521-A: RADIO CONTROL LARGE MODEL HELICOPTER PROGRAM

Approved by AMA Executive Council, August 23, 2023

OVERVIEW:

If you are interested in flying helicopters that weigh more than 55 pounds and are up to 125 pounds, this is the program for you!

AMA has worked with knowledgeable modelers to create a safe way to operate large model helicopters (LMH). The process requires the helicopter to be inspected, then test-flown in front of credentialed AMA members. After the process has been completed, you can fly the helicopter at AMA Chartered Club flying sites and AMA Sanctioned Events.

A helicopter is defined for the purpose of this document to include models that utilize one main rotor shaft and one tail rotor shaft, or two main rotor shafts in coaxial or tandem configuration.

Legislative requirement for LMH aircraft: Exception for Limited Recreational Operations of Unmanned Aircraft 49 USC 44809(c)2

(2) Unmanned aircraft weighing more than 55 pounds - A person may operate an unmanned aircraft weighing more than 55 pounds, including the weight of anything attached to or carried by the aircraft, under subsection (a) if -

(A) the unmanned aircraft complies with standards and limitations developed by a community-based organization and approved by the FAA Administrator; and

(B) the aircraft is operated from a fixed site as described in paragraph (1)

Required LMH Forms and Photos

These items are required to be completed and returned to AMA Headquarters Safety Department to register a new, repaired, or modified helicopter.

- LMH-1: Temporary Authorization to Fly
- LMH-2: Permit to Fly
- LMH-3: Builder's Declaration
- LMH-4: Turbine Class Permit to Fly Addendum*
- LMH-5: Preflight Inspection Checklist
- Three-View Photos of the Helicopter (front, side, and top)
- Payment Form Completed

*Only required if the helicopter is Gas Turbine powered.

For renewals of a helicopter, or new ownership of a helicopter, the following documents must be completed and returned to AMA Headquarters Safety Department.

LMH-2: Permit to Fly

LMH-5: Preflight Inspection Checklist

Please email the documents to: safety@modelaircraft.org, or mail to:

The Academy of Model Aeronautics, Attn: Safety
5161 E. Memorial Dr.
Muncie IN 47302

SECTION 1: General Information

Large Model Helicopters (LMH) are classified as shown in Table 1.1:

Large Model Helicopter Classification	Weight Criteria
Large Model Helicopter 1 (LMH-1)*	55 pounds (25 kilograms) to 77 pounds, 2 ounces (35 kilograms), with fuel, ready to fly
Large Turbine Model Helicopter (LTMH-1)	55 pounds (25 kilograms) to 77 pounds, 2 ounces (35 kilograms), with fuel, ready to fly
Large Model Helicopter 2 (LMH-2)*	77 pounds, 3 ounces (35 kilograms) to 125 pounds (56.7 kilograms) with fuel, ready to fly
Large Turbine Model Helicopter 2 (LTMH-2)*	77 pounds, 3 ounces (35 kilograms) to 125 pounds (56.7 kilograms) with fuel, ready to fly

Note: LTMH-1 or LTMH-2 helicopters powered by turbine engines require that the owner/pilot has obtained their AMA Rotary-wing turbine waiver *before* starting the certification process for the Large Model Helicopter

Table 1.1

Timeline

- Step 1: Owner collects data on certification of model by controlling authority in the country of manufacture/assembly OR conducts the 10.0 cumulative flight test hours as specified in Section 4.
- Step 2: Model is inspected by Owner (if LMH-1) or Large Model Helicopter Inspector (if LMH-2) and document LMH-1 is filled out. This gives the owner/pilot approval for the test flight(s) on the specific date on the form. After test flight(s) are completed, go to Step 2.
- Step 3: Form LMH-2 is completed, and the flight envelope is agreed upon by the model owner/pilot and observers. After the flight(s) is completed successfully, the form is signed, initialed, and dated by the observers. *Be sure to initial the line after the weight of the model!* This is a verification that the model has been weighed with fuel and the correct weight is on the form. ***Note that the date must match that on form LMH-1.***
- Step 4: The pilot must complete forms LMH-3, LMH-4 (if applicable), and LMH-5.
- Step 5: The owner must take three pictures of the model to provide to AMA Headquarters.
- Step 6: The owner must assemble all documents (see the following list) and forward

them to AMA Headquarters by email or US Postal Service *within 30 days of the date on form LMH-1*. *Be sure to include payment.*

The owner may continue to fly the aircraft for 30 days from the date on form LMH-1.

After AMA receives and processes the documents, the owner will be sent a Receipt of Acknowledgment for their records. The registration is good for 3 years from the date on form LMH-1. The owner should keep a copy of both the Receipt of Acknowledgment and form LMH-2 with them to show proof that the helicopter has been registered with AMA and that the model has been registered and can be flown past the 30-day timeline on Form LMH-2. Beginning January 1, 2020, AMA will be sending the owner a Large Model Helicopter Program card for each helicopter registered. These will be used as proof to any AMA member, club officer, Contest Director, or Event Manager that the helicopter on the card is legal to fly up until the expiration date on the card. You are required to show this card to the Contest Director or Event Manager of any AMA Sanctioned Event in which you plan to fly this helicopter.

If all the documentation is not provided to AMA within the 30-day allotted timeline, the application will be denied, and the helicopter will be grounded. The owner will be required to restart the process and resubmit all paperwork, again within 30 days.

1) All pertinent regulations from government entities and the AMA shall be applicable.

2) Each LMH model must be determined to be safe for flight through the issuance of a Permit to Fly prior to flying.

3) All turbine-powered LMHs are also subject to the rules and specifications outlined in the AMA's Turbine Regulations, unless specifically modified in the LMH regulations.

4) General information for inspectors and details on the inspection process can be found in Section 3, Inspectors.

5) Additional guidance and regulations pertaining to foreign participants can be found in Section 4, Foreign Participants.

6) A chart relating AMA LMH regulations to the larger scope of the National Airspace System, SUAS registration, foreign participant requirements, and insurance coverage is available in the Documents section of the AMA website, document 540-F.

LMH Pilot and Builder Requirements

To qualify for an LMH-1 class, the pilot shall have completed a minimum of 50 flights with a model having a dry weight of 25 pounds or greater.

To qualify for an LMH-2 class the pilot shall have completed a minimum of 50 flights with a model having a dry weight of 40 pounds or greater.

To operate a turbine-powered LMH, the pilot must have previously obtained their rotary-wing

turbine waiver.

The builder of a turbine-powered LMH shall have completely constructed one or more turbine-powered models having a dry weight of 25 pounds or greater. Completely constructed is defined as built from scratch or from a factory kit.

LMH Model Requirements

To ensure safe and reliable operation, a Large Model Helicopter must meet, or exceed, the requirements outlined in this section.

Definitions

A commercially available kit is defined as:

- Any LMH built or assembled from a set of parts, instructions, specifications, and plans that has been tested and subsequently made available to the public in kit form provided by a manufacturer.

A non-commercially available kit is defined as:

- Any LMH built or assembled from a set of design plans that has not been made commercially available to the public, is a first, one-of-a-kind design that has yet to be tested or have its technical data substantiated to determine it is capable of safe flight.

The term "approved for use" is defined as meeting one of the following two requirements:

1. The subject part or assembly has been approved for use in a Large Model Helicopter by the controlling authority in the country of manufacture/assembly (e.g., MFSD, DAeC, EMFU). Documentation of this approval must be provided at the time of inspection.
2. The subject part or assembly has been evaluated and qualified in accordance with Section 4 of this document. Documentation of this process must be provided at the time of inspection.

