S-TEC Corporation
One S-TEC Way, Mineral Wells Municipal Airport
Mineral Wells, TX 76067
Supplement No. HeliSAS-RFMS-407

S-TEC

FAA APPROVED
ROTORCRAFT FLIGHT MANUAL
SUPPLEMENT
TO THE
Bell Helicopter Textron 407
ROTORCRAFT FLIGHT MANUAL
WHEN EQUIPPED WITH THE
HeliSAS/Autopilot System

REGISTRATION #: _____ SERIAL #: _____

The information in this supplement is FAA approved and must be attached to the appropriate FAA Approved Bell Helicopter Textron Model 407 Rotorcraft Flight Manual when the Hoh Aeronautics, Inc., HeliSAS/Autopilot system is installed in accordance with:

STC No. SR02344LA

The information contained in this document supplements or supersedes the basic manual only in those areas listed herein. For limitations, emergency procedures, normal procedures, and performance information not contained in this supplement, consult the basic FAA Approved Rotorcraft Flight Manual.

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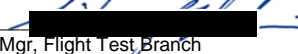
       Manager, Flight Test Branch, ANM-160L
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A	all 3 4 6-7 8 11 12	3 Jun 2013	- STC owner - IMC limit, temp limits - Fail cond. #3 - Start, Run-up procedure - SAS/AP speeds - ALT note - Refer to POH	Mgr, Flight Test Branch ANM-160L, FAA, Los Angeles ACO, Transport Airplane Directorate Date: June 3, 2013

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B	1 10	19 Jul 2013	- Update TOC - Add statement for published backcourse procedure	*(signature redacted)* for Mgr, Flight Test Branch ANM-160L, FAA, Los Angeles ACO, Transport Airplane Directorate Date: _July 19, 2013_
C	1 2 3 5-8 7 8 13-17 all	24 Jan 2014	- Update TOC - basic SAS added - SAS ON/OFF switch added - SAS switch procedures added - Trim description - HCP (if installed) - SAS switch and beep trim switch descriptions added repaginated	*(signature redacted)* Mgr, Flight Test Branch ANM-160L, FAA, Los Angeles ACO, Transport Airplane Directorate Date: _Jan, 24, 2014_

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Rev No.	Pg No	Date	Description of Change	FAA Approved
D	3	30 Apr 2015	Added external load operations limitation.	Mgr. Flight Test Branch ANM-160L, FAA, Los Angeles ACO, Transport Airplane Directorate Date: 4-30-2015

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SECTION 1:   GENERAL

This supplement contains the changes to the basic flight manual procedures and additional data applicable when the HeliSAS® two-axis (pitch & roll) stability augmentation system SAS) and optional autopilot is installed on the helicopter.

The attitude-command-attitude-hold SAS mode of the HeliSAS maintains helicopter attitude in all flight conditions by applying corrective inputs to the cyclic in order to maintain the commanded or reference attitude. An autopilot option can add modes providing altitude-hold, heading-hold, navigation signal tracking, and vertical (approach) navigation features depending on installed avionics.

> **CAUTION**
> SAS is intended to enhance safety by reducing pilot workload. It is not a substitute for adequate pilot skill nor does it relieve the pilot of the responsibility to maintain adequate outside visual reference.

With the basic system, SAS is selected and de-selected by pushing the SAS ON/SAS OFF switch shown in Figure 1.

Figure 1 HeliSAS SAS ON/SAS OFF Switch

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With the addition of the autopilot option, SAS and autopilot modes are selected and de-selected by pushing buttons the HeliSAS control panel (HCP) shown in Figure 1.

Figure 2 HeliSAS Control Panel (HCP)

If the optional beep trim is installed, there will be a four-way beep switch installed on the cyclic, similar to Figure 3.

Figure 3 Bell 407 Cyclic with Beep Trim

SECTION 2:   LIMITATIONS

1. Flight in Instrument Metrological Conditions is not authorized.
2. External load operations are not authorized.

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Flight and Maneuvering

Pilot's hand must be on the cyclic grip under the following conditions:

During SAS engagement or intentional disengagement

At indicated airspeeds less than 44 KIAS when flying in close proximity to the terrain

Altitude

Maximum density altitude with SAS engaged – 14,000 ft

Temperature

Operation of the HeliSAS is not permitted below an OAT of -32 degrees C.

SECTION 3:   EMERGENCY PROCEDURES

SAS Disengagement or Failure

SAS disengagement or failure is indicated by four beeps in the headset and/or erratic cyclic control motion or forces or unexpected deviations in pitch or roll attitude.

