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AMA Gas Turbine Program (GTP) Turbine Waiver Qualification

Ground Operations and Flight Skills Training for Models Powered by a Turbojet or Turboprop

This document is updated to correspond with AMA Documents 510-A & 510-D (both Revised Oct 2021)

Introduction

AMA members can operate a gas turbine-powered model and retain AMA insurance coverage if the model is operated in accordance with the following documents:

- AMA Safety Guide (Document 105)
- AMA Gas Turbine Program (Document 510-A)
- AMA Turbine Waiver Application (Document 510-D)
- AMA Turbine Waiver Holders (Document 510-M)

and, if applicable,

- AMA Large Turbine Model Aircraft Program (Document 520-A)
- AMA Guide for Home Built Turbines (Document 510-B)

Background

The AMA Gas Turbine Program (GTP) was launched in 1996 as commercially available turbines became available.

The GTP includes technical requirements, safety equipment requirements, and pilot knowledge/skill requirements which are demonstrated via the waiver qualification process which includes both ground-based and flight skills demonstrations.

The GTP has evolved over the years since its inception due to changing technology or conditions. A much-noted change to the GTP was the elimination of manufacturer-specific
turbine training (aka "ground school") in 2001. (See Appendix A for more info.)

As the special interest group (SIG) officially representing USA jet modelers to the AMA, the JPO advises the AMA on turbine-related matters and potential changes to the GTP.

Background – Why is it called a “turbine waiver”?

The “waiver” was a development of risk/insurance concerns. Some GTP terminology is best understood in that context.

Prior to the establishment of the GTP (with its integral “waiver” requirement), AMA members could not operate a turbine-powered model within the framework of the AMA system. Essentially, turbines were “banned” by the AMA rules.

The AMA worked with its insurance carrier to develop the GTP program to provide a means by which qualified AMA members could maintain their insurance coverage while operating turbine-powered models.

The “turbine waiver” is the qualification by which the rule banning turbines is “waived”. Thus, members having a turbine waiver maintain their insurance coverage when operating turbine-powered models in the category covered by their waiver.

Background – Categories of Turbine Waivers

Currently, the GTP includes the following waiver categories:

- Control Line
- Fixed Wing Turbojet (covered in this training package)
- Fixed Wing Turboprop (covered in this training package)
- Rotary Wing

Each of these categories has their own requirements for the pilot and the model used for the turbine waiver qualification.

GTP - Overview

Any AMA member is be permitted to fly a turbine-powered model on the slave transmitter of a buddy box provided that the master transmitter is operated by an experienced turbine pilot.

All AMA members operating a turbine-powered model aircraft SOLO (without a buddy box) must have a qualifying turbine waiver.

The GTP includes the requirements (knowledge, equipment, and skills) to operate a turbine-powered model and to obtain a turbine waiver.

GTP - Experienced Turbine Pilot

Per AMA document 510-A, an experienced turbine pilot is defined as a pilot who has completed 20 or more turbine-powered model flights during the preceding 24 months and who has a turbine waiver issued by AMA. For confirmation purposes, the pilot is required to keep a written log of all flights and will provide copies to AMA upon request.

It is an insurance-based term and NOT an ego-based term.

An “experienced turbine pilot” meets the experience and currency requirements of the AMA and its insurance provider.

ONLY experienced turbine pilots may:

- Provide turbine-powered model flight instruction (using a buddy box) to nonwaiver holder AMA pilots;
- Conduct turbine waiver qualifications and sign a turbine waiver application
- (AMA document 510-D).
- Supervise the first five solo turbine flights of a newly-waived turbine pilot.

Waivered pilots who DO NOT meet these currency & experience requirements can obtain/regain experienced turbine pilot status by performing the 20 or more turbine flights in the current 24-month continuous period; it is NOT necessary to reapply for a turbine waiver or re-perform a turbine waiver qualification.

GTP – Requirements

The GTP includes requirements of the:

- Airframe (Model)
- Flight Line (Flying Site)
- Pilot (Applicant)

Satisfying these requirements calls for knowledge of and compliance with:

- Technical Details (e.g., weight and thrust limits)
- Safety Procedures and Equipment (e.g., fire extinguishers)

As well as the skills to:

- Perform Technical Procedures (e.g., Learn RC, emergency shut down)
- Fly with consistency and full control in all phases of flight.