Rotor Head and Blades

The rotor head assembly shall include all mechanical components that are involved in manipulating the main rotor blades through varying degrees of change. This includes the swashplate, electronic servos, and servo control-arm hardware. These components shall be of adequate dimensions and structural strength to safely carry the dynamic load of the Rotor Disc System throughout the range of motion required to safely operate the aircraft. This includes the consideration of the main: rotor shaft diameter, main blade spindle shaft, swashplate connecting rods/rod ends, suitable servo torque capacity, and main rotor blade load capability.

When using commercially available main rotor heads and main rotor blades, the manufacturer's published rotor rpm limit and load capacity shall be followed and not exceeded. The manufacturer's documentation for these limits must be provided. The rpm shall be shown to be within manufacturer's limits through direct rotor rpm measurement during the inspection. Documentation of the maximum rpm of the powerplant and the main

rotor gear ratio must be provided. The maximum main rotor rpm that is attainable with this system when the engine/motor is running at full speed must be calculated. If the full speed attainable exceeds the published rotor rpm limit, the controls that govern the engine and main rotor speed to acceptable limits must be demonstrated. Showing turbine ECU controls that limit the turbine rpm is acceptable. Showing the electronic speed control governor programming is acceptable.

Commercially available main rotor blades must be either metal or composite and specified by the manufacturer for use in an LMH.

If the aircraft uses any rotor head components that were not already specified by the manufacturer for use on this model type, either those commercially available or those that are self-made, then the safety demonstration procedures outlined in Section 4 must be followed. For example, if the manufacturer specifies blades that create a 3.0M rotor disc but the model is equipped with blades that create a 3.5M rotor disc, that change must be reevaluated and qualified as outlined in Section 4. If stock components are removed and exchanged for aftermarket parts, either those commercially available or those self-made, that change must also be reevaluated and qualified as outlined in Section 4.

See section 4 ***Calculating Gear Ratios*** *for one method for calculating the gear reduction ratio and how to derive the maximum rpm attainable from that data.*

Tail Rotor

The tail anti-torque assembly shall include all mechanical components that are involved in manipulating the tail anti-torque assembly through varying degrees of change, this includes the electronic servos and servo control-arm hardware. These components, whether conventional, a Fenestron shrouded fan, or nozzle, shall be of adequate dimensions and structural strength to safely carry the dynamic load of the tail's anti-torque system throughout the range of motion required to safely operate the aircraft.

When using commercially available tail rotor heads and tail rotor blades, the manufacturer's published rotor rpm limits shall be followed and not exceeded. The manufacturer's documentation for these limits must be provided. The rpm shall be shown to be within manufacturer's limits through direct rotor rpm measurement during the inspection. Documentation of the maximum rpm of the powerplant and the tail rotor gear ratio must be provided. The maximum tail rotor rpm that is attainable with this system when the engine/motor is running at full speed must be calculated. If the full speed attainable exceeds the published tail rotor rpm limit, the controls that govern the engine and rotor speed to acceptable limits must be demonstrated. Showing turbine ECU controls that limit the turbine rpm is acceptable. Showing the electronic speed control governor programming is acceptable.

If the aircraft uses any tail rotor components that were not already specified by the manufacturer for use on this model type, either those commercially available or those that are self-made, then the safety demonstration procedures outlined in Section 4 must be followed. For example, if the manufacturer specifies blades that create a 0.5M rotor disc but the model is equipped with blades that create a 0.75M rotor disc, that change must be reevaluated and qualified as outlined in section 4. If stock components are removed and exchanged for aftermarket parts, either those commercially available or those self-made, that change must also be reevaluated and qualified as outlined in Section 4.

See section 4 ***Calculating Gear Ratios*** *for one method for calculating the gear reduction ratio and how to derive the maximum rpm attainable from that data.*

Skids/Landing Gear

If the model is commercially available as a kit or an ARF, the inspector shall verify that the subsystem was assembled according to the plans and with good craftsmanship.

If the aircraft uses any landing gear components that were not ~~p~~previously demonstrated for use on this model type, either those commercially available or those that are self-made, then the safety demonstration procedures outlined in Section 4 must be followed.

Fuselage

All fuselage frames, motor mount attachments, equipment and mechanics mounting decks, etc., are properly designed for strength and rigidity and are adequately bonded or attached to the fuselage structure with adhesive or hardware.

Powerplant and Fuel System

The powerplant chosen must be suitable for sustaining safe operation within the intended flight envelope and flight duration expected of the model. In general, a powerplant must be sized so that it supports the continuous operation of the aircraft without overheating the engine or motor and related power system components. The goals for turbine-, gas-, and electric-powered models are the same, with unique requirements for each.

If the powerplant in the model matches a power system that has already been demonstrated by the manufacturer to meet the safety qualifications in Section 4, then no further action is required. If the chosen power system has not been safety qualified, it must be evaluated as outlined in Section 4.

Radio System and Electronics

For the radio system for a large model helicopter, adding redundancy can significantly increase reliability and safety. Given that, the following are required for a radio system on an LMH:

- Dual power supply systems (e.g., batteries), each one of which are capable of supplying all of the power needed by the radio system and all servos or other actuators for the

duration of a normal flying session.

- A power distribution system that continuously monitors the power supply systems and selects the one best able to provide power to the radio system. This power distribution system, along with the power supply systems, must be able to supply a minimum continuous current of 20 amps.
- Proper sizing of the power supply wires and connectors to the servos to ensure a minimum voltage drop when the servo draws maximum current (minimum of 16 AWG recommended for power wires to primary flight control servos).
- Redundant receivers (minimum of 2) that will switch the active receiver that is providing control information to the one that has the best (or operational) link to the pilot's transmitter. These receivers should be positioned in the model to provide the maximum amount of antenna diversity.
- If the radio system provides gyro stabilization on primary flight controls other than the tail rotor, provision must be provided for the pilot to be able to disable, or significantly reduce, the gain of that gyro in flight.
- All radio system electronics, especially receivers and gyros, must be adequately isolated from any airframe vibrations.

In addition, the following are recommended for the radio system in an LMH:

- High-voltage operation (2S LiPo, 2S LiFe or 2S Li-Ion) for the radio system electronics and servos that eliminates the need for voltage regulators between the power supply system and other radio system components.
- Fail-safe switches that revert to the closed position upon failure of the mechanical portion of the switch mechanism.
- Telemetry downlink of radio system and aircraft parameters, such that they can be monitored by the pilot during a flight. This includes such things as power supply voltages and remaining capacity, receiver RSSI, engine rpm and temperature, etc.

Servo Requirements

If the model helicopter is built from a commercially available kit, all of the servos installed must meet or exceed the kit manufacturers' specified torque. If the manufacturer does not provide this information, or in the case of a scratch-built helicopter, servos on the primary controls (e.g., cyclic, collective, and tail rotor) will be digital and metal-geared, with a minimum torque of 250 ounce-inches for LMH-1 and LTMH-1 aircraft and and 400 ounce-inches for LMH-2 and LTMH-2 aircraft. The servos on all other controls must be digital, metal-geared, and sized according to standard practice.

Control Systems

Control linkages must be properly sized for the given control system and linkage length so that there is no evidence of bending during operation. All of the control linkages must have properly sized ball links on both ends and must operate freely with no binding throughout the

entire range of movement.

LMH Permit Regulations

1) Test-flight permit requirements:
   a) A *Temporary Authorization to Fly* is required for certification test flights. This authorization is only valid on the day of issue (Form LMH-1).
   b) The owner (LMH-1/LTMH-1) or Inspector (LMH-2/LTMH-2) shall examine the completed model helicopter immediately prior to the test flights, and shall issue a *Temporary Authorization to Fly*, provided all requirements listed in Table 2 are met. LMH Inspectors cannot sign off on their own helicopter if it is a LMH-2/LTMH-2.
2) A list of current LMH Inspectors is available on the AMA website under the Members Only Documents section.
3) If, for any reason, the observers are not completely satisfied with the airworthiness of the model as demonstrated, further test flights must be arranged after rectification of the faults noted.
4) For all LMH categories, pilot will maintain at least 100 feet of separation between the helicopter and spectators during certification test flights.
5) Upon satisfactory completion of the test flights, all required documentation listed in Table 1.2 will be filled out and signed by the owner and LMH Inspector. Copies of all documents must be submitted to AMA Headquarters immediately, but no later than 30 days from the date of the demonstration flights. The originals must be retained by the owner and will serve as proof of inspection.

