# SFAR 73

- Why SFAR 73 was created
- Applicability
- Required Training
- Aeronautical Experience
- Flight Review
- Endorsements
- Awareness Training

# Creation of SFAR 73

Between 1981 and 1995, the NTSB investigated 31 R22 and 3 R44 fatal accidents involving an in-flight loss of main rotor control.

Because of these accidents a special investigation was prompted.

# Creation of SFAR 73

The investigation found the following characteristics to be common in these accidents:

1)An in-flight breakup *or* main rotor blade contact to the airframe occurred in flight, before collision with any object or terrain.

2)There was no evidence of a pre-existing airframe or engine component malfunction.

3) Weather was not a factor (low visibility or ceilings).

4) Pilots tested negative from drugs or alcohol.

# Creation of SFAR 73

The investigation reported that because the R22 is operated so close to its maximum gross weight, which results in near maximum lift design capability of the main rotor system, the R22's main rotor blade angle-of-attack will occasionally be near the stall angle-of-attack during normal operations.

These conditions, coupled with the fact that the R22 controls are very sensitive, led investigators to believe that the accidents were a result of large, abrupt control movements, which caused excessive flapping and teetering of the main rotor. The excessive flapping and teetering eventually caused the blades to contact the tail boom and completely stall the main rotor.

According to Robinson and a simulation study conducted by Georgia Tech, as little as 11 large, abrupt control movements may produce main rotor blade stall and rapid decay of the rotor rpm.

# Creation of SFAR 73

After these facts the FAA concluded:

"Because the R22 is more responsive to cyclic control inputs than other helicopters normally used in training or by low-time pilots, special training requirements for both student pilots and flight instructors are needed."

# Creation of SFAR 73

As a result the FAA issued SFAR 73 on February 23, 1995.

These “special rules” altered the regulations for Robinsons by:

1) Changing biennial flight review requirements by requiring R22 & R44 pilots to perform flight reviews in the R22 & R44;

2) Increasing the amount of dual training required before a pilot may receive their private pilot certificate; and

3) Mandating special awareness training specific to the R22 and R44 helicopters.

# Creation of SFAR 73

Because of these changes, fatal accidents in Robinson Aircraft have since been reduced.

# SFAR 73
# Who does it apply to?

"Anyone who seeks to manipulate the controls or act as pilot in command of a R22 or R44 helicopter."

# SFAR 73
# Required Training

Anyone who seeks to manipulate the controls of an R22/R44, must have "Awareness Training" (ground instruction) outlined in paragraph 2.(a)(3)(i-v) with a sign-off for that training by an appropriately endorsed CFI (one who's authorized to give SFAR 73 training).

(3) Awareness training must be conducted by a certified flight instructor who has been endorsed under paragraph (b)(5) of this section and consists of instruction in the following general subject areas:

(i) Energy management;

(ii) Mast bumping;

(iii) Low rotor RPM (blade stall);

(iv) Low G hazards; and

(v) Rotor RPM decay.

*Exception:* If a rated helicopter pilot has recently attended the Robinson Factory Course, they can take their Robinson "graduation" certificate to the FAA FSDO and get a sign-off from the FAA for the Awareness ground training.

# SFAR 73
# Required Training

SOLO STUDENTS: Must have had Awareness ground training with a sign-off prior to manipulating the controls, plus at least 20 hours dual in an R-22 including maneuvers outlined in paragraph (2)(b)(3)(i-iii) with a sign-off prior to solo.

(A) Enhanced training in autorotation procedures,

(B) Engine rotor RPM control without the use of the governor,

(C) Low rotor RPM recognition and recovery, and

(D) Effects of low G maneuvers and proper recovery procedures.

NOTE: Even though "Low G" flight training is still contained in the SFAR, a FAA Airworthiness Directive and Flight Manual limitation prohibits doing "low G" training in flight.

This training and sign-off must be given each 90 days and is in addition to any other solo training or sign-offs required by FAR Part 61. Prospective students on a demo flight may not manipulate the controls without first having had the Awareness training. Since the SFAR doesn't define "manipulating the controls," one might safely assume that if only the instructor is manipulating (moving) the controls and the prospective student is merely following along on the controls, this would be OK so long as the instructor does not relinquish any operational control of the aircraft to the student.

# SFAR 73
# Required Training

RATED HELICOPTER PILOT WITH 200 HRS HELICOPTER/50 HRS R-22: To be PIC of an R-22, must have at least 200 hours helicopter, of which 50 hours was in the R-22, and must have evidence in his/her logbook of having completed the Awareness ground training w/sign-off. No immediate flight checkout under SFAR 73 is required, however, this pilot must have had some SFAR 73 ground and flight training and a sign-off for such training within the last two years. (See FLIGHT REVIEW )

RATED HELICOPTER PILOT WITHOUT 2OO HRS HELICOPTER/50 HRS R-22: To be PIC must first have Awareness Training and at least 10 hours dual in the R-22, including the "abnormal and emergency procedures" flight training specified in paragraph 2.(b)(1)(ii)(A-C) with a sign-off for such flight training by an appropriately endorsed CFI.

A rated helicopter pilot with less than 200/50 hours must repeat this flight training requirement each 12 months until they accumulates 200 hours helicopter and 50 hours R-22 time.