Many of these requirements are presented in the following slides. Refer to AMA document 510-A for a complete list of requirements.

GTP – Airframe Requirements

The GTP requires that the model to be used during a waiver qualification:
Be powered by a single turbine engine with an installed static thrust not to exceed 50 lbs.

Be equipped with:

- controllable rudder(s);
- a steerable undercarriage suitable for a rolling takeoff and landing;
- either flaps/flaperons or a speed brake
- the ability to come to a controlled stop on command with the engine at idle on a level hard surface
- (typically the model is fitted with wheel brake(s))

Be capable of a sustained speed of at least 75 mph (turboprop) or 100 mph (turbojet).

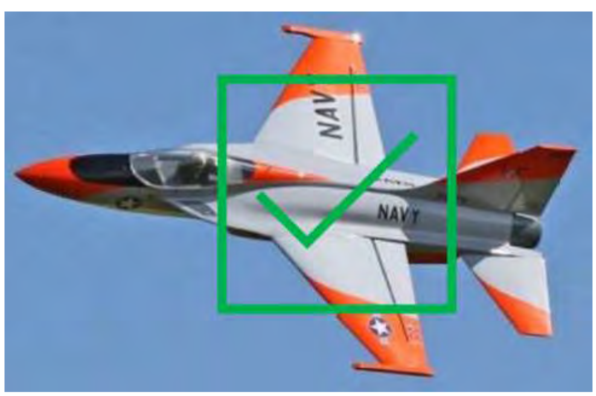
GTP – Airframe Requirements (Cont'd)

Additionally, per the GTP, models used to perform a waiver qualification must:
Weigh more than 12 lbs (dry)
OR
be an ARF specifically designed and produced by the manufacturer for turbine power or converted to turbine power using a conversion kit (including tailpipe) produced by the model's manufacturer.

Therefore, for models used to perform a waiver qualification:

- Converted ARFs (including many foam EDF's), which have not been designed and produced by the model's manufacturer for turbine power, may not be used.

- EDF ARFs (which have been designed and produced by the model's manufacturer for turbine use) MUST use the model manufacturer's turbine conversion kit.



GTP – Airframe Requirements (Cont'd)

The GTP also requires that the model to be used during a waiver qualification:

has two fuel shut-off provisions, one of which is manual, and the other is remotely operated. An ECU-operated shutdown is compliant as a remote shut-off if it closes with loss of power.

is equipped with a Tx failsafe and that the ECU is configured to shut down the engine within 2 seconds of failsafe activation.

is equipped with a turbine that has NOT been involved in an incident where high G-loads were probable without being examined and certified as safe to operate by a manufacturer approved service center.

Festo 4mm ¼ turn ball valve & mount

Jetcat GSU showing failsafe activated

High G-load "landing"

GTP – Flight Line Requirements

The Applicant shall have a “B/C”-rated or equivalent fire extinguisher present for ALL engine starts.

Carbon dioxide (CO2) fire extinguishers are commonly used for R/C turbine support. Five (5) lb extinguishers are easily available online for about $120 to $140.

You will want your own extinguisher. Write your name on it as they all look the same especially at jet events.

If you are an ironman athlete or plan on having a lot of fires, you can buy a 10 lb extinguisher (which weigh a lot more than 10 lbs) and lug it around yourself.

DO NOT BUY a dry chemical fire extinguisher. While it is considerably less expensive, if you discharge it at/into a turbine, the dry chemical WILL damage the turbine beyond economical repair.

GTP – Flight Line Requirements (Cont'd)

The Applicant shall ensure that water-based fire-fighting equipment is present on the field.

- Water-based equipment is intended for fighting grass/bush fires that may result from a crash or failure.

- In these cases, typically the model and turbine are a TOTAL LOSS.

- Fighting the fire yourself MAY save the fire department from having to respond (as well as preventing negative opinions of the town, landowner, or club members).

- At least 5 gallons of water (ideally 10 or 15 gallons) should be available FOR IMMEDIATE USE (not locked up in a shed) in case of a crash on or off the field.

- Shovels, rakes, and an axe (if appropriate for the terrain) should also be immediately available.