LMH Permitting Requirements

	LMH-1/LTMH-1	LMH-2/LTMH-2
Builders Declaration	Completed by builder/owner	
Temporary Authorization	Completed by owner	Completed by LMH inspector
Permit to Fly	Completed by owner and observer	Completed by owner and LMH inspector
Inspection Checklist	Completed by owner or LMH inspector	Completed by LMH inspector
Turbine Addendum	Completed by owner	

Maneuvers	Flight envelope—non-aerobatic (mandatory) **Level maneuvers:** i) Stationary Hover (tail-in and nose-in) ii) Forward flight transition to a level horizontal Figure 8 back to stationary hover. iii) Forward flight climb with a 180º return and descent to a stationary hover (right and left). The owner will determine additional flight maneuvers that will consist of at least two of the following items from either category (limited/aerobatic), or one from each category (limited/aerobatic), demonstrated once in each direction (right and left). **Limited Aerobatic (Option 1):** i) Hovering Pirouettes (right and left) ii) Stall turns (right and left) iii) Autorotation (need not be all the way to landing) **Aerobatic (Option 2):** i) Loops ii) Rolling Maneuvers (Axial/Split-S) iii) Back flips iv) Inverted flight	
Demonstration Flights	Two demonstration flights observed by the owner/pilot and either an AMA Contest Director, Leader Member, or LMH Inspector are required.	Two demonstration flights observed by an LMH Inspector
Permit Documents to be Submitted to AMA	Temporary Authorization to Fly (*Form LMH-1*) Fully completed and accurate Permit Form (*Form LMH-2*) Builder's Declaration (*Form LMH-3*) Turbine Addendum (if applicable; *Form LMH-4)* Completed Preflight Checklist *(Form LMH-5)* Photograph of model (3-views with sufficient detail)	

Table 1.2

6) Permit to Fly Operation

   a) Preflight Inspection:
   The operator shall verify all items in the Inspection Checklist before the first flight on any day, and after the model has been disassembled and reassembled. Items marked "P" must also be verified again before EACH flight.

   b) Possession of a valid *Permit to Fly* allows flights of the subject model by the owner, or by a competent pilot designated by the owner, both of whom must be current AMA members *for a period of 30 days from the date of issue on the form*. Designated pilot(s) must comply with the minimum pilot standards of this program.

   c) All required documentation must be received by AMA Headquarters within 30 days of the demonstration flights or the *Permit to Fly* becomes invalid. In case of extenuating circumstances, the Safety Committee may accept documentation received past the 30-day deadline. Delay explanations must be submitted in writing and acceptance will be granted on a case-by-case basis.

7) Permit to Fly Suspension

   a) *A Permit to Fly* shall be considered suspended whenever the model for which it is issued:

      i) suffers damage to its primary structure, mechanics, or rotor blades

      ii) suffers any control malfunction during flight

      iii) is structurally or aerodynamically modified

      iv) is fitted with a different type or size of engine or engine mount

      v) is fitted with different servos or batteries with lesser torque or capacity

      vi) is fitted with a different type of radio receiver

      vii) is fitted with any device that alters the control system

      viii) has any rotor or tail blades that is re-covered or repainted so that its unbalanced weight is increased

      ix) has not been flown during a period of twelve (12) months

      x) is operated outside the flight envelope defined in its *Permit to Fly*

      xi) undergoes a change of ownership

   b) AMA Headquarters must be notified immediately if a *Permit to Fly* is suspended.

   c) The AMA, through action by the Executive Director or its President, may suspend a *Permit to Fly* at any time.

i) The owner shall be notified of the suspension in writing, including a summary for the basis of the suspension. Such a suspension can be predicated on a written complaint by two AMA members.

ii) The permit holder can appeal the suspension within thirty (30) days of receipt of the suspension notice. The appeal must be accompanied by all documentation which the appellant believes supports his or her position.

iii) The AMA Safety Committee will consider the appeal, including the written documentation supplied by the appellant, and conduct any investigation or hold any hearing it deems appropriate, although it need not hold any formal hearing.

iv) The majority decision of the AMA Safety Committee is final and binding.

d) A suspended Permit to Fly may be revalidated:

i) Providing repairs and/or modifications causing the suspension to have been examined and the model in its modified state is again test-flown in accordance with the permitting process.

ii) If the *Permit to Fly* was suspended because of ownership change, a new *Permit to Fly* must be issued with the information for the new owner.

iii) If the *Permit to Fly* was suspended by AMA, the course for revalidation will be addressed and established on a case-by-case basis.

8) Permit to Fly Cancellation

a) A *Permit to Fly* shall be canceled whenever the model is damaged beyond repair or if modified such that it is no longer accurately described in the *Permit to Fly*.

b) AMA Headquarters must be notified immediately if a *Permit to Fly* is canceled.

9) Appeals

i) In the event of unresolved disputes, the applicant for a *Permit to Fly* can appeal to the AMA Safety Committee for a ruling and, if unresolved, the AMA Executive Council shall be the final arbiter in all disputes.

10) The *Permit to Fly* is valid for three (3) years and must be renewed every three (3) years. This will require the same preflight inspection, and two demonstration flights of 8- to 10-minutes duration.

11) In addition to the *Permit to Fly* document, you will also receive via US Postal Service a Helicopter Credential card that can be used to verify to the Contest Director, Event Manager, or club official that you are credentialed to fly the helicopter listed on the card. It will also help you to remember to recertify the helicopter prior to the expiration date on the card. You will be issued a card for each helicopter you have certified through the Large

Model Helicopter Program.

SECTION 2: Forms

FORM-1: Temporary Authorization to Fly for all LMH and LTMH

I have inspected this model helicopter in accordance with the current LMH preflight inspection outline. To the best of my knowledge and belief the model will be suitable for the intended demonstration flights as in accordance with the program requirements.

_____

Model description: e.g., yellow and black, 1/4-scale Bell 206

_____ _____

Name of owner | Signature of owner

_____

Name of LMH inspector (required for LTMH-2) (print)

_____

Signature of LMH inspector (required for LTMH-2)

_____ _____

Day of issue | AMA Number

This *TEMPORARY AUTHORIZATION TO FLY* is only valid on the day of issue.

FORM-2: Permit to Fly for all Large Model Helicopter Classes

(circle) ***New Helicopter*** or ***Renewal*** ***Type:*** **LMH-1 LMH-2 LTMH-1 LTMH-2**

Owner's name _____ AMA # _____

Helicopter type _____

Wingspan _____ Weight (wet) _____ **Observer's Initials** _____

Engine manufacturer displacement or thrust _____ Turbine ❒

Design by _____

Color scheme _____

Construction: ❒ Kit ❒ Plans ❒ Custom ❒ Other (explain) _____

Transmitter _____ Servo roll _____

Receiver _____ Servo pitch _____

Batteries _____ Servo yaw _____

Power distribution system _____ Servo collective _____

Flight Envelope:

❒ Level maneuvers (required)

❒ First limited/aerobatic maneuver (list) _____

❒ Second limited/aerobatic maneuver (list) _____

The above-described helicopter has been inspected and has been determined to be safe for flight and demonstrated its ability to perform within the designated flight envelope as indicated on this permit.