1. Immediately assume full manual control. Override the SAS/autopilot as necessary and disengage the system as soon as possible.

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2. If SAS annunciator LED is amber or white (standby mode), re-engagement may be attempted at pilot's discretion.

3. Inability to re-engage SAS indicates that it has failed.

> **CAUTION**
> If unexpected attitude deviations occur, and/or the cyclic forces and/or motions are erratic, the pilot should take manual control of the cyclic and disengage SAS immediately.

A disengagement of an autopilot mode that is not commanded by the pilot via the AP DISC or HCP push buttons is indicated by a single beep in the headset. Take appropriate corrective action for unassisted vertical and horizontal navigation. Normally the basic SAS is still functional after a disengagement of one or more autopilot modes. Normal operation of the SAS will be confirmed by continued illumination of the green LED just above the "SAS" push button on the HeliSAS control panel and existence of a cyclic-centering force gradient.

SAS/Autopilot Does Not Disengage

Pressing AP DISC or SAS ON/OFF button or SAS button on HCP does not disengage SAS – Circuit Breaker - Pull

Pilot should continue the flight using manual control.

> **NOTE**
> If the system is disengaged using the circuit breaker the pilot should not attempt to re-engage the circuit breaker during the remainder of the flight.

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Cyclic Jam

If the cyclic forces become excessive or the cyclic appears to be jammed:

1. Immediately disengage the SAS using the red AP DISC on the cyclic grip or the SAS button on the instrument panel or the SAS button.

2. If the above measure does not relieve the cyclic jam, pull the SAS circuit breaker.

3. Continue the flight using manual control.

SECTION 4:   NORMAL PROCEDURES
SAS Mode

Observe that SAS ON/OFF button is solid amber or the SAS LED on HCP is white, indicating that SAS is in standby mode.

SAS may be engaged prior to liftoff, throughout landing, and at any airspeed.

Engage SAS by pressing SAS button (on instrument panel or HCP) or holding FTR button on cyclic for at least 1.25 seconds.

SAS may be disengaged by pressing SAS button (on instrument panel or HCP) or AP DISC button on cyclic.

If autopilot modes are engaged, the AP DISC button must be pressed twice or held for at least 1.25 seconds to disengage SAS.

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NOTE

The pilot's hand must be on the cyclic when the SAS is disengaged.

Safety monitors automatically disengage the SAS/autopilot if a malfunction is detected. Automatic disengagement of an autopilot mode while the SAS remains functional is indicated by a single beep in the headset. Automatic or intentional disengagement of the entire system is indicated by four beeps in the headset.

Starting and Run-Up (once per day)

Apply power to the HeliSAS. Note flashing SAS ON/OFF switch or alternate white and green flashing annunciator lights on the HCP (if installed).

Observe that system enters standby mode (flashing stops and amber OFF for SAS switch or white SAS LED on HCP) when:
- ADAHRS is fully aligned or
- Panel mounted attitude gyro has bank angle less than 6 deg.

Engage SAS and note SAS ON is white on switch or SAS LED is green on HCP. If SAS will not engage, it is not functional and will not be available for use in flight.

Displace cyclic slightly in pitch and note resisting force. Release cycle and note that it returns to center. Repeat in roll.

Depress force-trim-release button and note very low resistance to cyclic motion in pitch and roll

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Depress AP Disc button on cyclic and note 4 beeps in headset and SAS ON/OFF switch changes from white ON to amber OFF, or the SAS LED changes from green to white on the HCP.

Move cyclic in pitch and roll and note lack of resisting force

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NOTE

Verify aural warning function (four beeps in headset) by engaging and disengaging SAS prior to liftoff

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CAUTION

With SAS engaged, pilot must always monitor the flight controls and aircraft attitude, and be prepared to immediately assume full manual control if required.

Autopilot Engage and Disengage (if HCP installed)

Autopilot modes may only be engaged if SAS is active.

Single press of AP DISC button on cyclic grip disconnects all autopilot modes – SAS remains engaged.

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To disconnect autopilot and SAS modes:
1. Press SAS button on HCP or,
2. Press AP DISC twice, or once for at least 1.25 seconds

SAS is available at all airspeeds. Autopilot modes are only available above 44 KIAS.

The following autopilot modes are available <u>depending on installed avionics</u>:

Heading Mode (HDG)

Set heading bug on HSI, EFIS display, or directional gyro.

Press HDG button on HCP - LED above heading on HCP turns green.

Helicopter will turn to and hold the selected heading.

NOTE

If a directional gyro is the heading source, and that sensor fails, HDG holds the current GPS track angle. The commanded GPS track angle may be reset by flying through the system to achieve a desired track angle and pressing and releasing the FTR button on the cyclic grip.