NOTE: The wording in Paragraph 2.(b)(1)(ii) may be misleading in that it uses the term "flight review." As used in the SFAR, "flight review" only means the flight training required by paragraph 2.(b)(1)(ii)(A-C) and should not be confused with the flight review (BFR) requirements of FAR 61.56.

# SFAR 73
# Required Training

CERTIFIED FLIGHT INSTRUCTORS: To instruct in an R22/R44 must have at least 200 hours helicopter of which 50 are in the R22/R44 (25 R22 hours may be credited toward the R44 time), Awareness Training w/sign-off, plus flight training by an FAA ASI/DPE in the maneuvers & procedures outlined in paragraph (b)(5)(iii)(A-C) w/sign-off by that ASI/DPE. The flight instructor must "satisfactorily demonstrate an ability to provide instruction on the Awareness Training items in paragraph 2(a)(3) and the flight training identified in paragraph 2(b)(5)(iii)" in order to receive this endorsement from the ASI/DPE.

# SFAR 73
# Aeronautical Experience

(1) No person may act as pilot in command of a Robinson model R-22 unless that person:

(i) Has had at least 200 flight hours in helicopters, at least 50 flight hours of which were in the Robinson R-22; *or*

(ii) Has had at least 10 hours dual instruction in the Robinson R-22 and has received an endorsement from a certified flight instructor authorized under paragraph (b)(5) of this section that the individual has been given the training required by this paragraph and is proficient to act as pilot in command of an R-22. Beginning 12 calendar months after the date of the endorsement, the individual may not act as pilot in command unless the individual has completed a flight review in an R-22 within the preceding 12 calendar months and obtained an endorsement for that flight review. The dual instruction must include at least the following abnormal and emergency procedures flight training:

(A) Enhanced training in autorotation procedures,
(B) Engine rotor RPM control without the use of the governor,
(C) Low rotor RPM recognition and recovery, and
(D) Effects of low G maneuvers and proper recovery procedures.

# SFAR 73
# Aeronautical Experience

(2) No person may act as pilot in command of a Robinson R-44 unless that person:

(i) Has had at least 200 flight hours in helicopters, at least 50 flight hours of which were in the Robinson R-44. The pilot in command may credit up to 25 flight hours in the Robinson R-22 toward the 50 hour requirement in the Robinson R-44; *or*

(ii) Has had at least 10 hours dual instruction in a Robinson helicopter, at least 5 hours of which must have been accomplished in the Robinson R-44 helicopter and has received an endorsement from a certified flight instructor authorized under paragraph (b)(5) of this section that the individual has been given the training required by this paragraph and is proficient to act as pilot in command of an R-44. Beginning 12 calendar months after the date of the endorsement, the individual may not act as pilot in command unless the individual has completed a flight review in a Robinson R-44 within the preceding 12 calendar months and obtained an endorsement for that flight review. The dual instruction must include at least the following abnormal and emergency procedures flight training --

(A) Enhanced training in autorotation procedures;
(B) Engine rotor RPM control without the use of the governor;
(C) Low rotor RPM recognition and recovery; and
(D) Effects of low G maneuvers and proper recovery procedures.

# SFAR 73
# Flight Review

FLIGHT REVIEW: If a person is eligible to be PIC of an R-22 under SFAR 73 and they take a BFR (FAR 61.56) in an R-22 to maintain currency and wish to keep flying R-22's, then in addition to the usual Part 61 BFR requirements, the pilot also must receive ground training in the awareness training subjects and the flight training as required by SFAR 73 paragraph 2(c)(3). Likewise, even if pilot is exempt from a BFR because of §61.56(d) or (e), or has taken a BFR in another type of aircraft, the FAA has determined that the requirements of SFAR 73 paragraph 2(c)(3) still apply, and the pilot must have an SFAR "flight review" and sign-off in an R-22 at least every 24 months. As stated in SFAR 73 Section 1: "The requirements stated in this SFAR are in addition to the current requirements of Part 61." Therefore, everyone who flies an R-22 or R-44 must have had some SFAR-specific flight and ground training and a signoff for such training within the last two years.

*CURRENCY: In order to carry passengers, day or night in an R-22, a pilot must do their 90 day currency flying in an R-22.

# SFAR 73 Endorsements

Awareness Training Endorsement
SFAR 73 2(a)

- Required before anyone can manipulate the controls of a R22 or R44
- Accomplished through ground training of:
    1) Energy management
    2) Mast bumping
    3) Low rotor RPM (blade stall)
    4) Low G hazards
    5) Rotor RPM decay

*"I certify that John Doe has completed awareness training as specified by SFAR 73-1 Section 2(a)(3)(i-v) for the Robinson R22/R44"*

# SFAR 73 Endorsements

Student Pilot/Non-Rated Pilot to Solo in a R22/R44
SFAR 73 2(b)(3) or 2(b)(4)

- Student must have at least 20 hours dual in a R22 or R44
- Only valid for 90 days – Must be trained prior to each endorsement
- In addition to part 61 solo endorsement

*"I certify that John Doe meets the experience requirements of SFAR 73-1 Section 2(b)(3) [2(b)(4) R44] and has been given the training specified by SFAR 73-1 2(b)(3)(i-v) [ 2(b)(4) R44] . He/She has been found proficient to solo in the R22/R44. "*

