

## Document Comment Log (Public Comment DISPOSITION)

Proposed Change to **AC 27-1, AC 27 MG 18**; Title: HELICOPTER TERRAIN AWARENESS AND WARNING SYSTEM (HTAWS).

Organization/ Commenter	Page & Para. No.	Comment & Reason for Comment	Recommendation / Suggested Change	Disposition / Comment Resolution
Garmin	Page MG 18-2, Para b. (1)	The sentence “The HTAWS certification should address the complete process.” refers to a “process” that is not otherwise defined.	Remove the sentence or define what “process” the certification should address.  If the sentence remains, recommend adding “installation” after “HTAWS” so the sentence points to the installation certification process vs the TSO certification process.	Adopted; change made.
Garmin	Page MG 18-4, Para d.(2)	The definition of aural alert is incorrect. Not all aural alerts are verbal.	Suggest changing to: “An <u>audible sound</u> <u>or</u> verbal statement used to annunciate a condition...”	Not adopted; DO-309 defines aural alerts as verbal.
Garmin	Page MG 18-4, Para d.(3)	Definition is stated as: “Caution Alert: An alert requiring flight crew awareness. Subsequent corrective action will normally be necessary.”  This is inconsistent with other previous definitions in AC27-1B of Caution level alerts which state: “serves to alert the operator to an impending dangerous condition requiring attention but not necessarily immediate action.”	Suggest changing to: “Caution Alert: <u>Alerts the operator to an impending dangerous condition requiring attention but not necessarily immediate action.</u> ”	Not adopted; this is the definition of “Caution Alert” found in DO-309, the HTAWS MOPS, and is used in this document for continuity and standardization

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Garmin	Page MG 18-4, Para d.(7)	<p>Definition is stated as:                      “Hazardously Misleading Information (HMI): An incorrect depiction of the terrain or obstacle threat relative to the rotorcraft during an alert condition (excluding source data). This means that the HTAWS alert information presented in the cockpit is in error relative to information contained in the terrain or obstacle database.”</p> <p>This definition is overly broad because it assumes that any error is both believable and results in the aircraft being placed at higher risk than prior to the information being received and acted on by the flight crew.</p>	<p>Suggest changing to “Hazardously Misleading Information (HMI): An incorrect depiction of the terrain or obstacle threat <u>relative to the rotorcraft that cannot be detected by the flight crew and which when acted upon by the flight crew results in an increased threat</u> to the rotorcraft during an alert condition (excluding source data). This means that the HTAWS alert information presented in the cockpit is in error relative to information contained in the terrain or obstacle database.”</p>	<p>Not adopted; this is the definition of “Hazardously Misleading Information” found in DO-309, the HTAWS MOPS, and is used in this document for continuity and standardization.</p>

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Garmin	Page MG 18-4, Para d.(7)	<p>Definition is stated as: “Hazardously Misleading Information (HMI): An incorrect depiction of the terrain or obstacle threat relative to the rotorcraft <b>during an alert condition</b> (excluding source data). This means that the HTAWS alert information presented in the cockpit is in error relative to information contained in the terrain or obstacle database.”</p> <p>Not sure if the intent is to define HMI as only during an alert condition.</p>	Consider intent and remove “during an alert condition” if appropriate.	Not adopted; this is the definition of “Hazardously Misleading Information” found in DO-309, the HTAWS MOPS, and is used in this document for continuity and standardization.
Garmin	Page MG 18-4, Para d.(8)	<p>Definition as stated is “HTAWS: A generic term used to describe an alerting system that provides the flight crew with sufficient information and time to detect potentially hazardous terrain or obstacle.”</p> <p>It may be communicative to provide the “decode” to what “HTAWS” stands for.</p>	<p>Consider changing to or adding to the definition of HTAWS the following:</p> <p><u>H</u>elicopter <u>T</u>errain <u>A</u>wareness and <u>W</u>arning <u>S</u>ystem</p>	Not adopted; Helicopter Terrain Awareness and Warning System (HTAWS) is spelled out in the section title.

