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Transportation

**Federal Aviation
Administration**

NSP GB

National Simulator Program
FSTD Qualification Guidance Bulletin

NSP GB 10-01

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Flight Standards Service
Washington, DC

National Simulator Program Guidance Bulletin

An NSP GB contains valuable information for FSTD sponsors that should help them meet certain administrative, regulatory, or operational requirements with relatively low urgency or impact on safety.

Subject: Night Vision Goggle (NVG) Evaluation for Helicopter and Airplane FSTDs.

Purpose: Outlines criteria for evaluating Night Vision Goggle (NVG) systems installed in FAA Qualified Helicopter and Airplane Flight Simulator Training Devices (FSTDs).

Background: This procedure applies to all helicopter and airplane Flight Simulator Training Devices (FSTD) used to satisfy the training and checking requirements pertaining to the certificate holder's approved NVG flight training program and the Flight Standardization Board Report for the aircraft. A copy of Flight Standardization Board Reports may be found on the FAA's public [Flight Standards Information System \(FSIMS\)](#). For the purpose of this document, "NVG" will be used as a generic term for Night Vision Goggles defined as a Direct View (Image viewed directly in-line with the image intensification process), head-mounted, binocular, light intensification appliance that enhances the ability to maintain visual surface reference at night.

Revision	Description of Change	Effective Date
0	Original Draft.	01/06/2010
1	Delete "Level A" FSTD in 3a. Add 3d. Clarify 3e, bullet 1 and 5(1) b, 5(3) c, & 5(5) a. Delete reference to pre-flight - 5(2) a. Added footnotes 1, 2 & 3.	04/30/2010
2	02/09/2012: Draft created during working group meeting in Dallas. 10/31/2012: Draft jointly created by FSI and CAE after system testing and validation. Distributed to Working Group for comment. 11/5/2012: Added Outlook comment on NVG Surface Resolution Test. 1/11/2013: Added NSP Comments and corrected typographical errors. 1/14/2013: Updates following meeting.	02/01/2013
3	Updated the reference location of FSB reports from opspecs.com to FSIMS. Provide additional clarification of objective testing procedures and provide attachment 1. Objective test requirement 4e altered to be contingent upon subjective evaluation.	05/05/2014
4	Clarify direct (unaided) measurements in objective test procedures. Simulator NVG Standards line "e" changed to require windshield panes for any FSTD used for NVG training.	04/04/2016
5	Updated to add airplane NVG requirements and Statement of Compliance for NVG Training Tasks. Clarified NVG Test procedures.	11/06/2017

Applicability

The methods, procedures, and standards defined in this document provide one means, acceptable to the Administrator, to evaluate and qualify a simulator for NVG training. If an applicant desires to use another means, a proposal must be submitted to the National Simulator Program Manager. If an applicant chooses to utilize the approach described in this document, the applicant must adhere to all of the methods, procedures, and standards herein. Creditable hours of training will be determined by the Training Program Approval Authority (TPAA) having oversight authority.

Statement of Compliance

Qualification Test Guides for new or upgraded simulators incorporating NVG training shall contain an NVG Statement of Compliance. This statement must attest that any associated NVG equipment, including Night Vision Imaging Systems (NVIS), effectively integrates all components required to successfully and safely use NVGs.

Simulator NVG Standards

This following describes minimum requirements to qualify a simulator for NVG training:

- a. The simulator used for NVG training must be an FAA qualified Level 6 or 7 FTD, Level B, C, or D FSTDs.
- b. The simulator's cockpit configuration must simulate the functionality and intent of the Aircraft Type Certificate or a Supplemental Type Certificate (STC) required for the specific make, model, and type of aircraft being simulated.
- c. The Training Facility shall maintain an adequate number of certified NVG appliances (TSO-C164a. or performance to the minimum operational performance standards of RTCA Document DO-275) to properly test the compatibility of the simulator for NVG training.
- d. The Training Facility shall maintain, in a binder, the following documents for inspection: Copy of the Statement of Compliance, Copy of the STC, a statement that the FSTD effectively simulates the Aircraft STC Conformity, Master Drawing List for supplemental lighting system, Rotorcraft or Airplane Flight Manual Supplement for NVG Compatible Lighting System, Instructions for Continued Simulator Maintenance and NVG component replacement, detailed drawings of NVIS lighting installation, filtration installation, and all other applicable cockpit NVIS adaptations.
- e. The simulator environment must be suitable for NVG training:

- Windshield panes are required for any FSTD used for NVG training tasks. The effects of the windshield on NVG visual and non-NVG visual should be similar as possible to the aircraft¹.
 - Displays or lighting outside of the cockpit area, if installed, do not interfere or distract from NVG training.
 - Helicopter operational steerable (visible light, non-IR) searchlight or airplane landing/taxi lights, as appropriate for the aircraft configuration, used for identification of wires, poles and other obstructions during landing, takeoff and en route. Use of the searchlight shall realistically aid in detection of poles and wires and obstacles².
 - Suitable seat adjustment for proper NVG training.
 - Proper cockpit lighting, suitable for NVG training.
 - No distracting light leaks, glare or unrealistic halo effects.
 - External lighting does not interfere or distract from NVG training.
- f. The instructor must be capable of selecting and viewing the visual scene (or a suitable representation) that is presented to the pilot. The viewing requirement may be satisfied with the provision of a set of NVGs for use by the instructor, or by an alternate video representation at the IOS that includes effects of the NVG image viewed by the pilot. An IOS compatible hand held (remote control) may be used in lieu of the IOS display by the instructor pilot if it does not distract from NVG training.
- g. An adequately modeled NVG training area in night visual meteorological conditions (VMC) must be available for evaluation by the NSP. Modeling must enable the following as applicable for the qualification level of the FSTD:
- Ability to conduct operations to and from a landing area.
 - Takeoff and landing areas suitable for ground maneuvering and taxi operations.
 - Confined area takeoffs and landings or unimproved areas and unlit runways for takeoffs and landings.
 - Pinnacle takeoff and landing for helicopters.

¹ Any tint or color is likely to adversely affect the brightness performance of the out-the-window (OTW) visual.

² Wires and poles are virtually impossible or at best difficult to see based on available ambient light conditions while using NVG's

- Representative obstacles associated with the landing area, specifically wires, power lines, power poles, towers or barriers.
 - Special weather representations as required in the applicable training program(s).
 - Visibility restrictions for dust, rain, fog and snow³.
 - Increase in the halo effect when viewing light sources is proportionally increased with an increase in density of water vapor, dust or particulate.
 - Increase in NVG scintillation / noise as scene illumination level is decreased.
 - Simulated external aircraft lighting (searchlight, taxi, landing lights, strobe lights, etc.) should appear as close to realistic as possible.
 - Simulated shadows of aircraft lighting should be available to cue pilots with regard to hover or runway threshold height above ground during touchdown (only required for Level 7 and above FSTDs, with approved hover model).
- h. A morning readiness test shall be available to validate system operation prior to use for NVG training. It shall include, under NVG illumination conditions, and as a minimum:
- Overall scene alignment and inter-channel luminance consistency.
 - Visibility of image modulation.
 - Support for focusing NVGs.

NVG Qualification Tests - Objective Testing

- a. **Visible Black Level** – Black level reduced from that required by standard visual check.
- b. **NVG Highlight Brightness** – Measure peak brightness in NVG mode.
- c. **NVG Surface Contrast Ratio** – Similar to normal visible surface resolution.
- d. **Lunar Illumination** – Measures brightness at 100% lunar illumination (full moon).
- e. **NVG Image Color** – Measures color shift (red boost) in NVG mode.
- f. **NVG Surface Resolution** – Similar to visible surface resolution.
- g. **NVG Light Point Contrast Ratio** – Similar to visible light point contrast.