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Navigation Mode (NAV)

Select VLOC or GPS as course reference on navigation receiver and check for valid signal.

If HDG is active, turn heading bug to desired intercept angle

Press NAV button on HCP and observe that the LED above NAV is white, indicating that NAV is armed

NAV will automatically transition from armed to active at course intercept. NAV LED changes from white to green at intercept.

If HDG is not active when NAV is selected, autopilot will intercept course at a 45 deg angle.

NOTE

If an ILS is programmed into the GPS, the GPS navigation radio may automatically switch from GPS to VLOC. If in NAV mode, this will cause the autopilot to automatically transition from tracking an active GPS course to the course that is set on the HSI.

NOTE

When executing an ILS or localizer approach in VLOC mode, it is recommended that the GPS overlay for that approach be active in the navigation receiver. This will enhance localizer capture and tracking in strong crosswinds and improves pilot situational awareness.

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Backcourse Mode (BC)

Use of backcourse mode is only permitted when flying a published backcourse procedure.

If HDG is active, turn heading bug to desired intercept angle

Press BC button on HCP and observe that the LED above BC is white, indicating that BC is armed

BC will automatically transition from armed to active at course intercept. BC LED changes from white to green at intercept.

If HDG is not active when BC is selected, autopilot will intercept course at a 45 deg angle.

Altitude Hold Mode (ALT)

Select ALT at the desired altitude. Autopilot will hold this altitude.

If in climb or descent when ALT is selected, rotorcraft will gently level off and fly back to selected altitude

To make a small change in altitude with ALT engaged:

1. Fly through system to desired altitude
2. Press and release the FTR button
3. Reference altitude will be reset to current altitude

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NOTE

If in a rapid climb or descent, the lag in the altimeter will cause the final altitude to be slightly different than selected. Fly through system to desired altitude and reset reference altitude.

NOTE

The autopilot uses pitch attitude to control altitude so airspeed will vary with power setting. Rapid changes in collective will result in changes in altitude. This can be avoided by making collective changes slowly when ALT is engaged.

Vertical Navigation Mode (VRT)

VRT is used to track ILS or VNAV glideslopes associated with instrument approach procedures.

For ILS approaches, tune ILS frequency in navigation receiver and ensure that glideslope is valid.

For GPS approaches, ensure approach is loaded and activate approach on GPS receiver.

Select VRT on HCP prior to glideslope intercept. The GPS glideslope must be valid for VRT to arm. LED above VRT will be white showing that glideslope is armed.

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Autopilot will automatically intercept and track glideslope. LED above VRT changes from white to green at glideslope intercept.

NOTE

Recommend slowly reducing power just prior to glidepath intercept. Power changes should be made slowly while tracking glidepath to avoid large excursions from the glidepath.

NOTE

Selecting ALT while VRT is armed will cause VRT to dis-arm. It is therefore necessary to re-arm VRT if ALT is selected after arming VRT.

NOTE

VRT will automatically disengage when the GPS navigation radio CDI button is switched from VLOC to GPS at the beginning of a missed approach procedure. This will be accompanied by a one second beep in the headset.

SECTION 5:   WEIGHT & BALANCE

No Change

MANUFACTURE'S DATA

Additional information is available in the HeliSAS Pilot Operating Handbook.

System Description

The HeliSAS SAS/Autopilot consists of two electromechanical servo-actuators, a flight control computer (FCC), a special panel-mounted analog attitude indicator or digital attitude heading reference system (AHRS)/ air data attitude heading reference system (ADAHRS) which provides the FCC with attitude information, two or three buttons on the cyclic stick, and interconnecting cables. The basic system provides only the SAS functions, and includes a SAS ON/OFF switch. The optional full system provides both SAS and autopilot functions, and includes a HeliSAS Control Panel (HCP). One servo-actuator controls pitch, the other controls roll, and both are connected to the cyclic through electromagnetic clutches. If the attitude source is from a remote ADAHRS, the Fast/Slave switch not used in flight, but is only used for maintenance functions.

When the SAS/autopilot is engaged, the FCC senses aircraft attitude, heading, angular rates and linear accelerations using a combination of sensors in the flight control computer and attitude gyro and directional gyro, or AHRS.   Airspeed and altitude information is obtained from the aircraft pitot/static system. The FCC sends signals to the servo-actuators to apply small corrections to the cyclic as required to maintain the commanded or reference attitude.

Force-trim-release (FTR) and autopilot/SAS disconnect (AP DISC) buttons are mounted on the cyclic grip. The FTR button is used to reset the trim attitude reference when in SAS mode.