- Water is heavy so carrying it in a usable quantity (5 gallons) quickly over any distance can be a challenge. An Indian Fire Pump backpack is an excellent solution to the transportation issue.

GTP – Pilot Requirements

- The GTP requires that the turbine waiver applicant:
- is an AMA member.
- has accomplished at least 50 flights of a high-performance model.

AMA Document 510-A defines a high-performance model as being capable of sustained speeds of:

- ✓ 100 mph or higher (for turbojet waiver applicants)
- ✓ 75 mph or higher (for turboprop waiver applicants)

- JPO strongly recommends that turbine waiver applicants also have experience flying models which are equipped with retracts and flaps.
- 80+" wingspan warbirds are an excellent lead-in to turbine-powered fixed-wing models.
- is familiar with the requirements of the AMA Gas Turbine Program (AMA document 510-A).

GTP – Waiver Qualification Requirements

Per the GTP, the applying pilot will successfully perform a turbine waiver qualification.

consisting of all ground operation and flight skills as specified in AMA Turbine Waiver.

Application (AMA Document 510-D) under the supervision of two experienced turbine pilots, one of whom is a contest director.

The waiver qualification includes evaluating the waiver applicant's skills in:

- Ground operation of the turbine; and
- Flight skills

The applicant must demonstrate knowledge/skill in both areas.

GTP – Ground Operation

Equipment, Knowledge, & Skills

GTP – Ground Operation – Safety Equipment/Knowledge

The Applicant shall explain the potential for a post-crash fire and the response plan to deal with the situation. Explanation to include the local fire department contact number and firefighting equipment immediately available for the modeler to respond to the fire.

Example Response Plan:

1. If possible, shut off the fuel flow using the manual shut off valve or power off the model. (Point to valve and switch location)

2. If the fire is limited to the model, use a leaf blower to attempt to blow out the fire. Leaf blower should be within ~10 feet of the model when the turbine is started.

3. If the leaf blower is unsuccessful, deploy the CO2 fire extinguisher into the inlet of the turbine/model and/or the base of the flames. Extinguisher should be within ~10 feet of the model when the turbine is started..

4. If the fire has spread to the terrain, use the water-based equipment. State the location of equipment.

5. If there is the possibility that you will not be successful in extinguishing the fire, immediately call the fire department (dial 911). Make sure you give them an adequate description of your location (e.g., latitude & longitude from your cell phone GPS). Have someone greet them at the field entrance to direct them.

GTP – Ground Operation – Skills

The Applicant shall explain and demonstrate:
General knowledge of turbine setup (ECU learn, setting the failsafe)

- Fueling the model. Explanation to include ensuring that the manual shut-off valve is closed, avoiding fuel spillage from the fueler or from the model fuel tank vents, ensuring the tanks are evenly/completely filled, prevention of over-pressurizing the tanks by leaving any plugs installed during fueling or by having too high a speed on the fueling pump.

- Performing the startup. Explanation to include examination of the startup area, orienting the model such that the exhaust gases do not impinge on people or any flammable object, ensuring that nobody is standing in-line-with or aft-of the turbine wheel (potential for throwing a turbine blade during startup) as well as the items to be performed to the transmitter/model to start the turbine.

Fueling using a Jersey Modeler 5 gal electric fueler and overflow tank.

Kingtech GSU shown
(Note: Trim Low)

Typical startup area.
Note: blast deflectors, fire extinguishers, people are forward of turbine, pilot and spotter are both are physically restraining the plane from moving.

GTP – Ground Operation Knowledge/Skills

The Applicant shall explain and demonstrate (cont'd):

• Using the Ground Support Unit (GSU):

• The GSU is a HUGE source of information of the status of your turbine. The GSU is your friend and is not just for priming the pump or Learn R/C.

• The GSU can notify you of a potential problem BEFORE the turbine fails (saving you $$$$ and much grief).

• DO NOT fall into the trap of thinking you look cool when your airplane is all buttoned up and you're standing back when you start the engine. You won't look cool if your turbine doesn't start, catches fire, or seizes.

• Fault isolation using GSU error messages – GSU operation and error messages/codes vary per manufacturer and date of manufacture. The turbine manual will list the messages/codes. Read the manual!