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Garmin	Page MG 18-5, Para d.(12)	<p>As defined: “Obstacle: A human-made structure that is in the flight path of the rotorcraft.”</p> <p>An obstacle is an obstacle regardless of its location relative to the aircraft flight path.</p>	Suggest changing to “Obstacle: A human-made structure such as a cell tower, power lines, or building.”	Not adopted; this is the definition of “Obstacle” found in DO-309, the HTAWS MOPS, and is used in this document for continuity and standardization.
Garmin	Page MG 18-5, Para d.(15)	<p>As defined: “Unannounced Failure: A form of hazardous misleading information that is particular to warning systems, such as HTAWS.”</p> <p>It seems inappropriate to define any unannounced failure as HMI.</p>	Consider changing to: “Unannounced Failure: A failure condition that is not apparent to the flight crew.”	Not adopted; this term is used in DO-309, the HTAWS MOPS (see paragraph 2.1.6) and is used in SAE ARP 4761.
Garmin	Page MG 18-5, Para e.(2)	<p>As stated “Although TSO-C194 and RTCA/DO-309 do not require a reduced protection mode, applicants should consider providing a mode that will account for off-airfield operations that will still provide the pilot with essential alerts regarding terrain without ...”</p> <p>The “applicant” in this comment seems to be the TSO applicant not the installation applicant.</p>	<p>Clarify “TSO applicant” or “appliance applicant” since this function cannot be implemented at the installation level (the scope of this AC) without the “box” having the capability built into it.</p> <p>Alternately remove the paragraph since the comment seems to be directed to the appliance applicant vs the installation applicant and does not address a regulatory requirement.</p> <p>If the paragraph stays, please see next comment.</p>	Adopted; changed to read “TSO applicants.”

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Garmin	Page MG 18-5, Para e.(2)	<p>States that Reduced Protection (RP) mode should eliminate nuisance alerts during off airport operations.</p> <p>The elimination of nuisance alerts while operating in a non-airport environment is not practical if it is desired to provide protection from terrain. The realistic objective is to minimize nuisance alerts while providing positive protection.</p>	Suggest changing to: “(2) Although TSO-C194 and RTCA/DO-309 do not require a reduced protection mode, applicants should consider providing a mode that will account for off-airfield operations that will still provide the pilot with essential alerts regarding terrain <u>while minimizing</u> nuisance alerts.”	Adopted; change made.
Garmin	None	<p>Because Reduced Protection (RP) Mode performance is not specified by TSO-C194 nor RTCA/DO-309, it is necessary to test RP mode during initial airworthiness certification of the HTAWS system to ensure that alerts are provided with sufficient time to avoid terrain or obstacles.</p> <p>Specific test cases should be included such as – direct path into steep terrain, turn into steep terrain, slow descent into level terrain, and level flight into rising terrain.</p>	<p>Add a section discussing Reduced Protection Mode performance and testing including key points:</p> <ol style="list-style-type: none"> <li>1) Reduced Protection (RP) Mode should be evaluated during the initial airworthiness certification of the HTAWS system</li> <li>2) RP Mode should always provide an alert with sufficient time to avoid terrain or obstacles</li> <li>3) Specific tests that should be conducted with RP Mode</li> </ol>	Adopted; added content as paragraphs e.(2)(i) and (ii).

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Garmin	Page MG 18-6, Para e.(3)	<p>States that: “the FAA recommends that the HTAWS be designed such that the obstacle alerting envelopes remain the same as normal mode when the reduced protection mode is selected”.</p> <p>This design recommendation is not consistent with the stated scope and intent of the AC. This recommendation contains good input but it should be considered for the appliance level policy since there is nothing the installing applicant can do regarding this aspect of appliance design.</p>	<p>Consider removing this paragraph.</p> <p>If it stays, consider the next comment.</p>	<p>Not adopted; TSO-C194 and RTCA/DO-309 do not require a reduced protection but it is recognized that systems may include a reduced protection mode and guidance should be provided.</p>
Garmin	Page MG 18-6, Para e.(3)	<p>States that: “the FAA recommends that the HTAWS be designed such that the obstacle alerting envelopes remain the same as normal mode when the reduced protection mode is selected”.</p> <p>It has been Garmin’s experience from testing that the obstacle clearances required for normal mode, when considering normal mode to be that appropriate for IFR, provided excessive alerts and that a reduced alerting volume should be utilized for obstacles in reduced protection mode.</p>	<p>Suggest changing to “the FAA recommends that the HTAWS be designed such that <u>if obstacle alerting envelopes in reduced protection mode are different from those in normal mode, that they provide sufficient clearance from obstacles when conducting operations under envisioned VMC conditions.</u>”</p>	<p>Partially adopted: A reduction protection mode is a function of the HTAWS “box”. However, flight evaluations have shown that reduction protection mode allows the aircraft to come uncomfortably close to obstacles. The paragraph is changed to read:</p> <p>TSO-C194 and RTCA/DO-309 do not require a reduced protection mode. Applicants with systems that have a reduced protection mode with terrain and obstacle alerting envelopes different from those in the normal mode, should provide for sufficient alerting and clearance from terrain and obstacles when conducting VMC operations.</p>