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In addition, if the SAS is in a standby condition holding the FTR button for more than 1.25 seconds engages the SAS. Pressing and releasing the FTR button resets the reference altitude when in ALT mode and the reference track angle if in HDG mode with no directional gyro heading or AHRS heading reference. The latter function requires that a functioning GPS is connected to the FCC. This reversion to GPS-track-hold only applies when the heading source is a directional gyro (does not apply to systems that use an AHRS for heading).

An optional beep trim switch may be installed in addition to the FTR button, and allows the pilot to proportionally modify the trim pitch and roll attitudes. This is a four-way momentary switch on the cyclic grip in the shape of a coolie hat. Holding the switch aft results in a steadily increasing change in trim pitch attitude (nose up). Pushing it forward results in a steadily decreasing trim pitch attitude (nose-down). Holding it right causes the trim roll attitude to increase right wing down, and holding it left causes the trim roll attitude to increase in a left-wing down direction. The maximum trim attitudes that may be achieved with beep trim are the same as noted above for the FTR button.

Safety monitors can automatically disengage autopilot modes due to detected malfunctions or loss of a valid navigation signal. Automatic autopilot disengagement is indicated by a single beep in the headset. The basic SAS (attitude hold) is still functional after a single beep. Intentional disengagement of an autopilot mode does not trigger a headset beep.

The SAS is powered from the helicopter electrical buss via a dedicated circuit breaker.

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Normal Operation

The SAS performs a self test and enters standby mode during aircraft start and warm-up. Standby mode is indicated by annunciation of the white LED light above the SAS mode button on the HCP. The HCP mode LEDs alternate between white and green during power-up and self test. An aural warning test (four headset beeps) is part of the self test.

> **NOTE**
> After initial power up the SAS will not enter standby mode until the attitude gyro bank angle is less than 6 degrees or the AHRS is aligned.

Once the system is in standby mode and while still on the ground and wearing the headset, the system should be engaged with cyclic friction off. The cyclic should exhibit a centering tendency. Disengage the system using the AP DISC button on the cyclic and note 4 beeps in the headset. Note that the cyclic forces are nearly zero with the system disengaged.

HeliSAS is intended to be active or in standby mode at all times. This is to ensure that the SAS can be quickly engaged if needed.

HeliSAS may be engaged at pilot's discretion using the HCP SAS mode button.   An white OFF indication turns to green ON when the system is engaged. If the HCP is installed, HeliSAS may be engaged at the pilot's discretion using the HCP SAS mode button. A white indication on the SAS LED turns green when the system is engaged. The SAS may also be engaged by pressing the force-trim-release (FTR) button on the cyclic grip for more than 1.25 seconds.

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Additional autopilot modes may be engaged using the other HCP mode buttons (if installed), but only when indicated airspeed is greater than 44 KIAS. .

The SAS may be used throughout the flight envelope (including hover and autorotation) at pilot's discretion.

> ***NOTE***
> Cyclic friction must be off for the SAS or autopilot to work properly. Engaging cyclic friction inhibits the ability of the SAS to stabilize the helicopter.

When the SAS is engaged while airborne, it will maintain the pitch and roll attitude at the time of engagement within the following limits. The system will not trim to pitch attitudes greater than 6 degrees nose-down, 11 degrees nose-up, and 5 degrees bank. If the system is engaged with the helicopter in a large pitch or roll attitude, it will fly the helicopter to a nearly level attitude. After SAS engagement, the reference attitude may be adjusted using the FTR button on the cyclic grip. The system will maintain the attitude at which the trim button is released, within the above limits.

To re-trim, use a small amount of force to override the SAS and then push and release the FTR button at the desired attitude. The "fly-through" SAS is designed to remain engaged during maneuvering. If the cyclic force to override the SAS is objectionable, the system may be disengaged, or the FTR button may be held down while maneuvering. SAS inputs to the cyclic are disabled while the trim button is held down. Proportional "beep" trim is an option that may be installed in addition to the force trim release button. This consists of a four-way momentary switch mounted on the cyclic that allows the trim pitch and roll attitude to be modified proportionally within the trim limits stated in Manufacturers Data.

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> **NOTE**
> The SAS should always be in standby mode when it is not engaged.   This allows immediate engagement if required.

Safety Tip

The SAS provides stability to reduce pilot workload and enhance safety. It is important that pilots do not misuse this capability and allow their attention to be diverted from monitoring helicopter attitude and looking for traffic and other obstacles. Due to the unstable nature of helicopters, SAS disengagement requires immediate pilot attention. Pilots must always be prepared to take immediate manual control.