• The GSU can also be used to monitor engine parameters - Example: if normally your fuel pump voltage is 2.4V max at full throttle, and it was 2.6V during your last flight, your fuel filter may be clogged, or your fuel pump may be wearing out. Get to know your turbine!!!!!!

• Several modern radio systems and turbines have telemetry capabilities which monitor and log engine performance on the ground and IN THE AIR. Telemetry can make the difference between going home with an intact turbine & model versus going home with a garbage bag of debris.

• Monitor total run time – the turbine must be returned to the manufacturer for scheduled maintenance & bearing replacement (typically at 25 hours of run time).

GTP – Ground Operation Knowledge/Skills

The Applicant shall explain (cont'd):

What to do in the event of a failed start attempt where fuel has flowed to the engine but has not been ignited.

• During the initial start sequence, the ECU will command the fuel pump to turn for 1-2 seconds to prime the turbine.

• If there are multiple start attempts WITHOUT ignition, a significant quantity of fuel will have pooled in the engine.

• If a subsequent start attempt achieves ignition, the pooled fuel will also ignite to produce a "hot start" which can easily result in hidden or obvious damage to the model.

• After multiple unsuccessful start attempts (3 maximum), the turbine should be removed from the airframe and tilted to drain any excess fuel from the front of the engine.

• Fault isolate the root cause of the failed starts (e.g. insufficient ECU battery capacity or charge, faulty ceramic ignitor or glow plug) before attempting another start.

Results of a hot start when correct procedures and equipment pre-positioning were NOT performed.

GTP – Ground Operation Knowledge/Skills

What to do if a hot start occurs:
• Perform an emergency shutdown (using the shutoff devices – see below).
• Initially use a blower if you have access to the turbine through an open hatch.
• Use a fire extinguisher to put out the fire.
• Before attempting another start, inspect the model and turbine.

How to perform an emergency shutdown (typical, may vary with turbine brand):
• Use the manual shutoff, or
• Use the transmitter-controlled shutoff, or
• Turn off the model (loss of power will automatically stop the fuel flow), or
• Use the radio system failsafe by turning the transmitter off.

How to perform the shut down and cool down procedures:
• Keep the tailpipe area clear of people and flammable items during start, shutdown, and all ground operations.
• Note: Many facilities have a “kill line” which you cannot cross until you have shut down the turbine. This is inherently safe as the jet blast points away from people/equipment, as well as minimizing the risk of “runaways” and collisions.)
• Perform an “RC off” to shut down the turbine
• Close the manual shutoff valve.
• Point the model into the wind (if safely possible) or use a leaf blower to improve cooling of the turbine (and save capacity of your ECU battery).

GTP – Ground Operation Knowledge/Skills

The Applicant shall explain typical turbine maintenance:

Turbines are relatively maintenance free. For any serious issue, the turbine will likely need to be returned to the manufacturer for service. However, by performing some limited tasks as listed below, the modeler may prevent small issues from escalating into serious and expensive issues.

These include:

- Using a FOD screen to protect from debris being sucked into the inlet. Ensure that the FOD screen remains tightly in place
- Inspect the inlet and compressor wheel for any damage.
- Replace the starter motor O-ring if grinding or slipping is detected.
- Inspect the turbine disc and exhaust nozzle for damage and uneven discoloration (due to a hotspot)
- Keep the fuel system clean by using a fuel filter and regularly cleaning the filter element.
- Refer to Appendix C – Turbine Maintenance for additional photos and details.

GTP – Ground Operation Knowledge/Skills

The Applicant shall explain/demonstrate the effect of turbine lag.
Unlike piston engines which have quick response (~ 1 sec or less) to throttle changes, turbines have noticeably slower response which is called "turbine lag" or "throttle lag". Older generation turbines may take 8-10 seconds for the turbine to spool-up from idle to full power or vice versa. Recently manufactured turbines typically have 3-4 seconds of "lag". However, A LOT of things can happen in 3-4
seconds (and many more in 8-10 seconds).

Throttle lag MUST be considered when operating a turbine-powered model as follows:

• **Taxiing –** Slowly advance the throttle to give the turbine the time to react and the model to begin to taxi slowly. Make minor adjustments to maintain a safe taxi speed. If the ground is uneven and a wheel engages a rut/hole, advance the throttle to overcome the obstacle but be ready to engage the brakes and reduce the throttle as the model returns flat terrain.