# SFAR 73 Endorsements

Rated Pilots to fly a R22/R44 – with less than 200 hours helicopter and less than 50 hours R22/R44
SFAR 73 2(b)(1)(ii) or 2(b)(2)(ii)

- Given once student passes FAA practical test
- If the training was given within the last 90 days before the checkride, then no training is needed until 12 calendar months from when the training was done.
- If the rating was obtained in a helicopter other than a R22/R44, 10 hours dual instruction must be given in a R22/R44 prior to acting as PIC. (5 R22 hours may be credited toward R44 time)
- This endorsement is given every 12 calendar months
- For R44 pilots, 25 R22 hours may be credited toward 50 hour requirement

*"I certify that John Doe has been given training specified by SFAR 73-1 Section 2(b)(1)(ii)(a-d) [2(b)(2)(ii)(a-d) if R44] for the R22/R44 and is proficient to act as pilot-in-command . A flight review must be completed by (12 months) unless the requirements of Section 2(b)(1)(i) [2(b)(2)(i) R44] are met"*

# SFAR 73
# Endorsements

Rated Pilots to fly a R22/R44 – with more than 200 hours helicopter and more than 50 hours R22/R44
SFAR 73 2(b)(1)(i) or 2(b)(2)(i) and Section 2(c)

- To continue flying a R22/R44 , a flight review must be accomplished in a R22/R44
- This endorsement must be given every 24 calendar months
- Can be given in addition to or combined with 61.56 flight review endorsement

*"I certify that John Doe has been given training specified by SFAR 73-1 Section 2(b)(1)(ii)(a-d) [2(b)(2)(ii)(a-d) if R44] for the R22/R44 and is proficient to act as pilot-in-command ."*

# SFAR 73
# Awareness Training

Energy management

Low G / Mast bumping

Low rotor RPM (blade stall)

RPM decay

# SFAR 73
# Awareness Training

## Energy Management

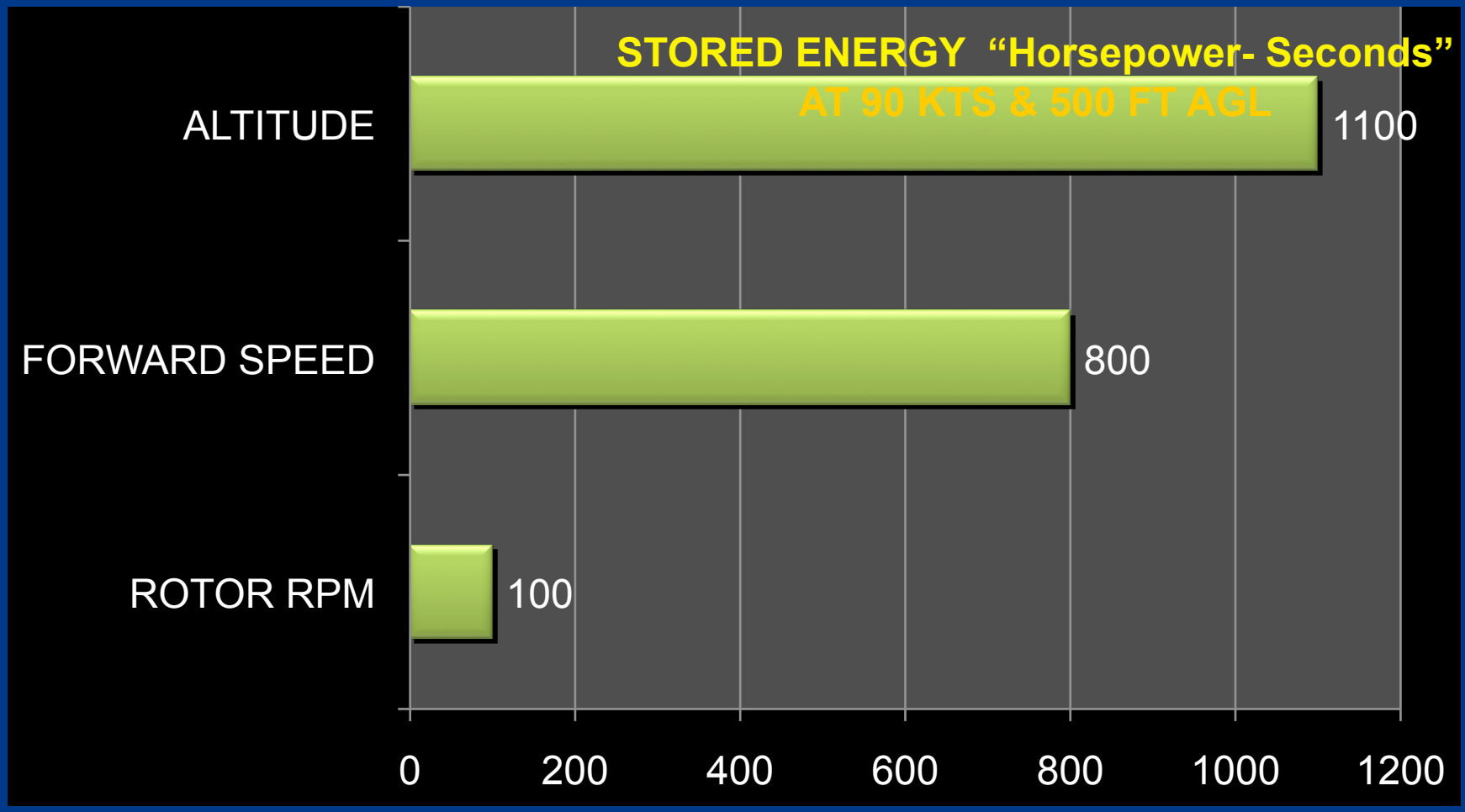
The helicopter has three kinds of energy:

1)potential (altitude)

2)kinetic (forward speed)

3)angular momentum (blade speed)

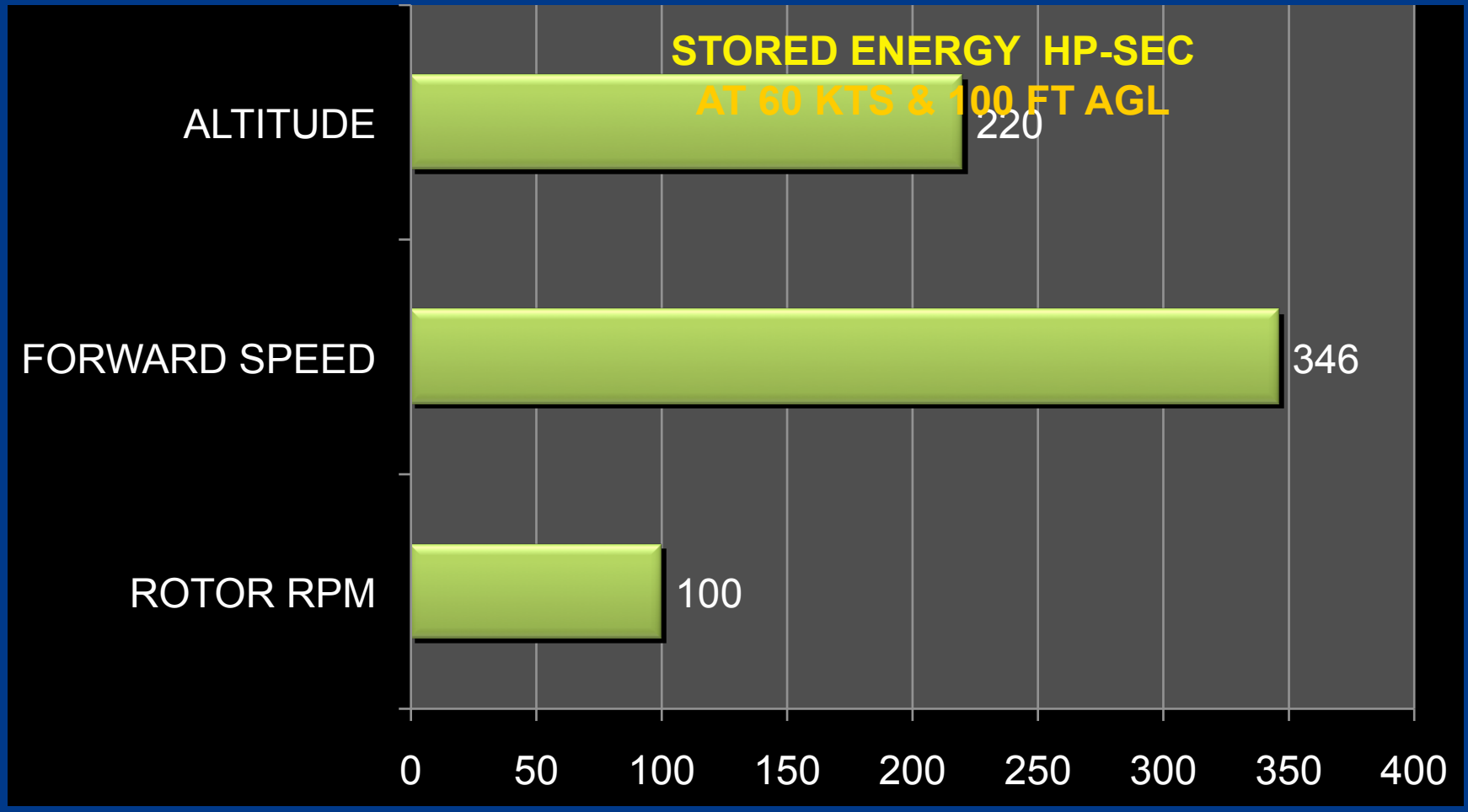
# SFAR 73
# Awareness Training




**HP-SEC = How much Horsepower the R22 can produce from stored energy**
**The power required in an autorotation is about 75 HP per second**

***SO….  2000 ÷ 75 = 26 seconds***

# SFAR 73
# Awareness Training




**HP-SEC = How much Horsepower the R22 can produce from stored energy**
**The power required in an autorotation is about 75 HP per second**