³ Ambient light levels decrease, and a loss of visual acuity occur with increased in dust, rain, fog or snow

While cockpit lighting, aft-cab, IOS and flight deck ambient light levels should typically be configured for NVG operations, it is recognized that resulting glare may impede objective measurement. Where light levels influence measurement or create distracting effects, it is permissible to lower lighting levels during objective testing portion of the evaluation. Measurements should be accomplished using a calibrated CS100/LS100 Minolta Color & Luminance meters or equivalent.

- a. **Visible Black Level:** The display brightness for a low visibility night scene, when configured for NVG operations, should be no more than 0.01 candelas/square meter (cd/m^2) in an unlit portion of a displayed scene as measured from the pilot eye-point. This test is performed using an unaided photometer (Note: typically tested by taxiing aircraft into a dark hanger building).
- b. **NVG Highlight Brightness:** When configured for NVG operation the highlight brightness shall not be less than one (1) foot-lambert (3.4 cd/m^2). This test is performed using an unaided photometer. The pattern shall be a white square with a highlight imposed on the square corresponding to that used in the Part 60 visual display objective test 4.e, Highlight Brightness.
- c. **NVG Surface Contrast Ratio:** NVG surface contrast ratio shall be a minimum of 4.0:1. Measurements should be made using a raster drawn test pattern filling all channels of the entire visual scene with a test pattern of black and white squares with a white square in the center of each channel similar to that used in the Part 60 visual display objective test 4.d, Surface Contrast Ratio. Each square should subtend 5° . The white squares should provide a visible brightness of no greater than 0.04 foot-lamberts or 0.14 cd/m^2 when measured using an unaided photometer. Measures should then be taken from the pilot's eye point using a 1o spot photometer through an NVG appliance representative of the type used in training. The ratio is calculated by dividing the NVG-aided radiance of the center bright square by the NVG-aided radiance of any adjacent dark square. The appliance gain must be the same for both readings. A direct photometric measurement will not yield an equivalent value.
- d. **Lunar Illumination:** The luminance of a full white Lambertian surface ⁴under 100% lunar illumination at 90 degree elevation (moon directly overhead) with clear atmospheric conditions shall be between 0.075 cd/m^2 and 1.025 cd/m^2 . The luminance under other lunar elevations and phases shall realistically simulate real-world lunar illumination to the extent possible. The displayed visual model may be a real world or generic scene. The surface under test shall only be illuminated by the moon. No aircraft, cultural, or artificial lighting shall be applied. The area to be tested shall be identified as part of the test

⁴ Lambertian reflectance is the property that defines an ideal diffusely reflecting surface. The apparent brightness of such a surface to an observer is the same regardless of the observer's angle of view.

procedure, and would typically be expected to be a white paint stripe or other runway marking. This test is performed using an unaided photometer.

- e. **NVG Image Color:** The NSP evaluator will first attempt to subjectively determine that there is no distracting color shift from white light in the unaided view. Scenes that exhibit an unrealistic color tint are not acceptable. If acceptability cannot be determined subjectively, the sponsor must verify acceptability of the NVG image color using the following objective test.

When configured for NVG operation, the CIE 1931 xy color co-ordinates of white objects in the scene (e.g. paint stripes) shall fall within a specified radius circle of radius relative to object chromaticity under daylight conditions. The radial xy deviation of white objects from daylight to NVG mode operation shall be less than 0.03 for lunar illumination levels between 100% and lunar illumination resulting in a luminance of 0.02 candela per square meter on a fully reflective Lambertian surface. Higher levels of xy deviation are allowed on lunar illumination levels less than the above; however, the resulting color shift shall be non-distracting. This objective test does not preclude using different sun and moon illumination colors; however, the daylight chromaticity reference measurement for the deviation calculation must use the moon illumination color. The method of establishing the reference shall be identified as part of the test procedure. No distracting color shifts shall be applied to light points, searchlights, and other highlights. For additional background, reference attachment 1 of this document.