• **Takeoff roll –** Slowly advance the throttle to ~half to get the model rolling (and air moving over the flight controls). Ensure you have directional control before advancing to full throttle. Any decision to abort the takeoff must be done sufficiently early to allow the turbine to spool-down and the model to stop BEFORE reaching the end of the runway and careening into the overshoot where it may be damaged.

• **Maneuvers –** When performing maneuvers with varying throttle levels (e.g., loops with high throttle when climbing and low throttle when descending), you must plan ahead. Advance the throttle BEFORE starting the climb and reduce the throttle BEFORE starting to descend.

GTP – Ground Operation Knowledge/Skills

The Applicant shall explain and demonstrate the effect of throttle lag (cont'd):

• Throttle lag MUST be considered when operating a turbine-powered model as follows:

• **Landing approach –** Give the turbine and model time to react to throttle commands. Typically, you will need to make longer and flatter approaches where the airspeed is stabilized. Don't cross the fence at a medium speed, then throttle down to idle, and expect the airspeed to quickly bleed off in time to land in the first half of the field. Also, if you get too slow and need to add power, you must give sufficient time for the turbine to spin up to a useful RPM & thrust before the plane stalls. Fly consistent approaches (flight after flight) to avoid making mistakes and getting behind the "power curve". When learning what approach speed, glideslope, power setting works best for each model, give yourself the opportunity and space to learn the model's characteristics (e.g., don't do a maiden flight at a short field if a longer field is available).

• **Go-around decision point –** The decision point for going around with a turbine model is FAR EARLIER than a propeller-driven model. If the approach doesn't look good (too high, too fast, too low, too slow) then GO AROUND. Don't wait to the last second to decide. When learning to land a new model, shorten the flight to ensure you have sufficient fuel on board to do at least 2-3 missed approaches/go-arounds. Being out of airspeed, altitude, fuel, and ideas at the same time is not a recipe for success.

GTP – Waiver Qualification Flight

Preparation & Skills

GTP – Waiver Qualification Flight Preparation

The turbine waiver applicant must first have flown the turbine-powered model on a buddy box with an experienced turbine pilot in control of the master transmitter. This typically occurs during training as listed below.

- Per the GTP, the experienced turbine pilot will assist the applicant with as many flights as necessary until satisfied that the applicant is prepared for the qualification flight after which the experienced turbine pilot will declare the applicant qualified to perform the qualification flight flying solo without buddy box assistance.

- Performing the waiver qualification flight will be the FIRST TIME that the applicant flies a turbine-powered model SOLO.

- The applying pilot will successfully perform a qualification flight consisting of all flight maneuvers listed in the turbine waiver application (AMA Document 510-D) under the supervision of TWO experienced turbine pilots, ONE of whom is a contest director.

Notes on the Waiver Qualification Flight

Waiver flights MAY NOT be performed DURING an event. These flights MAY be performed BEFORE or AFTER the official event hours.

Prior to the waiver qualification flight, the Applicant must perform a buddy box flight (of the model to be used during the qualification flight), under the supervision of one of the experienced turbine pilots who will supervise the qualification flight.

- Typically, one of the experienced turbine pilots supervising the qualification flight is the Applicant's instructor. As such, this buddy-box flight will have already been performed during the Applicant's training.
- In the rare instance that the readiness of the Applicant and model are unknown to both the experienced turbine pilots supervising the flight, by first conducting a buddy-box flight, the readiness of the Applicant and model can be safely confirmed before the Applicant is permitted to fly solo without a buddy box (as required during the waiver qualification flight.)

A buddy-box flight on the day of the qualification flight is a best practice to give the Applicant an opportunity to "warm up" and get comfortable, particularly if the Applicant is not completely familiar with the field where the qualification flight will be performed.

- The experienced turbine pilots supervising the qualification flight shall give a pre-flight briefing to the Applicant regarding:
- Expectations, duration, and performance standards,
- Any special notes about the field, airspace, safety line, crash and recovery plan, etc.
- The importance of communication on the flight line and that there will be questioning and commentary while flying is taking place; and
- If asked to "land" the Applicant will immediately comply or relinquish control to an Experienced Turbine Pilot. Any discussion or questioning as to why should be conducted after a safe landing.