***SO…. 666 ÷ 75 = 9 seconds***

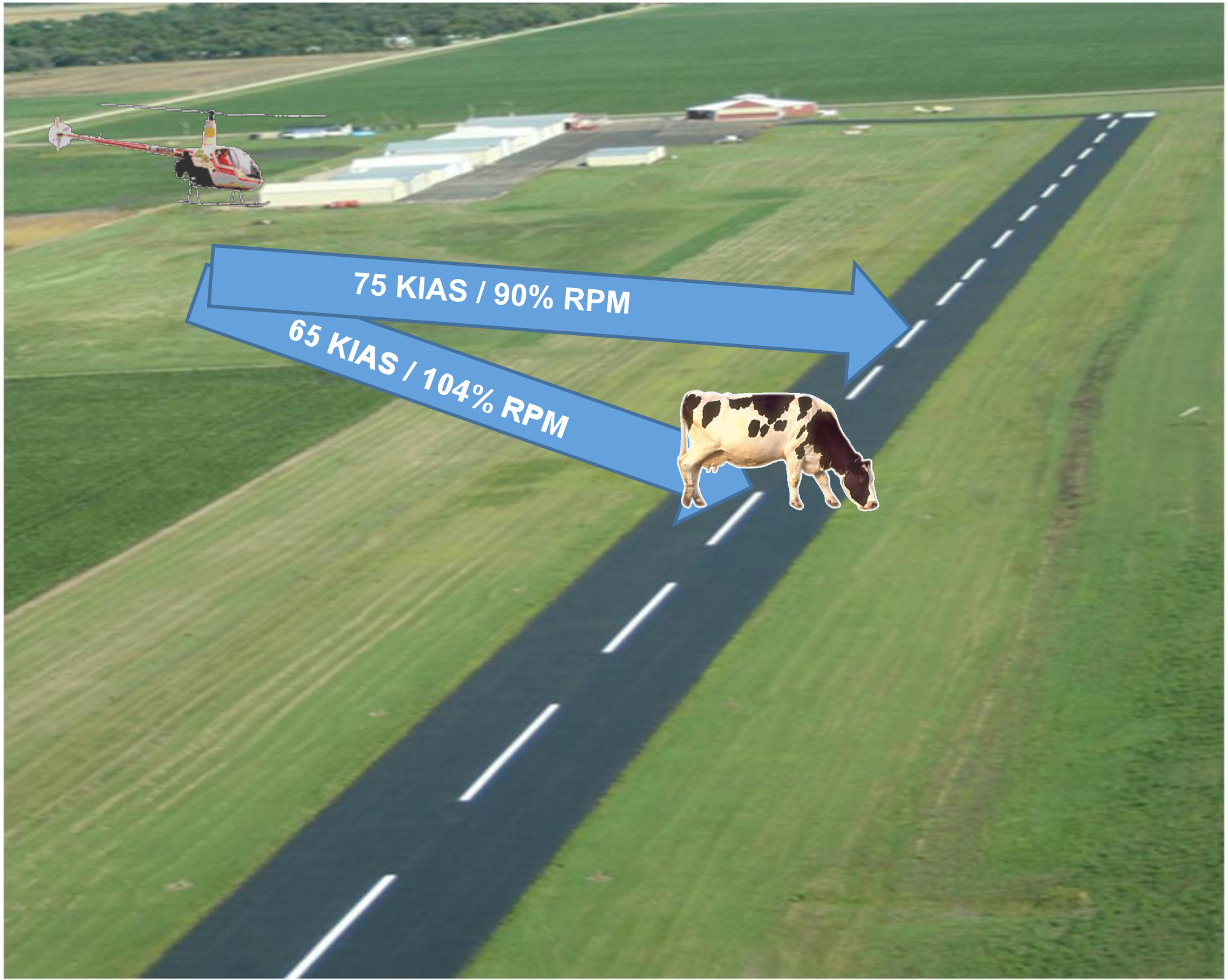
# SFAR 73
# Awareness Training

## Energy Management

**A glide can be extended by:**

- **Increasing airspeed – The increase in airspeed will extend the gliding distance mainly due to a higher ground speed. This holds true up to a point; past a certain speed the increase will result in a 'dive' like approach that will affect the glide distance.**
- **Reduce RPM – Lower RPM is a result of an increase in collective pitch. The increased pitch will result in an increase in lift.**

- **Max Glide – 75 knots and 90 percent for the R22.**
  **– 90 knots and 90 percent for the R44.**


75 KIAS / 90% RPM
65 KIAS / 104% RPM

# SFAR 73
# Awareness Training

## Energy Management

**A glide can be reduced by:**

- **Reduction in airspeed – Reducing the airspeed simply reduces ground speed and makes for a steeper glide angle. More rotor RPM will result from the rate-of-descent and the pilot must ensure that airspeed is regained prior to the flare.**
- **S-turn maneuvers – S-turns/spirals and other similar maneuvers will allow the pilot to lose altitude without covering a great deal of 'ground distance'.**
- **Side slipping the aircraft – Another possibility is to put the aircraft in an out-of-trim position. A steeper glide angle will result from the reduction in ground speed.**