The ability of instruments to measure color at low luminance levels may require that the measurement be made at the output of the projector rather than with a direct view of the visual display system image. The apparent color shift under this high brightness test condition may be quite apparent, even while respecting the allowed tolerance. Given that the color will be less saturated when seen by the pilot under NVG illumination conditions, this should not be a point of concern. Exercise extreme caution as injury to personnel or damage to equipment may result.

- f. **NVG Surface Resolution:** Surface resolution shall be no greater than five (5) arc minutes when viewed through the NVG under 100% moon luminescence. Subjective degradation of resolution should be demonstrated for 50%, 25%, and no moon luminescence. The displayed scene shall be similar to that used in Part 60 visual display objective test 4.f, Surface Resolution. It is suggested that initial aircraft distance from the runway threshold be greater than the minimum required such that the FSTD may be “flown” down the glideslope with corresponding cockpit indications and frozen in position when the individual white paint stripes are discernable. The distance from the runway threshold should be available at the IOS.

When the eye is positioned on a 3° glide slope at the slant range distances indicated with white runway markings on a black runway surface, the distance between the runway stripes

will subtend five (5) arc minutes (only necessary to show one of the following configurations):

- i. For Configuration A, a slant range of 2750 ft. with stripes 150 ft. long and 16 ft. wide, spaced 4 ft. apart.
- ii. For Configuration B, a slant range of 2063 feet with stripes 150 ft. long and 12 ft. wide, spaced 3 ft. apart.
- iii. For Configuration C, a slant range of 3953 feet, with stripes 150 ft. long and 5.75 ft. wide, spaced 5.75 ft. apart.

An SOC is required and must include appropriate calculations and explanation of those calculations.

- g. **NVG Light Point Contrast Ratio:** The NVG light point contrast ratio shall not be less than 25:1. A white square test pattern of at least 1° filled with light points should be displayed similar to that used in the Part 60 visual display objective test 4.h, Light Point Contrast Ratio. The brightness of this square should be no greater than 1 ft-L when measured with an unaided photometer.

Measurements should then be taken from the pilot's eye point using a 1° spot photometer through an NVG apparatus representative of the type used in training. The appliance gain of the NVG device must be the same for both readings. A direct photometric measurement will not yield an equivalent value.

The NVG Contrast Ratio is then calculated by dividing the NVG-aided radiance for the light square by the NVG-aided radiance of the adjacent background.

Functions and Subjective Testing

An FAA-NSP Simulator Evaluation Specialist or other qualified pilot designated by the NSP will evaluate the simulator for NVG compatibility. The evaluation will include the tasks listed below using the operator's approved manuals and checklists. Handling qualities, aircraft performance, and simulator systems operation will be evaluated while wearing NVGs.

Only those phases of flight and qualified tasks (in accordance with the qualification level of the device as defined in Table C1B or D1B of 14 CFR Part 60, as applicable) authorized for NVG use will be evaluated. Additional tasks not listed may be required to assure NVG performance is appropriate for use in pilot training as specified in the sponsor's approved training program. The evaluation will be conducted using night conditions. The visual scene shall simulate the actual night environment as viewed both aided and unaided at moon illumination levels between 0% and 100%.

NVG training may be conducted with the moon elevation angle fixed at 90 degrees. If training is to be conducted with angles other than 90 degrees, then shadows computed as a function of moon angle shall be displayed.

Preparation for Flight:

- a. Inspect and adjust NVG appliance in accordance with the operator's approved (OEM recommended) procedures.
- b. Evaluate cockpit environment for suitability of head-mounted NVG. Determine ability to view cockpit instrumentation, switches, and controls below NVG field of view.

Taxi / Takeoff:

Evaluate the use of NVGs for focus, depth perception, brightness, contrast, and field of view while performing the following tasks:

- a. Taxiing, on wheels (helicopter and airplane) and/or while hovering (helicopter).
- b. Normal takeoff from a hover (helicopter) or Normal rolling takeoff (airplane).
- c. Takeoff with abnormal occurrence: Engine failure, CAT A / B.