Owner:

_____ _____

Owner's name (print) Owner's signature

_____ _____

Date of flight AMA number

Observer:

Contest Director/Leader Member/LMH Inspector Name (print)

Contest Director/Leader Member/LMH Inspector Signature

AMA Number

For LMH-2:

Owner:

Owner's name (print)

Owner's signature

Date of flight

AMA Number

Observer :

LMH Inspector's name (print)

LMH Inspector's signature

AMA Number

The *Permit to Fly* will be invalid if all required documentation is not received at AMA Headquarters within 30 days of issuing. Documentation should be **mailed to** 5161 E. Memorial Dr., Muncie IN 47302 **or emailed to** **safety@modelaircraft.org.**

APPLICATION FEE $25 (no charge for renewals)

If paying by credit card, we recommend that you call AMA HQ Safety Dept. to make your payment (765) 287-1256, ext. 230) during regular business hours, Monday-Friday, 8-5 Eastern time.

If paying by check, please mail completed forms and check to:
Academy of Model Aeronautics
Attn: Safety Director
5161 E. Memorial Dr.
Muncie IN 47302

FORM-3: Builder's Declaration

I certify that the materials, methods, and standards used in the construction of this model helicopter are, to the best of my knowledge and belief, suitable for the intended purpose and are in accordance with the program requirements.

Model description: e.g., yellow and black, 1/4-scale Bell 206

Name (print)

Signature

Date

AMA Number (if applicable)

In case of ownership change, this declaration should be kept with the model.

FORM-4: Turbine Class Permit to Fly Addendum

Addendum is for a ❒ LTMH-1 ❒ LTMH-2

Owner's name_____AMA #_____

_____

Model description: e.g., yellow and black, 1/4-scale Bell 206

Owner's Declaration

I affirm that I will verify that any individual operating this turbine-powered model has the necessary experience and skill level and has a current rotary turbine waiver/affidavit on file with the Academy of Model Aeronautics.

_____ _____

Owner's signature Date

FORM-5: Checklist for Preflight Inspection

New Helicopter or *Renewal (*circle one)

The following is considered the criteria for certification of a Large Model Helicopter. If appropriate, add items that might be specific to this model.
This checklist is to be completed by the owner of an LMH or an appointed inspector prior to test-flights. All items are to be marked "N/A" if not applicable, checked if passed, or left blank pending reinspection if failed.

The checklist is subsequently used by the operator of the helicopter:
(a) Once at the beginning of a flying session (all items)
(b) Before every flight (items marked with a P only)

The checklist is arranged in a systematic fashion assuming a standard single rotor helicopter.

		Check

1. Rotor Head and Blades Group

Rotor blade grips and blades are mounted correctly and secured • adequate threads (3) showing at main blade bolt locking nut • Main blade leading edge pointed in the direction of rotation		
Rotor blade bolts are straight and show no signs of fatigue		
Rotor blades are free of warps or other irregularities		
Nylock nuts are used to hold the blade bolts and are in good condition		
Main rotor grips and pitch horns: • Inspected for damage and cracking, rod end balls secure • Controls rods/rod ends to swash plate inspected for damage, cracking, and secure connections		
Swash plate and related control rods/rod ends/ rod end balls inspected for damage, cracking, and secure connection.		
Cyclic servos: • Servos securely mounted and all mount screws present • Related control arms, linkage, and rod end balls connected to the swash plate are inspected for damage, cracking, and secure connections. Rotor head assembly reacts correctly to gyro input		
Blade tracking checked - static		
Flybar centered and paddles mounted correctly and secured (if applicable)		

2. Tail Rotor and Blades Group, Fenestron ducted-blade group, or Notar nozzle

Rotor blade bolts are straight and show no signs of fatigue		
Rotor blades are free of warps or other irregularities		
Nylock nuts are used to hold the blade bolts and are in good condition		
Blades are all adequately attached, correctly mounted, correctly track the input from the anti-torque tail servo, move freely when commanded		
• Servos securely mounted and all mount screws present Servo to slider rod/rod ends/ball end/control arms: • Linkage and rod end balls connected to the tail rotor slider/Fenestron pitch input are inspected for damage, cracking, and secure connections.		
• NOTAR with direct servo connection. Nozzle is firmly mounted; nozzle to mounting screw (if visible) is present. • Nozzle rotates freely and does not bind. • Tail anti-torque assembly reacts correctly to gyro inputs.		
Drive-shaft gearing mesh correct		
Drive-belt tension correct		
Blade pitch-range adequate		

3. Skids/Landing Gear

Skid tubes, if present, are free of visible fatigue		
Landing gear mounting bolts are appropriately fastened		
Skids, if equipped, do not move independently of the fuselage		
Landing skids/gear assembly is firmly attached to the fuselage • Skids/skids to fuselage brackets are not cracked or deformed. • Skid mounted items e.g. mirrors, lights, steps are securely attached Gear and gear doors cycle freely through range of intended travel		
Skids/landing gear strong enough for aircraft weight		

4. Fuselage

• Interior mechanics appear to be secure, mount bolts to fuselage, if visible, are all present and secure. • Fuselage is not visibly deformed or cracked. • Doors and hatches are secure when closed • Window glass is secure • Tailboom assembly is not visibly deformed, securely attached or cracked.		

• External items e.g. antennae, cable cutters, camera turrets, night sun lights, horizontal air foils, and tailboom skid are secure • Upper fuselage cowlings around swash and other removable cowlings are adequately secured. Servo/ESC wiring is routed as best possible to preclude interference.		

5. Powerplant and Fuel Systems

Fuel tubing appropriate		
Tank mounting cushioned		
Clunk and feed connected correctly		
Tank height correct or fuel pump equipped		
Engine, transmission aligned and movement free		
Ignition kill switch (IC engine) or fuel cutoff (turbine) installed		
ESC has electrical filter on control feed from receiver		
A turbine shall not be operated beyond the service interval for that engine. The hours toward the next overhaul must be less than the service limit before and after the flight.		
Flight batteries must be in good condition. For example, puffed LiPo batteries cannot be used.		
Flight batteries must have cells that are closely balanced (within 0.005 volts)		
Turbine, engine, or motor appear to be securely mounted; all intended attachment points have hardware installed. Fuel tank is securely fastened, and fuel lines routed away from engine hot spots. Flight pack battery is adequately secured, power leads are routed with adequate separation from receiver to preclude interference, wiring/connector to pack is of adequate gage.		
Motor to ESC wiring/connector is of adequate gauge.		

6. Radio System and Electronics

Determine radio is compatible with the helicopter and has adequate channel capability.		
Dual power-supply systems installed and protected (vibration, heat, etc.)		
Power distribution system installed, securely mounted and protected		
All power leads and connectors properly sized		
Power switches adequately sized, accessible, and secured		
Redundant receivers properly installed and protected		
Antennae positioned for diversity		

Gyro gain/cutoff configured correctly		
All wires secured and protected		
Gyro correctly installed and protected		
Servo torque as required (each)		
Servos rubber mounted or vibration proofed		
Servo arms adequately sized and secured		
All transmitter functions set up correctly, including fail safe	P	
Transmitter batteries indicate adequate voltage level for the intended flight	P	
Radio range sufficient (e.g. range checked each flight session)	P	
Helicopter receiver batteries are adequately charged and securely mounted.	P	

7. Control Systems

Ball links large enough		
Ball joints locked and centered		
Arms free and not fouling		
Pushrods large enough and not bent		
Ball races smooth		
Controls free with sufficient travel		

8. Miscellaneous

Fasteners locked where appropriate		
No stripped threads		
Metal-to-metal contact minimized		
Nyloc nuts or locknuts used where appropriate		
Fastener size appropriate		
Center of gravity correct		
Ensure spectators are a safe minimum distance away from the model prior to engine start		
Fire extinguishing equipment is on hand and readily available		
Review flight demonstration requirements and intended maneuvers		

9. Checks with Engine Running and Rotor Spinning

Vibration levels low	P	
Blade tracking–low speed		
Engine tuning and cutoff	P	
Clutch operation	P	