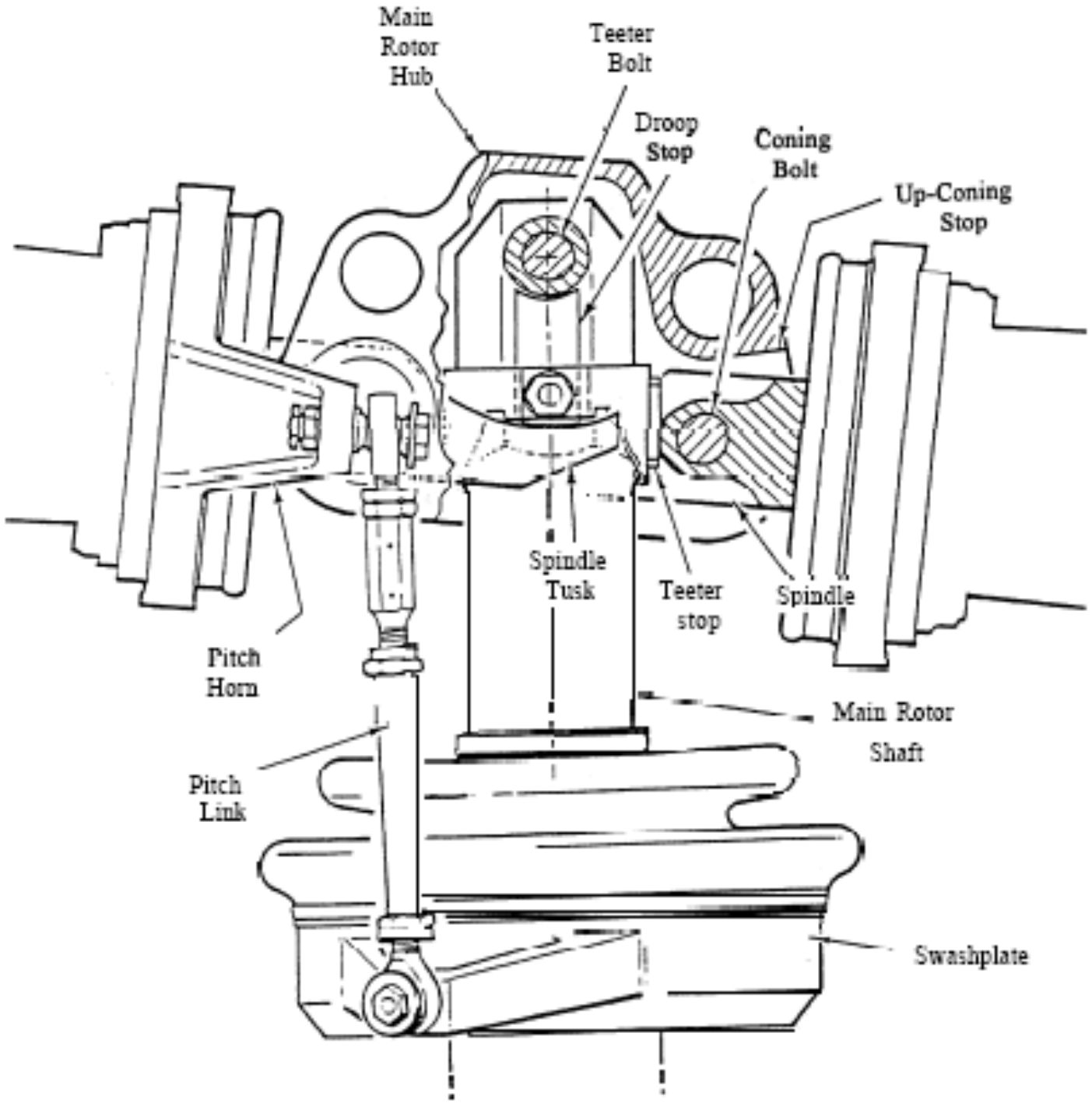
# SFAR 73
# Awareness Training

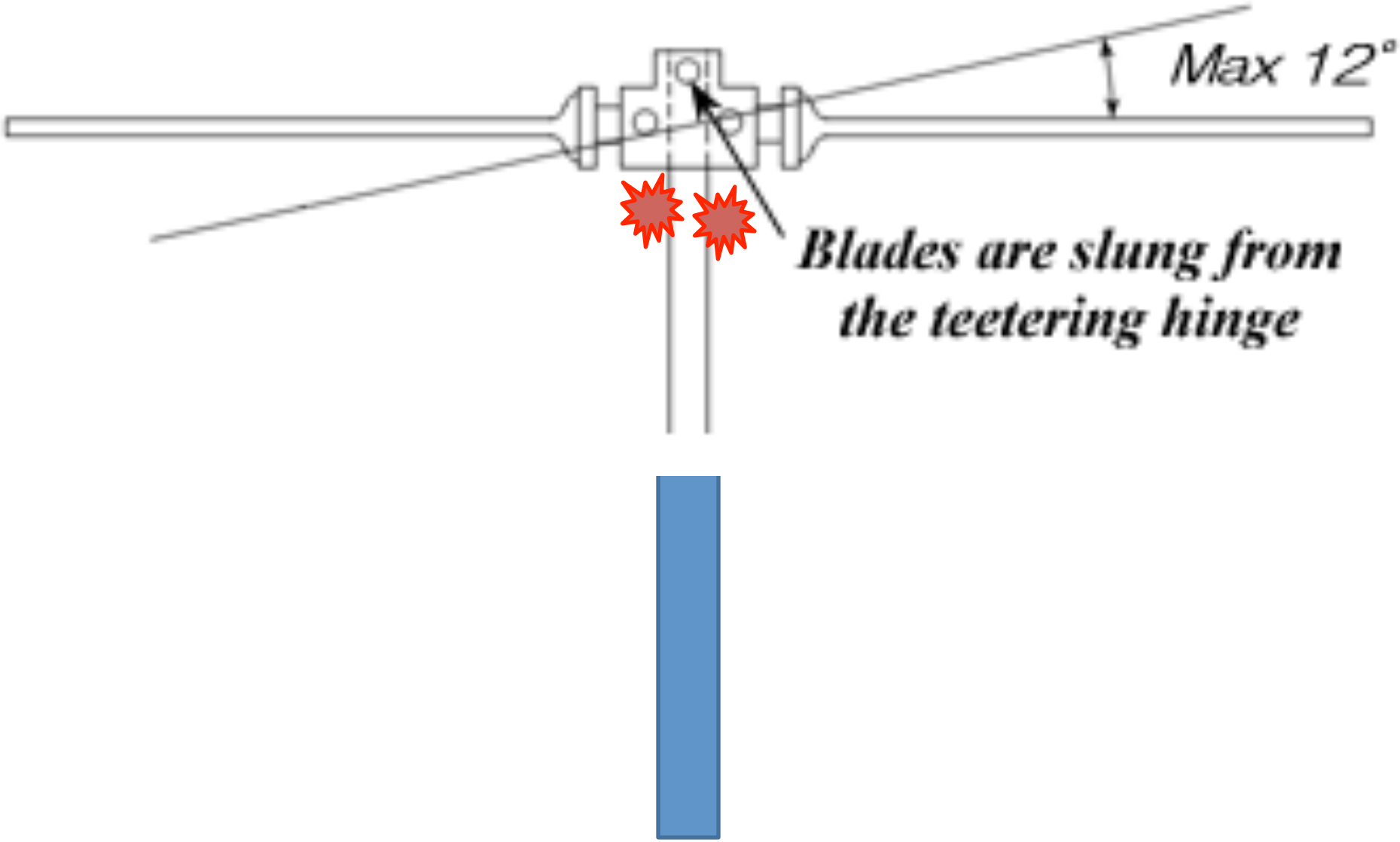
## Low G Mast Bumping

The result of excessive rotor flapping. If flapping exceeds the maximum allowed angle, the main rotor hub will violently contact the mast, causing mast damage or separation.

The excessive rotor flapping is due to out of CG conditions and low G conditions. If excessive roll rates develop, the pilot may apply abrupt opposite cyclic. As a result the mast is likely to be bumped if the rotor disk is not loaded (low G condition).

Low G Mast Bumping accounts for 7% of fatal accidents in Robinson aircraft. It is very common when a private pilot takes out their first passenger.


Main
Rotor
Hub
Teeter
Bolt
Droop
Stop
Coning
Bolt
Up-Coning
Stop
Spindle
Tusk
Teeter
stop
Spindle
Pitch
Horn
Main Rotor
Shaft
Pitch
Link
Swashplate


Max 12°
Blades are slung from
the teetering hinge

# SFAR 73
# Awareness Training

## Low G Mast bumping

Occurs in 2 bladed, semi-ridged, under slung rotor systems.

### Causes

- When a push over is performed the angle of attack and thrust of the rotor is reduced
- Abrupt / aggressive forward cyclic inputs (initiate descents with collective)
- Any form of turbulence

### During the low G condition

- The lateral cyclic has little if any effect because the rotor thrust has been reduced
- There is no main rotor thrust component to the left to counteract the tail rotor thrust to the right
- The tail rotor thrust will cause the helicopter to roll to the right.
- If you attempt to stop the right roll by applying full left cyclic before regaining main rotor thrust, the rotor can exceed its flapping limits and cause structural failure of the main rotor shaft due to mast bumping
- It may allow a main blade to contact the airframe or tail boom

### Recovery

First -Gentle aft cyclic (to recover from low G condition)
Second -Apply lateral cyclic (to recover from right roll)
Third –Land immediately

# SFAR 73
# Awareness Training

## Low Rotor RPM Blade Stall

Low  Rotor RPM Blade Stall which accounts for 14% of fatal accidents has no recovery.

Low Rotor RPM Blade Stall can occur by:

- Letting the rotor RPM get below 80% plus 1% for each thousand feet of altitude
- Over pitching the collective in high density altitude during a climb or high airspeed
- Rolling the throttle the wrong way
- Aggressive maneuvering
- Turbulence

After rotor RPM is reduced the helicopter will begin to descend. This descent will change the relative wind of the rotor blade to a more vertical path. If collective is then pulled to stop the descent, the pitch of the blades will increase causing a high angle of attack. This high angle of attack then causes the rotor blade to stall.