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Garmin	Page MG 18-6, Para f.(1)	<p>As stated: “ (1) The scope of the applicant’s program should be directed toward airworthiness approval through the type certification, amended type certificate (TC), or supplemental type certificate (STC) processes. Installation of the HTAWS when integrated with other systems and equipment may result in a significant change under the changed product rule, 14 CFR 21.101. Installation of HTAWS in legacy aircraft may require meeting the current regulations that address installation of these newer technologies.”</p> <p>While this paragraph has permissive language and the AC itself is guidance not policy, this paragraph points strongly to STC or TC for HTAWS installations and fails to communicate that installations can accomplished under field approvals IAW Order 8900.1 CHG 198.</p>	<p>Add language to communicate when HTAWS is a candidate for field approval. Or, perhaps remove this paragraph since there is no new information specific to the installation of HTAWS contained in the paragraph. It is a reiteration of policy located in other places with the exception of setting the TC/STC “requirement” for the installation of HTAWS.</p> <p>Recommend the AC’s guidance promote installation of life saving HTAWS instead of raising potential barriers to installation.</p>	<p>Partially adopted; Field approval guidance is found in Order 8900.1. Current version does not mention HTAWS, but requires for GPWS an STC, for TAWS A engineering support, and for TAWS B an evaluation by an aviation safety inspector to determine certification path.</p> <p>Added wording in paragraph b.(3) to include certification of “terrain advisory” systems that do not meet this AC or TSO-C194.</p>

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Garmin	None	Obstacle alerting. Obstacles are frequently treated as a single point object but in reality obstacles, particularly tall obstacles, may have significant length and width due to guy wires. Obstacle alerting functions need to ensure that alerts are provided at sufficient distances and times to prevent flight into guy wires.	Add discussion on obstacle attributes and testing for those attributes.	Adopted; added content to paragraph g.(1).
Garmin	Page MG 18-7, Para g.(3)	<p>This paragraph discusses minimum design assurance levels in the wrong context. The list below this paragraph provides the minimum probability requirements for foreseeable HTAWS related failure conditions. It does not prescribe any DAL requirements. The terms DAL and Design Assurance Levels should be replaced with probability requirements or a more general term like “criteria” (which is the term used in the Part 23 and 25 ACs).</p> <p>Items (E) and (F) are not related to Design Assurance Level.</p>	<p>Suggest changing the terms “design assurance levels” and “DAL” to the same terms used in the equivalent paragraphs in the Part 23 and 25 TAWS guidance.</p> <p>Move items (E) and (F) to another location so they are not confused with DAL.</p>	<p>Partially adopted; “design assurance” level or development is language common to TSO-C194, DO-309, and SAE ARP 4761.</p> <p>Items (E) and (F) were not moved but paragraph wording was changed to align with the intent of items (A) through (F) as installation requirements rather than design assurance levels.</p>

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Garmin	Page MG 18-7, Paragraph (3)	<p>States that “Rotorcraft that operate under regulations that require HTAWS must conform to ... operational reliability and functional requirements.”</p> <p>It does not matter whether the rotorcraft is operating under regulations that require HTAWS. Rather, if the HTAWS equipment is installed in the aircraft, it must meet the required operational reliability and functional requirements.</p>	Suggest changing to “Rotorcraft <u>with HTAWS installed</u> must conform to ... operational reliability and functional requirements.”	Not adopted; HTAWS may be installed in rotorcraft that operate under rules that do not require HTAWS. There is no requirement or DAL for availability or against “loss of” HTAWS if it is not required. The DAL for MHI is the same whether it is required or not.
Garmin	Page MG 18-7, Paragraph (3)	<p>States that: “The loss of all HTAWS functions is assigned the failure condition classification of minor by TSO-C194.”</p> <p>The loss of HTAWS is minor only when it is an annunciated loss.</p>	Suggest changing to “The <u>annunciated</u> loss of all HTAWS functions is assigned the failure condition classification of minor by TSO-C194.”	Adopted; change made because “annunciated loss” is consistent with DO-309 language.