10. Flight Checks

Vibration minimized	P	
Head speed too high or too low	P	
Blade tracking–flight speed	P	
Engine tuning correct	P	
Muffler operational (as fitted)	P	
Gyro gain and centering correct	P	
Pitch range matched to engine power	P	
Governor operation correct	P	

SECTION 3: Inspectors

For a list of inspectors, access our website at **www.modelaircraft.org**. Log in to the website and move your mouse over the heading *Media & Resources* and then select *AMA Documents* from the blue drop-down box. Next, find *Large Model Helicopter Program (over 55 pounds)* and click on "+." Select document 520-B to see the current listing, or contact:

Academy of Model Aeronautics
Safety Department
5161 E. Memorial Dr.
Muncie IN 47302
(765) 287-1256, ext. 230
safety@modelaircraft.org

A) Overview

1) The AMA maintains a pool of potential inspectors for the Authorization Procedure for Large Model Helicopters. This procedure is designed to provide insurance for individuals wishing to fly a model helicopter between 55 and 125 pounds in specific, controlled situations.
2) This pool of prospective inspectors can be found on the AMA website Members Only Section under Members & Club tab (www.modelaircraft.org).
3) Individuals desiring appointment to the inspector pool can do so by submitting a complete application to AMA Headquarters. The application involves completing the appropriate form LMH-8, as well as providing a résumé detailing qualification and a list of references. A majority approval vote of the Safety Committee members will result in the addition of the individual to the inspector pool. Additional names can be added to the pool by the Safety Committee or Executive Council if needed, to adequately maintain the program.
4) In accepting the nomination as an inspector, a member accepts the responsibility implicit in the appointment and undertakes:

    a) To be available with reasonable notice to attend and observe test flights when requested.

    b) To carry out all duties in accordance with this program.

    c) To not charge for services (compensation for expenses and travel are permissible).

    d) Inspector cannot be the builder, pilot, owner, or buyer/seller of the LMH-2 helicopter being inspected.

e) Inspector must be a current AMA member when inspecting a helicopter.

5) AMA's member insurance coverage applies to a certified Large Model Helicopter Inspector for alleged negligence resulting in a bodily injury or property damage claim or suit arising out of the inspection of a helicopter for the purpose of qualifying it for flight approval.

B) Inspector Qualifications

1) Applicants for the Large Model Helicopter Inspector designation will complete and submit the LMH Inspector application, form LMH-8. The application will be reviewed and acted upon by the AMA Safety Committee.
2) The candidate must meet at least three of the following criteria to be considered for approval:
    a) A minimum of 10 years of AMA membership.
    b) Must be one of the following: Contest Director, Leader Member, Life Member, AMA Committee Member, or past or present EC/AVP.
    c) Must have owned, built, and flown at least one LMH/LTMH-1.
    d) At least one of the three references must be an LMH owner or inspector.

    Professional or educational experience with design of uncrewed aircraft weighing more than 55 pounds.
3) Applicant must submit a written résumé addressing all applicable information as requested in the résumé section of the application.
4) Inspectors are the AMA's representative at both the time of inspection and demonstration flights. That inspector must ensure that all provisions of this document are satisfied. If an inspector is suspected of an improper or superficial inspection, falsification of forms, or other misconduct the Safety Committee may, at its sole discretion, suspend an inspector's designation until such time as the Committee completes an investigation. At that time, the LMHI Inspector designation will either be revoked or reinstated.

C) Guidelines for Inspection

1) Inspector should validate the following information:
    a) Total weight, ready to fly, with fuel. The Contest Director/Leader Member/LMH Inspector will either provide the scales or take reasonable effort to check the accuracy of the scales used.
    b) Weight and balance methods and data provided by builder.
    c) Servo torque requirements provided by kit manufacturer or servo torque calculations per Section 4 of the LMH regulations.
    d) AMA card.

e) Pilot qualifications for LTMH permit applications.

f) Builder's Declaration, form LMH-3.

g) Turbine class addendum if applicable, form LMH-4.

h) Compliance with Foreign Participant Requirements, if applicable.

i) Ground support or fire suppression equipment as necessary (required for turbine operation).

2) Conduct preflight inspection, completing form LMH-5.

3) Photograph model (3-view with sufficient detail).

4) Complete a safety check of the site to ensure compliance with Section 1.C.4) if applicable.

5) Issue Temporary Authorization to Fly, completing form LMH-1.

6) Preflight briefing

a) Inspector expectations.

b) Maneuvers to be performed.

c) Emergency procedures.

7) Flight

a) All flights will be done in accordance with the current Safety Code, particularly that all pilots shall avoid flying directly over unprotected people, vessels, vehicles, or structures, and shall avoid endangerment of life and property of others. The model helicopter must occupy airspace that will permit safe impact upon loss of control. This infers function of the fail-safe system to a limited dispersion impact.

b) Flight maneuvers shall not exceed the design limits of the vehicle.

c) Flight velocity shall not exceed 120 mph in level flight for LMH-2.

d) The flight test program should include the following items during the initial two shake-down flights, *prior* to certification:

i. First flights shall be relatively short in duration and be devoted to checking out such items as dynamic blade tracking, control system effectiveness, gyro gain settings, trim settings, etc.

ii. Later flights during testing must be designed to demonstrate control and structural integrity. A little tighter-than-normal left- and right-hand turns (in case it may be needed), and higher speed flight and descents, enough to add a little extra stress to check out structural integrity. If the full-scale helicopter was capable of aerobatics (and they are to be part of the flight

demonstration), then these maneuvers, such as rolls, loops, flips, etc. should be included.

iii. The final test-flight conducted for the inspector shall demonstrate the entire flight envelope as it might be flown at sanctioned event demonstrations.

8) Post-flight debriefing and helicopter inspection is required.

9) Review of completed paperwork with owner/pilot.

10) Issue Permit to Fly, form LMH-2.

11) Submit required paperwork immediately to AMA Headquarters.

FORM-8: Inspector Application

Name _____ AMA # _____

Address _____

City _____ State _____ Zip _____

Phone (_____)_____- day (_____) _____

evenings (_____) _____

Email _____ Fax _____

Occupation _____

I pledge that if I am granted LMH Inspector status, I will:

Maintain a high level of proficiency in the use of materials as well as building and flying techniques for large helicopter models.

Maintain strict safety standards and adherence to the AMA Safety Code, the AMA Large Model Helicopter Program, and its authorization documents.

Submit all required documentation promptly.

Please check all that apply:

❒ I have been an AMA member for at least 10 years.

❒ I am a Contest Director, AMA Leader Member, AMA Life Member, AMA committee member, or present/past AMA Executive Council member, or an AMA Associate Vice President.

❒ I own/built and have flown at least one LMH/LTMH-1 helicopter (list each applicable model in résumé.)

❒ I have professional or educational experience with design of unmanned aircraft over 55 pounds (please provide more details in résumé.)

❒ At least one of my references is an LMH owner or inspector.

Signature _____ Date _____

References:
To be completed by three (3) individuals who are current AMA Adult Members

We, the undersigned, consider the applicant fully qualified to act on behalf of the AMA as a Large Model Helicopter Inspector.

Name (please print) _____ AMA # _____

Address _____

City _____ State _____ Zip _____

Signature _____ Date _____

❒ I own or have owned a LMH or LTMH ❒ I am a LMH Inspector

Name (please print) _____ AMA # _____

Address _____

City _____ State _____ Zip _____

Signature _____ Date _____

❒ I own or have owned a LMH or LTMH ❒ I am a LMH Inspector

Name (please print) _____ AMA # _____

Address _____

City _____ State _____ Zip _____

Signature _____ Date _____

❒ I own or have owned a LMH or LTMH ❒ I am a LMH Inspector

Résumé

In addition to meeting at least three of the Inspector Qualification criteria, please also provide a detailed résumé.