Prevention:

- Learn how to recognize it.
- The engine noise is be drastically lowered leading to an increase in vibration.
- Low RPM light and horn will come on at 97%.
- Simultaneously increase the throttle & lower collective

Rotor stalls can occur at any airspeed and its more critical at altitude because you're likely to be at full throttle.  Another factor is the relationship between engine power to engine RPM.  If you want to get 100% of the rated horsepower out of the engine, you'll need to have rotor at full speed first.

# SFAR 73
# Awareness Training

## Rotor RPM Decay

The R22 has a low-inertia rotor system. A low-inertia rotor system can lose energy quickly as the collective is raised and the power required exceeds the power available. This can lead to an aerodynamic stall of the rotor blades, loss of lift and a descent. Air rushing upward through the blades further increases their angle of attack, resulting in more drag, further slowing the rotor speed. Excessive main rotor RPM decay can happen rapidly.

RPM decay is identifiable by a change/decrease in noise, an increase in vibrations, a left yaw, a higher collective setting required to maintain altitude and, eventually, the activation of the low RPM warning system.

Pilots need to be familiar with the recovery techniques. Lowering collective while rolling on the throttle simultaneously is the required technique. In forward flight, aft cyclic will help the recovery process.

A R-22 with a gross weight of 1300 lbs, climbing 1000 fpm at 60 KIAS will allow the pilot 1 second to lower the collective should an engine failure occur.

# SFAR 73
# Awareness Training
# Fatal Accident Statistics

In the early 80's before the safety progra

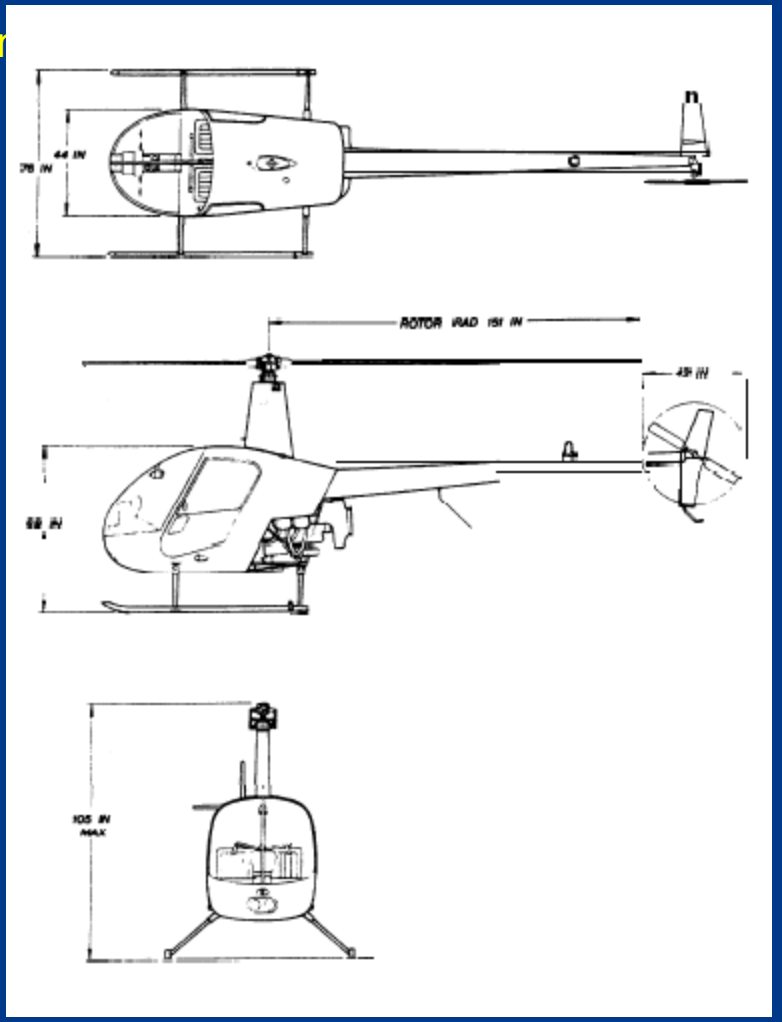
36% - Low Rotor RPM Stall
14% - Weather
14% - Collision - Mostly Wires
14% - Fuel Exhaustion
14% - Aircraft Failure
7% - Mishandling Controls

In the late 80's to Early 90's

32% - Collision - Mostly Wires
22% - Low Rotor RPM Stall
14% - Weather
9% - Low G Mast Bumping

Mid 90's & 2000's

36% - Collision - Again, mostly Wires
22% - Weather
14% - Low Rotor RPM Stall
7% - Low G Mast Bumping
21% - Other - Unknown



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This SFAR lesson plan was created as a comprehensive learning tool for students. As a student my 'Awareness Training' was accomplished by a "watch this video then answer these questions" approach. This was not sufficient training.
(This is a rough draft – Please edit if needed)

The following resources were used:
SFAR 73

**"What SFAR 73 really means" by Barry Lloyd**
(http://hummingbirdhelicopters.us/source/sfar73b.htm)

**NTSB Special Investigation Report**
"Robinson Helicopter Company Loss of Main Rotor Control Accidents"

**"R22 rotor stall for Dummies"** ***By Capt Spry***
(http://www.helicopterlive.com/r22stall.htm)

**"Robinson tips - Emergency Procedures" By Guillaume Maillet**
(http://www.helinews.com.au/articles/print/160/)