Inflight:

- a. Check for adequate ground reference while straight and level.
- b. Check for adequate ground reference while maneuvering: turns, climbs and descents.
- c. Night scenes with a moon shall be evaluated for suitability with NVIS.
- d. Navigate to a designated area via ground reference.
- e. Check navigation by instruments.
- f. Check system parameters. (instruments, panel illumination, ability to read checklist, etc.).

Approach/Missed Approach/Go-Around:

- a. Visual approach to a confined area or unimproved / unlit runway without reference to ground lighting.
- b. Engine out approach for multiengine aircraft.
- c. Respond to a change from VMC to instrument meteorological conditions (IMC).

Malfunctions:

- a. During hover, takeoff, cruise, approach and landing.
- b. Malfunctions may be selected from the Operator's Approved Flight Manual Abnormal Procedures section.

Note: Emphasis should be placed on the simulator's capability to demonstrate compatibility for NVG training and the ability to display adequate visual scenes such that the pilot can identify the required visual references for night VFR flight.

Attachment 1

The Nature of Chromaticity

The concept of color can be divided into two parts: a pair of chromaticity coordinates (x,y) and a luminance (Y). The xy value specifies a color, and the Y luminance value is related to perceived brightness. For example, the color white is a bright color with a particular xyY value, while the color grey is a less bright version of that same white with the same xy values but a smaller Y. As the level of illumination decreases, so does the eye's ability to discern color. A person's perception of color, then, is dependent both on the "true" color of the object (as would be measured by an instrument and represented by the CIE chart below), and by the brightness of the scene. Scenes with low brightness levels, such as those typical of NVG operations will be perceived to have less color saturation, and will eventually be perceived to be monochrome.

Current flight simulators often take advantage of this psychophysical phenomenon to achieve acceptable NVG training using real goggles looking out the-window. Typical flight simulator displays do not have enough near-infrared energy to properly stimulate NVGs. Simulators equipped for NVG training often employ an "NVG-mode" compromise where the night scene is made slightly reddish to better stimulate the NVGs. If this is done properly, the NVG view is enhanced while the unaided under-the-goggle view appears virtually normal since color is hard to distinguish at low lunar illumination conditions. However, if too much red is added or if the scene is made to bright, the NVG view will indeed be further enhanced; but the unaided scene can take on a distracting reddish cast or the pilot's unaided view can be unrealistically good for the lunar illumination level being simulated.

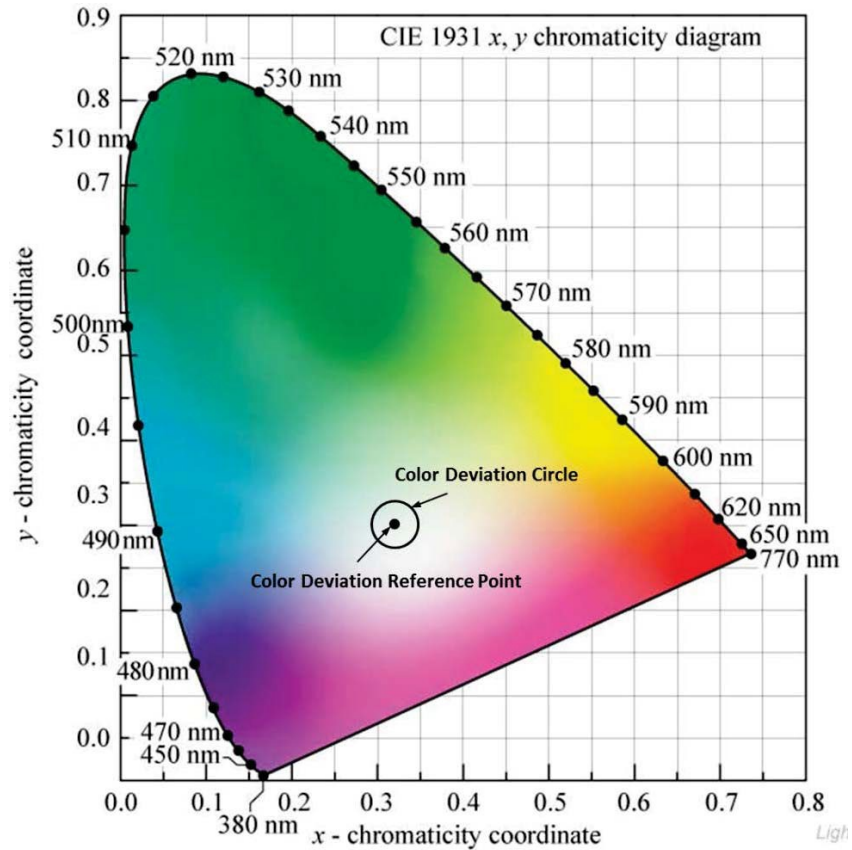
This Guidance Bulletin places objective limits on the above artifacts by:

- 1. Specifying Allowed Lunar Illumination Levels** – Objective test 4d tests that lunar illumination levels are within an acceptable range compared to equivalent real-world lunar illumination conditions. As a result, the out-the-window scene cannot be made too bright to artificially enhance the NVG view.
- 2. Specifying Allowed Color Deviation** – Objective test 4e limits the allowed color deviation as a function of lunar illumination level. A moderate color deviation is allowed between 100% lunar illumination and light level approximately equivalent to 30% real-world lunar illumination. No color deviation limits are levied below the approximate 30% level since color perception is virtually non-existent at those levels.

Allowed color deviations are specified in terms of 0.03 radius circular regions on the 1931 CIE chromaticity diagram as illustrated in the figure below. The allowed deviation is referenced to a Color Deviation Reference Point as shown on the figure. We cannot reference the allowed deviation to "white" because simulators may use different non-white colors for daylight solar illumination and for lunar illumination. Rather, the reference point for the deviation calculation must be measured. As suggested in test 4e, this can be done by measuring a fully reflective scene

object under high illumination levels where no color boost is being employed while assuring that same illumination color is being used. The specific method of establishing the reference, then, shall be identified as part of the test procedure.

Figure 1: CIE1931 x, y Chromaticity Diagram showing a typical reference point and the allowable .03 xy deviation



Attachment 2

Statement of Compliance for NVG Training Tasks

(Date)

Mr. (Name of Training Program Approval Authority)
Name of FAA FSDO
Address
City/State/Zip

Dear Mr/Ms (Name of TPAA)

RE: FSTD Statement of Compliance for Qualification of Night Vision Goggle (NVG) Training Tasks

(Operator Sponsor Name) requests evaluation of our (Aircraft Type) Flight Simulation Training Device (FSTD) for qualification of Night Vision Goggle training tasks. The FSTD with (FAA ID # or serial/project number####) is fully defined on the Preliminary Statement of Qualification FSTD Configuration List enclosed.

We have completed the tests of the FSTD and certify that it meets all requirements of 14 CFR Part 60 and National Simulator Program (NSP) Guidance for NVG qualification to include the cockpit configuration which accurately replicates the manufacturer's design, or replicates the appropriate Supplemental Type Certificate (STC) adaptation, for NVIS operations.

Appropriate hardware and software configuration control procedures have been established. Our Pilot(s), (Names(s)), who is (are) NVG qualified on (Aircraft Type) aircraft have assessed the FSTD and found it conforms to the (Operator/Sponsor) (Aircraft Type) cockpit configuration and is equivalent to those in the aircraft and that NVG devices used by the sponsor, or its clients, are compatible.

Any exceptions to the statements above including documented discrepancies or other considerations concerning NVG status or condition are attached along with expected correction or completion dates.

Sincerely,

(Sponsor Representative)

cc: FAA, National Simulator Program