The résumé should describe your interest in this program, why you want to volunteer as an LMH Inspector, and how you would conduct an inspection.

In addition, you must also include items such as:

(a) Years of modeling experience involving flying and building.

(b) Models built/flown. Please be sure to highlight all LMH or LTMH aircraft built.

(c) Full-scale aircraft experience including type of license held, if any, as well as any background in home building such as EAA activity.

(d) Number of years' experience as a Contest Director, if any, and major event(s) administered.

(e) Professional experience in RC-related business such as commercial drone, radio manufacturer/repair, aircraft design, or hobby show ownership/management.

(f)) Ability to travel; articles published; administrative positions held.

(g) Other items pertinent to being selected for position.

Please be as specific as possible. This information is crucial for the Safety Committee to evaluate your application.

SECTION 4: Requirements for Modified or Self-Designed and Built Large Model Helicopters

LMH that are either modified or designed and built using self-designed, non-commercial parts or have novel and unproven systems, must demonstrate that the model (with all new or modified parts) is suitable for use before being issued a Permit to Fly.

Demonstrating that components are suitable for use is accomplished through a practical flight test procedure. This demonstration requirement is achieved by providing evidence that the helicopter has operated for 10.0 cumulative flight hours without failure of any component. You must further declare that you have examined all parts after the 10.0 cumulative hours, found them to be within specification, and found no evidence of impending failure.

Conducting Test Flights

The test flights can be completed over any number of flights and any number of days necessary to achieve the 10.0 cumulative flight hours. The location, date, time, and weather conditions are left to the sole discretion of the pilot. During the test flights, only the pilot and one visual observer can be on the actual flightline. All other persons present must be a minimum of 200 feet from the aircraft at all times. It is recommended that the test flights be conducted at locations, dates, and times where the number of persons present are minimal, and ideally limited to the pilot, visual observer, and a limited number of others who are directly involved in the test flights.

Documenting Test Flights

The test flights must be documented with the date, time, location, and flight duration (duration in the air) recorded in a logbook signed by the pilot. Beyond keeping an accurate logbook of these test flights, there shall also be a video record that documents the test flights. The video record shall include 3 full-duration flights from startup to shut down, one at the beginning of the test flight sequence (cumulative time <= 1 hour), one in the middle (filmed between cumulative time >= 4 and <= 6 hours), and one at the end (cumulative time >= 9 hours). If a typical flight is 10 minutes, there will be a total of 30 minutes of flight time documented in the videos. Use of any video recording device is allowed. The video itself must show the helicopter and provide audio from the flight. It is not important or necessary to have a professional film the event. Setting up the recording device on a tripod that faces the helicopter and uses a relatively wide angle will suffice. Any given flight video should demonstrate takeoff, hovering, forward flight, turns left and right, and landing. It is not necessary for witnesses to attend the test flights.

The 30 minutes of video must be made available to the LMH inspector for their review. In general, this means that the video might remain on a smartphone to share in person or may be uploaded to a video sharing service such as YouTube. In either case, access to the video must be provided to the inspector along with the logbook. These video records serve as a demonstration of typical operation expected from the machine. The inspector may ask to view

one or all of these flight videos at their discretion.

Special Considerations

Although it is true that not all modifications or deviations from a manufacturer's specification are created equal, for the purposes of LMH safety qualification, all modifications or deviations are considered equal and subject the model to the full 10.0-hour flight test requirement.

Design Considerations

Some design considerations that will lead to a model capable of meeting the requirements of the practical demonstration are documented below. They are guidelines that will help a model helicopter to have the essential elements for success. Ultimately, all components and systems must operate properly and reliably, and it is possible to follow these guidelines and still develop a model that is not capable of meeting the requirements. It is not possible to document all design principles that must be followed. Additional design improvements might be required in order to build a helicopter model to a sufficient level to meet these testing requirements.

Main and Tail Rotor Heads and Blades

The design and materials must be shown to be capable of handling the anticipated flight loads. This means that the main shaft, tail output shaft, main rotor yoke, tail yoke, spindle bolts, blade holders, and blade bolts must have sufficient strength to support the mass of the matching rotor blades at the maximum target operating rpm. See section Calculating Gear Ratios for additional details.

Skids/Landing Gear

If the subsystem is either modified or self-made, then there are two areas of concern. The model must have skids/landing gear sufficiently strong enough to support the weight of the model at takeoff and upon typical landing scenarios, and the landing gear must have a sound connection to the fuselage and/or mechanics to handle the loads placed upon this system. A visual inspection should reveal that this subsystem is sound and free of wear and tear that could lead to failure.

Powerplant Requirements for Electric-Powered Helicopters

An electric-powered helicopter should have a motor that can support continuous operation of the aircraft without overheating the power system including the motor, electronic speed controller, batteries and wiring.

An ESC with current logging or telemetry capability, or a separately installed current logger or telemetry module must be used to document the power consumption of the model through its flight envelope. Using the telemetry data, determine the typical (average) power consumption of the model during flight.

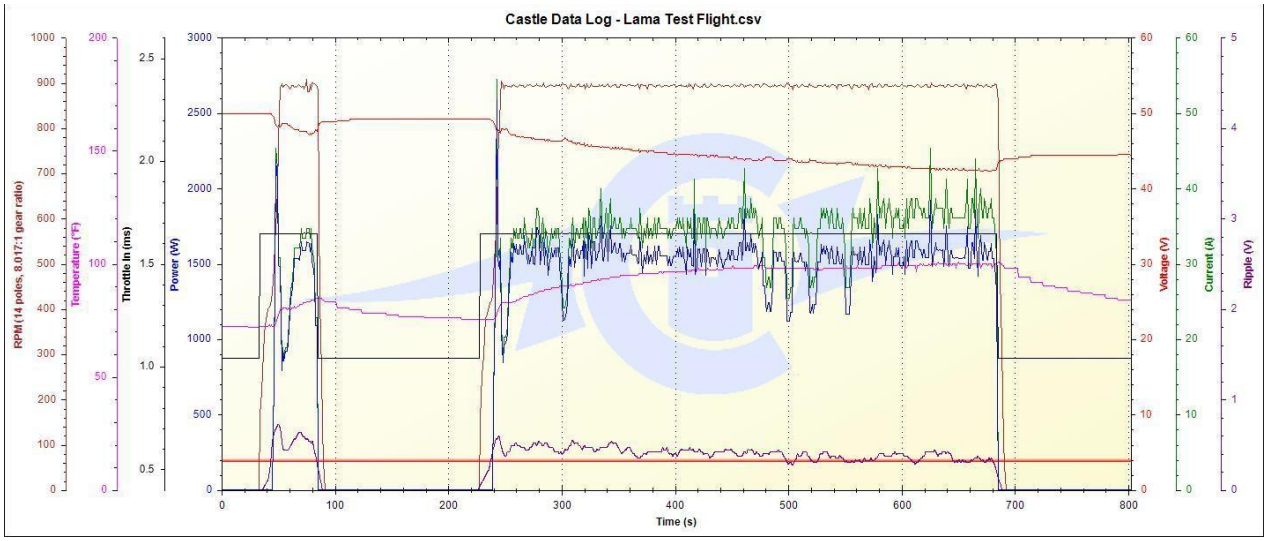

Figure 1 - A full flight log

The flight log (in this case, a Castle Creations flight log) shows the variables of interest. In this case, the chart contains power, voltage and current readings. The full flight log shows power at idle time, spool-up, flight, and spool down. In order to determine the actual average power consumption while flying, it is necessary to examine that portion of the graph where the model was in the air flying and experiencing flight loads. We can see that the model was under normal flight loads from approximately 250 seconds to 680 seconds. Using the data from that window of time, we can read an average power value by looking at the Power axis (blue line in the chart) and read roughly 1,500 watts. The Castle Creations data visualizer can also calculate an exact minimum, maximum, and average for the data displayed on screen. By zooming into the window from 250 seconds to 680 seconds, the software can show us that the average power consumption was 1,534 watts, corresponding to an average current of 34.8 amps, and an average 44.1 volts. Using Castle Creations speed controls and their data visualizer is not required. The same information can be gleaned using other forms of telemetry.