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Garmin	Page MG 18-7, Para g.(3)	<p>States that: “Failure of the HTAWS to provide accurate terrain and obstacle aural and visual alerts, on rotorcraft that operate under rules that require HTAWS ...”</p> <p>The word “accurate” is not an appropriate choice; a better choice would be “required”.</p> <p>Also, it does not matter whether the rotorcraft is operating under rules that require HTAWS. Rather, if the HTAWS equipment is installed in the aircraft, it must function as intended whether or not it is required by operating rules.</p>	Suggest changing to “Failure of the HTAWS to provide <u>required</u> terrain and obstacle aural and visual alerts, on rotorcraft <u>in which it is installed</u> , ...”	Not adopted; DO-309 is a performance specification and accuracy of information display is a performance criteria. The term “required terrain” is not found in the MOPS.
Garmin	Page MG 18-7, Para g.(3)(A)	Fails to differentiate between annunciated and unannunciated failures.	Suggest changing to “The probability of an <u>annunciated</u> failure that would lead to the loss of all HTAWS functions that are described in paragraph e. above must be less than or equal to 10-3 per flight hour.”	Adopted; change made because “annunciated loss” is consistent with DO-309 language.

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Garmin	Page MG 18-7, Paragraph.(3)(B)	<p>States that “The probability of a false caution or warning alert due to undetected or latent failures must be less than or equal to <math>10^{-5}</math> per flight hour.”</p> <p>The effect of the false alert is that the pilot will attempt to make visual contact with the terrain or obstacle then maneuver the rotorcraft appropriately. If visual contact cannot be made the pilot may maneuver the rotorcraft proactively (climb). The effect of this failure would be a slight increase in workload which would be a MINOR classification.</p>	Suggest changing to “The probability of a false caution or warning alert due to undetected or latent failures must be less than or equal to $10^{-3}$ per flight hour.”	<p>Not adopted; misleading information can occur in two different ways:</p> <ol style="list-style-type: none"> <li>1. A false alert occurs if HTAWS issues a caution or alert for terrain or obstacle when an alert is not justified by terrain or obstacle inside the alert envelope.</li> <li>2. An unannounced caution or alert occurs if HTAWS fails to issue a legitimate alert justified by terrain or obstacle inside the alert envelope.</li> </ol> <p>This comment addresses the first possibility. Item two is arguably the most hazardous and justifies the DAL assigned for hazardously misleading information defined by TSO-C194 and DO-309.</p>

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Garmin	Page MG 18-7, Para g.(3)(B), g.(3)(C), g.(3)(D)	Both Part 23 and 25 ACs acknowledge that at the TAWS equipment level probability of a false caution/warning, unannounced loss, or misleading event is to be improbable (1E-5) per the TSO. Therefore, as installed, it is possible that the probability of this event may be higher than 1E-5 since there will be other airframe contributors. The Part 23 and 25 ACs allow the system, when installed, to meet a probability of E-4 for the false cautions or warnings, unannounced system failure and HMI to the TAWS display failure conditions. The proposed part 27 AC does not make these same allowances and will make it very challenging to meet these requirements.	Suggest changing the probability requirements listed in this AC to the same allowed for Part 23 and Part 25.	Not adopted; part 27 or 29 operations that require HTAWS (such as HEMS) where rotorcraft routinely operate in close proximity to, around and between obstacles and terrain, landing and taking off from remote locations are much different than part 23 or 25 operations.  TSO-C194 by reference to DO-309 specifies the failure rate for hazardously misleading information to be 1E-5.

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Garmin	Page MG 18-9, Para h.(2)	<p>States “Locate visual alerts in the pilot’s primary field of view. HTAWS status and mode selection annunciation (i.e., inhibit, reduced protection mode, or other pilot selectable mode) should be as close to the pilot’s primary field of view as possible to enable rapid assessment of HTAWS status and configuration.”</p> <p>Primary field of view is not defined elsewhere in AC27-1B and therefore needs to be defined.</p>	<p>Suggest changing to “Locate visual alerts in the pilot’s <u>optimum</u> primary field of view. HTAWS status and mode selection annunciation (i.e., inhibit, reduced protection mode, or other pilot selectable mode) should be as close to the pilot’s primary field of view as possible to enable rapid assessment of HTAWS status and configuration.”</p> <p>From AC20-138B: <b>Primary Field of View.</b> The vertical and horizontal visual fields relative to the design eye reference point that can be viewed with eye rotation only using foveal or central vision. The values for the horizontal (relative to the normal line of sight) are +/-15 degrees optimum, with +/- 35 degrees maximum. The values for the vertical (relative to normal line of sight) are +/-15 degrees optimum, with + 40 degrees up and -20 degrees down maximum (see AC 25-11 latest revision).</p>	Not adopted; “primary field of view” is now defined in update to AC 27-1 section 27.1321 and AC 29-2 section 29.1321.