GTP – Waiver Qualification Flight Skills

The Applicant shall operate the model solo and perform the following maneuvers:

- Takeoff
- Horizontal Figure 8
- Two (2) aerobatic maneuvers with combined looping/rolling elements to be selected by the turbine Applicant (see Appendix B for examples)
- High Speed Circuit
- Square Traffic Pattern including a missed approach go-around (opposite direction of the takeoff and landing if conditions allow).
- Landing to a complete stop.

These maneuvers are detailed on the following pages.

At no time during the flight shall the model pass behind the designated safety line.

GTP – Flight Skills – Takeoff

1. Taxi model a sufficient distance (downwind) such that the takeoff roll will pass the Applicant while the model is on the ground. Turn upwind and line up on centerline. Bring model to a complete stop. When ready, advance the throttle to begin the takeoff roll.

During the takeoff, model to be held within 10 feet (either direction) of centerline, with smooth, controlled corrections, as necessary.

2. Advance the throttle to take off power.

3. The model rotates and lifts off.

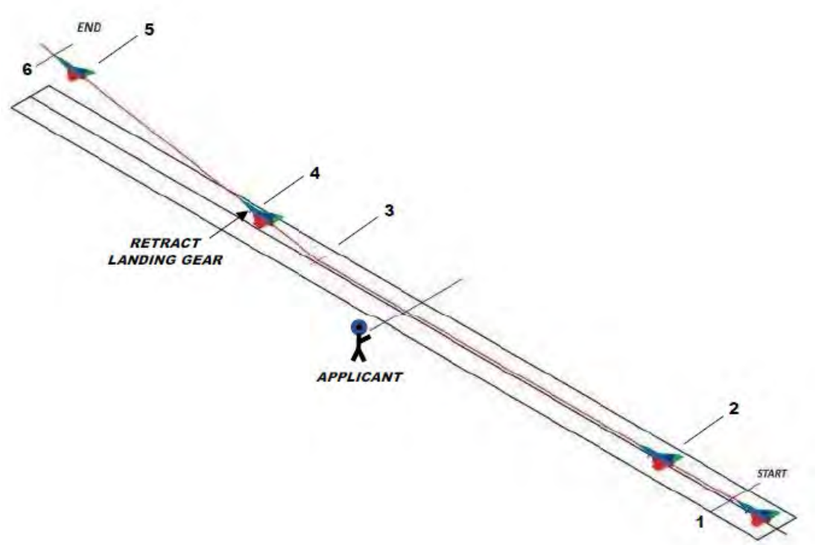
4. Establish a climb angle. Retract the landing gear.

5. Maintain the climb angle. Raise the flaps when sufficient airspeed and altitude have been achieved.

6. The maneuver ends beyond the runway at the same heading (+/-5˚) as the start.

Evaluation elements written in red

At no time during the flight shall the model pass behind the designated safety line.



GTP – Flight Skills – Horizontal Figure 8

1. The model approaches in straight and level flight at an appropriate altitude and at a heading parallel to the runway.

Applicant to maintain altitude to within +/- 50 feet during the Figure 8.

