Static
- Bright/dark center
- Water spots





- Problems associated with temperature change should go away with calibration.
- In an emergency, if you do not hear the shutter during calibration, and the problem persists, place your hand or lens cover over the thermal lens as you calibrate.

PMCS AND TROUBLESHOOTING

WHAT IF THE DEFECT DOESN'T GO AWAY WHEN YOU CALIBRATE?

No action is required as long as dead pixels or rows do not interfere with your ability to complete the mission.

PMCS AND TROUBLESHOOTING

FUSED IMAGE ALIGNMENT CHECK

Are both I^2 and Thermal images aligned at 45m?

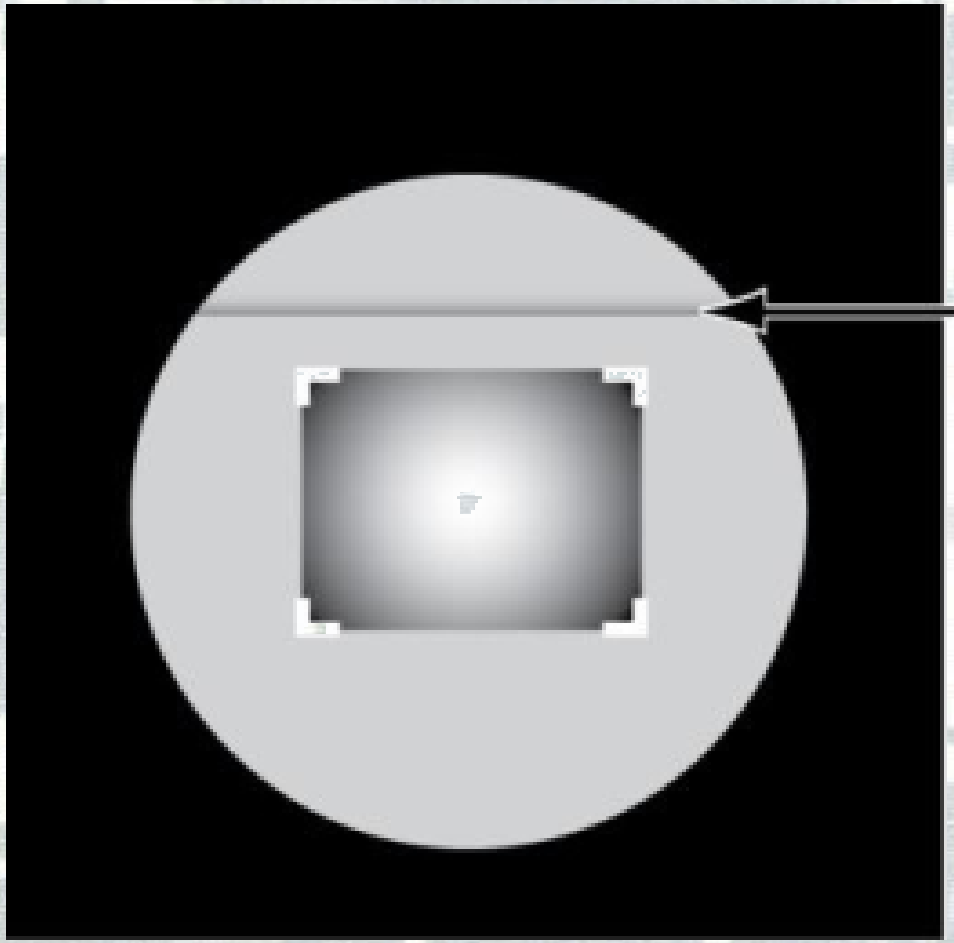
You may use it as long as it does not interfere with your ability to complete the mission. You should notify maintenance as soon as possible.

PMCS AND TROUBLESHOOTING

Horizontal line in I^2 image

Edge of beam combiner.

Adjust tilt mechanism to minimize problem, this is normal.



PMCS AND TROUBLESHOOTING

HELMET MOUNT WIRING ASSEMBLY (HMWA)

- Check security of HMWA before each use.
- If loose, tighten with cross-tip screwdriver in multi-tool.

Check on Learning

Question: What does edge shading or glow indicate?

Answer: Imminent tube failure, NVD needs to be turned in ASAP.

Question: At what distance should the I^2 and thermal image align?

Answer: 45m and beyond.

Question: At 45 meters, how far off can the alignment be?

Answer: ½ a head.

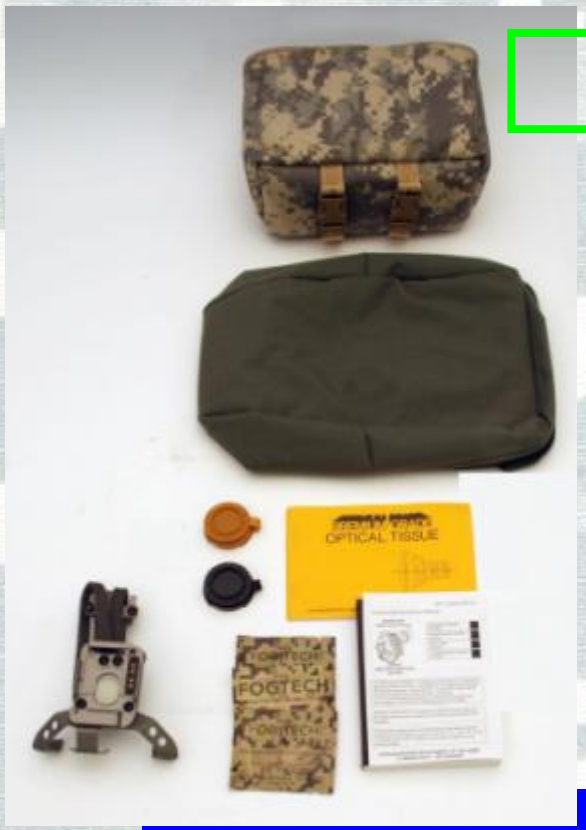
ENABLING LEARNING OBJECTIVE G

Action: Prepare the NVD system for storage.

Conditions: Given student handout(s), NVD system, and taught in a classroom environment.

Standards: In accordance with lesson materials students will prepare the NVD system for storage.

PREPARATION FOR STORAGE



Turn off NVD prior to removing

Stow components as shown

Operator Action:
Prepare NVD for storage and place into the carrying case

PREPARATION FOR STORAGE

Question: Before you disconnect the NVD system from the battery pack what should you do?

Answer: Turn off the NVD system.

Question: What items belong in the carrying case?

Answer: Rhino, NVD system, Battery Pack.

SUMMARY

- Fused operation – Advantages/disadvantages of I2 only, thermal only and fused operation
- Characteristics of the AN/PSQ-20A NVD
- How to put the AN/PSQ-20A into operation
- Mounting procedures
- Operation in adverse conditions
- PMCS and troubleshooting
- Preparation for storage

Questions?