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Garmin	None	Terrain alerting - selection of databases. Terrain databases vary significantly in resolution, quality and treatment of permanent features such as forests which may be significantly different in elevation than the underlying terrain. It is necessary to evaluate the operation of HTAWS over a variety of topological conditions to ensure that protection is provided.	Add discussion on the terrain data used in the HTAWS system and the need to consider alerting performance over a range of topographies.	Adopted; added content to paragraph j.(2).
Garmin	None	Neither TSO-C194 nor RTCA/DO-309 have a requirement for a particular terrain scale to be used for the map that depicts terrain elevation relative to rotorcraft altitude. Therefore, the terrain scale should be carefully evaluated during initial certification of the HTAWS system. Additionally, it should be recommended that terrain scales not change based on selected mode and that the terrain scale be able to be selected by the pilot for display on the terrain map.	<p>Add a section discussing terrain scales including the key points that:</p> <p>The terrain scale:</p> <ol style="list-style-type: none"> <li>1) Should be evaluated during the initial airworthiness certification of the HTAWS system</li> <li>2) Should not change based on selected mode of operation</li> <li>3) Should be able to be displayed if selected by the pilot.</li> </ol>	Adopted; added content paragraph j.(3)(iv).

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Garmin	Page MG 18-11, Para j.(3) Note	<p>States that: “Operations into off-airfield locations should not trigger nuisance alerts.”</p> <p>The elimination of nuisance alerts while operating in a non-airport environment is not practical if it is desired to provide protection from terrain. The realistic objective is to minimize nuisance alerts while providing positive protection.</p>	Suggest changing to “Operations into off-airport locations should <u>have a minimum of</u> nuisance alerts.”	Adopted; change made in the “Note:” paragraph.
Garmin	Page MG 18-11, Para j.(4)	<p>States that: “The applicant should perform sustained standard rate turns to evaluate: ...”</p> <p>Testing with standard rate turns alone is an insufficient means of evaluation. The test should also include climbs and descents.</p>	Suggest changing to “The applicant should perform sustained standard rate turns <u>and climbs/descents to</u> evaluate:...”	Adopted; change made to include “climbs, and descents...”
Garmin	Page MG 18-12, Para k.(2)(ii)	<p>States that: “Terrain or Obstacle Warning Alert. When a terrain or obstacle warning alert occurs, immediately initiate a maneuver that will provide maximum terrain or obstacle clearance, until all warning alerts cease.”</p> <p>The word “maximum” is ambiguous and unnecessary. The word “sufficient” is more appropriate.</p>	Suggest changing to “Terrain or Obstacle Warning Alert. When a terrain or obstacle warning alert occurs, immediately initiate a maneuver that will provide <u>sufficient</u> terrain or obstacle clearance, until all warning alerts cease.”	Not adopted; the descriptor “sufficient” is more ambiguous than “maximum.”

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Honeywell Gary Ostrom <a href="mailto:gary.ostrom@honeywell.com">gary.ostrom@honeywell.com</a>	Page 12 k. 2 i	It would be good to make this paragraph consistent with the definition provided in d. 3 and k. 2 ii.	Change: From: (i) Terrain or Obstacle Awareness Caution. When a terrain or obstacle caution alert occurs, verify the rotorcraft flight path and correct it, if required. To: (i) Terrain or Obstacle Awareness Caution <b>Alert</b> . When a terrain or obstacle caution alert occurs, verify the rotorcraft flight path and correct it, if required.	Adopted; change made.
Honeywell Gary Ostrom <a href="mailto:gary.ostrom@honeywell.com">gary.ostrom@honeywell.com</a>	Page 12 k. 2 ii	It would be good to make this paragraph consistent with the definition provided in d. 17 and k. 2 i.	Change From: (ii) Terrain or Obstacle Warning Alert. When a terrain or obstacle warning alert occurs, immediately initiate a maneuver that will provide maximum terrain or obstacle clearance, until all warning alerts cease.  To:  (ii) Terrain or Obstacle <b>Awareness</b> Warning Alert. When a terrain or obstacle warning alert occurs, immediately initiate a maneuver that will provide maximum terrain or obstacle clearance, until all warning alerts cease.	Adopted; change made.

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Garmin	None	The minimum operating speed for HTAWS is not defined in TSO-C194 nor RTCA/DO-309 and should therefore be considered during airworthiness certification of the HTAWS system. Protection should be provided down to a speed associated with normal operations when the ability to avoid obstacles or terrain may benefit from alerting. However, alerting should not be provided at very low speeds due to the possibility for a large number of alerts, ability of the pilot to see and avoid terrain at slow speeds, and lack of certainty regarding rotorcraft flight path. A minimum operating speed of 20 to 30 knots is appropriate for most rotorcraft.	Add discussion on minimum operating speeds for HTAWS alerting.	Not adopted; this is beyond the scope of the AC change. This should be addressed by TSO/MOPS.