2. Make a one-quarter circle turn in a direction away from the Applicant,

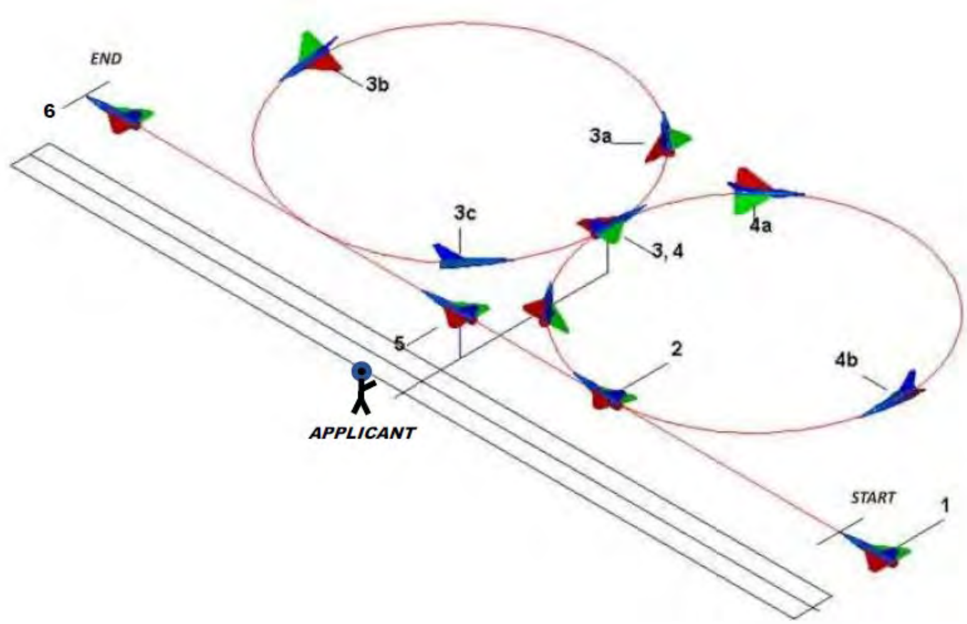
3. Make a 360° circle turn (3a, 3b, 3c) in the opposite direction.

4. Make a three-quarter circle turn (4a, 4b) in the same direction as the first turn. Circles (3) & (4) should intersect in front of the Applicant.

5. Complete the figure eight on a heading parallel to the runway.

6. The maneuver ends well beyond the Applicant at the same altitude (+/- 50 feet) and heading (+/-5˚) as at the start.

Evaluation elements written in red
At no time during the flight shall the model pass behind the designated safety line.



GTP – Flight Skills – Combined Looping/Rolling Maneuvers

The Applicant shall perform two maneuvers which combine looping and rolling.

Example maneuvers are listed below

- Cobra Roll
- Cuban Eight
- Reverse Cuban Eight
- Humpty Bump
- Immelmann
- Loop with Roll
- Split S
- Vertical Roll
- Victory Roll (IJMC)

Flight diagrams for these maneuvers are provided in Appendix B.

If another maneuver is chosen, the Applicant should first confirm with the experienced turbine pilots (supervising the waiver flight) that the maneuver is an acceptable choice.

GTP – Flight Skills – High Speed Circuit

1. The model approaches in straight and level flight at an appropriate altitude and at a heading parallel to the runway. The entire maneuver is to be flown at a safe high speed.

2. Maintain the heading until the model is past the runway. Perform a 90° turn, then a second 90° turn. Alternatively, a single 180° turn may be performed.

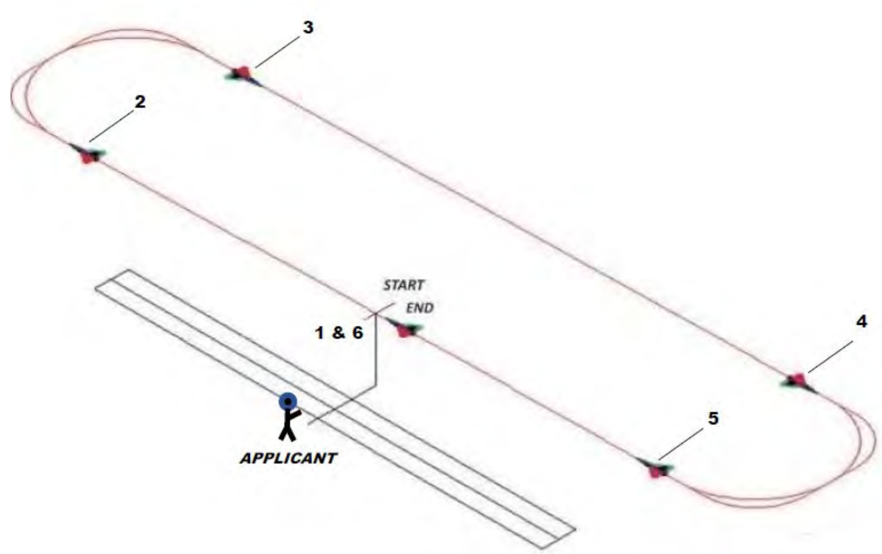
3. Complete the turn when the model on a reciprocal heading (+/-5˚) to the heading at the start.