The motor must have a continuous power output rating that is greater than or equal to 1.5 times the average power consumption of the model. You must provide the manufacturer data for the motor that shows the continuous power output rating.

The electronic speed control must be rated for a continuous power output that is greater or equal to the maximum power output of the motor. You must provide the manufacturer's data for the ESC that shows the continuous power output rating.

The flight batteries must have a power output rating that is at least 1.5 times the average power consumption of the model. The advertised "C" rating for the battery is sufficient documentation for use in the calculation. For example, if the average power consumption is 1,534 watts, the battery system must be capable of providing 1.5* average power

consumption in watts:

1.5* 1534 watts = 2301 watts

The watt output of a battery is determined by the nominal voltage (using 3.7 volts per cell for LiPo batteries) * the capacity in amps * the battery C rating. For example, a 12S LiPo battery with a capacity of 6,000 mAh (e.g. 6 amps) with a 25C rating is capable of outputting:

12 cells * 3.7 volts/cell * 6A * 25C = 6,660 watts maximum

The battery can deliver sufficient power to the motor, but that alone does not mean it can supply power long enough for sustained flight.

Batteries must also be sized with enough capacity to sustain a flight duration of the pilot's choosing. Upon landing, the batteries must have at least 20% capacity remaining as measured by the mAh put back into the battery relative to the rated capacity. For example, if a 6,000 mAh battery is used, the battery should be charged after the inspection flight. Make note of the mAh used to charge the battery. This number should be no more than 80% of 6,000 mAh, e.g. 4,800 mAh.

There are some inefficiencies in charging. The charge put back into the battery is a close representation of the capacity drained, but it is not absolute. The goal is to be close without draining the reserve capacity of the pack. When a LiPo battery is discharged below 20%, it rapidly loses voltage and generates excessive heat, which can lead to a reduced lifespan for the battery (and model if you are not careful). To maintain a safe margin, it is therefore desirable to avoid discharging the battery more than 80% of the total capacity. If other battery chemistry is used, safe discharge limits for that chemistry should be observed.

In order to size a battery properly, it can either be determined experimentally or it can be calculated based upon the measured power consumption of the model and the intended flight duration. For the purpose of illustration, let us say that the model shall be capable of flying for 10 minutes, and the average power consumption is 1,534 watts. If you do not already know the average amp draw, derive the amp draw by calculating average power consumption in watts/nominal battery voltage. In this case:

1,534 watts/(12s * 3.7 volts) = 34.54 amps

Convert 34.54 amps to mAh

34.54 amps * 1,000 mAh/Ah = 34,540 mAh

Using the total number of milliamps consumed per hour (e.g. mAh), determine how many mAh are consumed per minute by dividing by 60:

34,540 mAh/60 minutes = 575.6 mAh/minute.

If the intended flight duration is 10 minutes, then the model will consume approximately:

10 minutes * 575.6 mAh/minute = 5,756 mAh

In order to land with 20% capacity remaining, the battery must be a large enough size such that 5756 mAh is no more than 80% of the pack capacity. To find the size of the battery such that 80% of that capacity is 5,756 mAH, we calculate that total capacity as:

5,756 mAh/0.8 = 7,195 mAh

Therefore, a battery with at least 7,195 mAh total capacity should be used. This typically means an 8,000 mAh battery would be chosen.

All connectors and switches that pass power from the batteries to the ESC and motor must be rated for the maximum expected power output of the system. You must provide the manufacturer's data for the connectors that shows the continuous power output rating.

Powerplant Requirements for Gas-Powered Helicopters

A gas-powered helicopter should have an engine that can support continuous operation of the aircraft without overheating the engine. The engine must be instrumented with temperature telemetry that monitors cylinder-head temperature. A qualifying flight of at least 5 minutes (in the air) must be flown. At the conclusion of the flight, the telemetry data must be examined to determine the maximum temperature during the flight. The temperature must be either below the engine manufacturer's maximum operating temperature if specified, or 350^{o} F if no manufacturer's data is published.

The fuel system must be demonstrably leak free. The fuselage must be free of fuel residue resulting from a plumbing leak. Additionally, the fuel tank system must empty without drawing significant air. A header tank or air trap must be used between the fuel tank(s) and the carburetor. A visual inspection shall demonstrate that the header tank or air trap is full of fuel and nearly free of air at the completion of the flight. A header tank or air trap must be made with transparent material to enable such a visual inspection

Powerplant Requirements for Turbine-Powered Helicopters

A turbine-powered helicopter should have an engine that can support continuous operation of the aircraft without overheating the turbine. The turbine-engine control unit (ECU) keeps track of many operating parameters, including exhaust gas temperature (EGT), a leading indicator of engine load. A qualifying flight of at least 5 minutes (in the air) must be flown. At the conclusion of the flight, use the turbine data terminal or other telemetry device to read the maximum EGT that was experienced on that flight. The maximum EGT recorded must be below the limit specified by the manufacturer for that specific model turbine. The average EGT recorded by the ECU must be at least 10% below the maximum EGT specified.

The fuel system must be demonstrably leak free. The fuselage must be free of fuel residue resulting from a plumbing leak. In addition, the fuel tank system must empty without drawing

significant air. A header tank or air trap must be used between the fuel tank(s) and the turbine fuel pump. A visual inspection shall demonstrate that the header tank or air trap is full of fuel and free of air at the completion of the flight. A header tank or air trap must be made with transparent material to enable such a visual inspection.

Main and Tail-Rotor Servos

These must be rugged enough and deliver adequate torque and rate to drive the associated mechanical linkage throughout the range of rotation required to maintain operational control of the aircraft. Calculations are required to show that the installed servo is capable of providing 1.5 times the dynamic torque required to operate the respective control position.

Calculations or dynamic data is acceptable. Note the minimum torque requirements stated in the previous section on LMH Model Requirements must be followed.

Calculating Gear Ratios

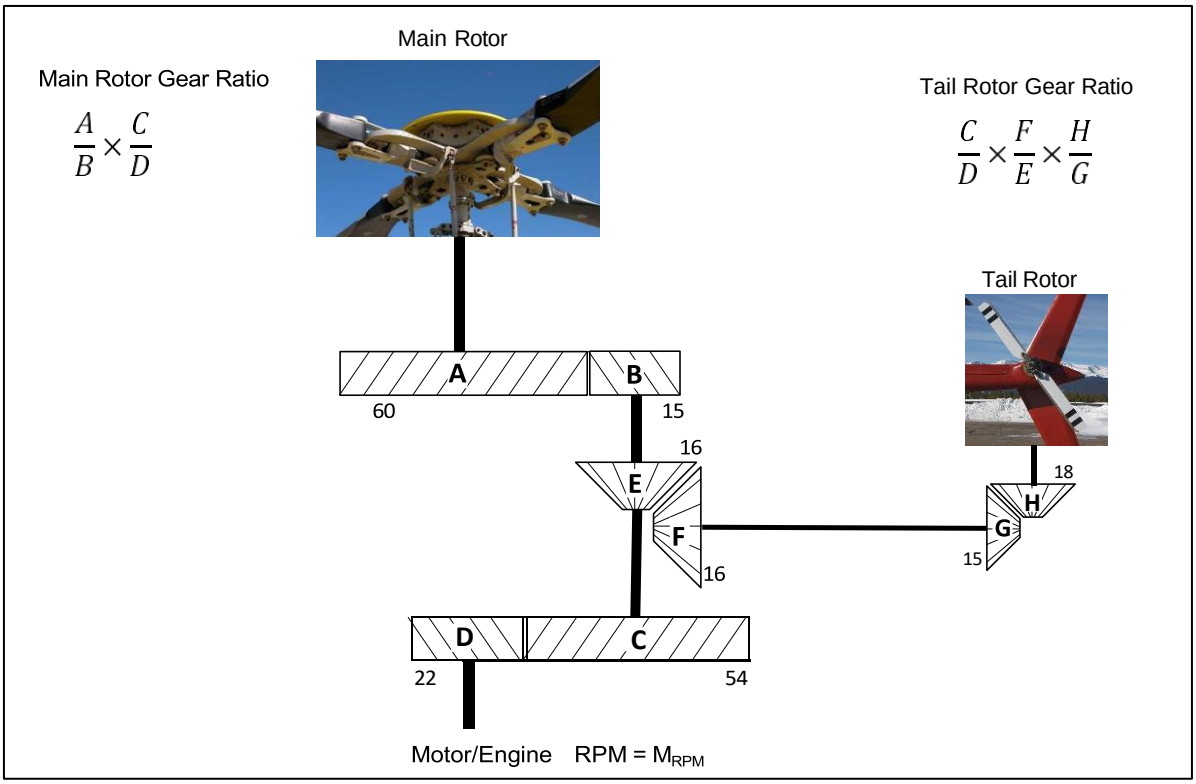

Figure 2- Gear Ratio Example

The term “gear-reduction ratio” describes the number of revolutions that the powerplant output shaft must make to generate one revolution of the given rotor shaft. The powerplant spins at a higher rpm than the rotor system and the gear-reduction ratio properly reduces the input speed while increasing the torque.

The gear-reduction ratio is often expressed as a value that describes the number of input revolutions required to achieve one output revolution, thus a ratio has the form X.YZ : 1. It means that for every X.YZ revolutions of the powerplant, one revolution of the output shaft occurs.

In general, a gear ratio is calculated by properly combining the sets of gears with mating faces with the other sets of gears with mating faces. Gears with mating faces divide each other, and are multiplied against the next gear set that is connected by a driveshaft. By starting from the main gear connected to the main shaft and working our way through all the gear sets until the final pinion gear is reached, we can calculate the full gear reduction.

In this example, shown in Figure 2, gear A has 60 teeth and directly meshes with gear B having 15 teeth. Gear B is connected via a driveshaft to bevel gear E with 16 teeth and to gear C with 54 teeth. Gear C directly meshes with gear D with 22 teeth. Gear D is the pinion gear which is connected to the motor or engine output shaft.

The main rotor gear reduction is determined by calculating A/B * C/D. In this case, 60/15 * 54/22 = 9.81. The final main rotor gear reduction is therefore 9.81:1.

Rotor rpm is determined by calculating motor or engine rpm (Mrpm)/gear reduction ratio. If the motor has an rpm of 16,000, the main rotor rpm would be 16,000 rpm/9.81 = 1,630 rpm.

The tail rotor-gear reduction is determined using the same approach, while using the gear set related to the tail drive. In this example, the tail rotor rpm is determined by calculating C/D * F/E * H/G. In this case, 54/22 * 16/16 * 18/15 = 2.95. The final tail rotor gear reduction is therefore 2.95:1.

After the tail rotor gear reduction ratio is known, the tail rotor rpm is determined by calculating Mrpm/tail gear reduction ratio. Using the same motor with 16,000 rpm, the tail rotor rpm would be 16,000 rpm / 2.95 = 5,424 rpm.

Once a powerplant's maximum rpm is established, that value can be used in the rotor rpm equations given here to determine the maximum main rotor and tail rotor rpm attainable.

Inspection FAQ

Q: What maneuvers must be flown in the video test flights?
A: Takeoff, hover, forward flight, yaw left, yaw right, and land.

Q: Are there any special weather requirements for the test flights?
A: No. This is left to the pilot's discretion.

Q: Do the flight videos need to be publicly available?
A: No. The availability is at the discretion of the pilot. The videos do need to be made available to the inspector.

Q: Is there a template for the logbook?
A: Not at this time. Record the date, time, location, and flight duration (in the air) on paper and sign each entry at the time you complete the flight.

Q: Do I really need a 10.0-hour flight to prove even a small change that I made is safe to fly?
A: At this time, yes.

Q: What maneuvers must be flown live, in front of the inspector?
A: Startup, takeoff, hover, forward flight, yaw left, yaw right, climb out, descent, landing, shutdown, and any aerobatic maneuvers you plan to fly as part of a typical flight routine.

Q: Can a manufacturer get approval through this process for a product line and transfer that approval to the end user?
A: No. The only way, at this time, for a manufacturer to gain approval for a helicopter beyond the specific singular helicopter being tested is to go through the approval process of another country that has an approval process mandated by a controlling authority.

SECTION 5: Foreign Participants

Event Permit to Fly

Because most foreign participants attending AMA sanctioned events would find it difficult to comply with the requirements of obtaining a Permit to Fly, the AMA Executive Council has approved the following provision, effective December 18, 2008:

1. Any foreign participant must be an Affiliate AMA member. This requirement also applies to current MAAC members who wish to apply for an event permit and their helicopter is between 77 pounds, 3 ounces and 125 pounds. This is due to discrepancies between the AMA and MAAC safety codes and liability policies.
2. Pilots/Owners must conduct an inspection according to the LMH inspection guidelines and sign an attestation that the helicopter has flown a minimum of three successful flights on previous occasions (*Form LMH-6*).
3. An AMA LMH Inspector will conduct an inspection according to the LMH Program inspection guidelines for LMH-2 and LTMH-2.

The AMA LMH Inspector will issue an "Event Permit" based on the pilot's verification and a successful inspection (*Form LMH-7*). The issued permit will allow the helicopter to be immediately flown at any time during the sanctioned event and AMA's liability coverage would apply.

An "Event Permit" is required for each specific model helicopter and is only valid for the dates of the sanctioned event.

FORM-6: Sanctioned Event Permit to Fly for Foreign Participants

Owner's Name_____AMA # _____

Model Description:

Helicopter type_____

Wingspan_____Weight (wet) _____

Contest Director/Leader Member/LMH Inspector Initials _____

Engine manufacturer and displacement or thrust _____

Turbine? ❒(check if yes) Designed by _____

Color scheme _____

Construction: ❒ Kit ❒ Plans ❒ Custom ❒ Other explain)_____

Transmitter _____ Servo roll _____

Receiver_____ Servo pitch _____

Batteries_____ Servo yaw _____

Power-distribution system_____ Servo collective _____

Flight Envelope:

❒ Level maneuvers (required)

❒ First limited/aerobatic maneuver (list) _____

❒ Second limited/aerobatic maneuver (list) _____

The above-described helicopter has been inspected for airworthiness and has demonstrated its ability to perform within the designated flight envelope as indicated on this permit. (In the case of Foreign Participants, the *Form LMH-7* will be attached to this form attesting to three successful previous flights.)

_____ _____

Owner or Contest Director/Leader Member/ LMH Inspector Name (print)

Owner or Contest Director/Leader Member/ LMH Inspector Name (signature)

Date of issue _____

Permit to Fly is only valid for the dates of the sanctioned event.
Documentation should be mailed to 5161 E. Memorial Dr., Muncie IN 47302 or emailed to safety@modelaircraft.org.

FORM-7: Event Permit to Fly–Foreign Participant Attestation

Owner/Pilot Attestation:

I,_____, hereby attest that the model helicopter,

_____ _____

Model Description

has had a minimum of three (3) successful flights on previous occasions and that it complies with the current AMA LMH program guidelines.

_____ _____

Owner/Pilot Name (print) Owner/Pilot Signature

_____ _____

Date AMA Number