4. Maintain the heading until the model is past the runway. Perform a 90° turn, then a second 90° turn. Alternatively, a single 180° turn may be performed.

5. Complete the turn when the model on the same heading (+/-5˚) as at the start.

6. The maneuver ends when the model passes the Applicant at the same altitude (+/- 50 feet) and heading (+/-5˚) as at the start.

Evaluation elements written in red
At no time during the flight shall the model pass behind the designated safety line.



GTP – Flight Skills – Rectangular Traffic Pattern & Missed Approach

This maneuver is to be in the opposite direction as takeoff and landing if conditions allow.

1. The model approaches in straight and level flight at an appropriate altitude and at a heading parallel to the runway. The flaps may be lowered to takeoff setting and the gear may be extended at this point ("gear pass") or at position (4).

2. Maintain the heading until the model is past the runway. Perform two 90° turns or, alternatively, a single 180° turn.

3. Complete the turn when the model on a reciprocal heading (+/-5˚) as that of the start.

4. Lower the flaps to takeoff. Lower the landing gear (if not done at position (1).

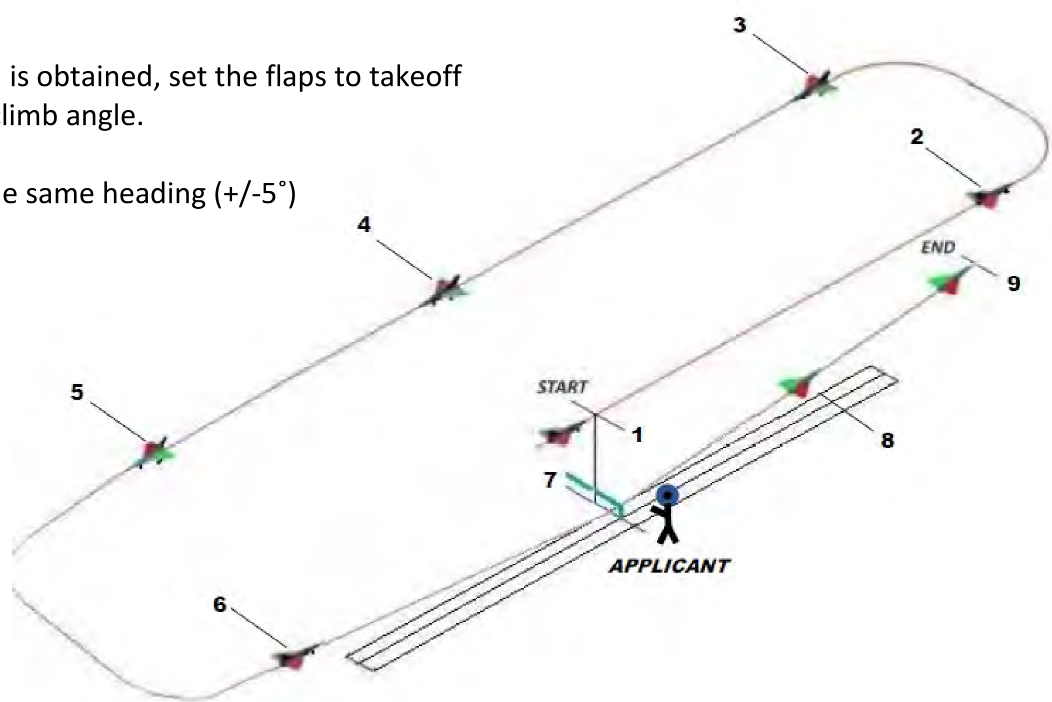
5. As the model passes the end of the runway, lower the flaps to landing and start the descent while maintaining the heading, then perform two descending 90° turns or, alternatively, a single descending 180° turn to final.

6. Complete the turn to final (+/- 5˚). Adjust the descent rate for a touchdown point 1/3 to ½ way down the runway.

7. Advance the power to takeoff thrust to perform a missed approach. Establish a climb angle. Retract the landing gear.

8. When sufficient airspeed is obtained, set the flaps to takeoff position and maintain the climb angle.

9. The maneuver ends at the same heading (+/-5˚) as at the start.



GTP – Flight Skills – Circuit, Approach, and Landing

1. The model approaches in straight and level flight at an appropriate altitude and at a heading parallel to the runway. The flaps may be lowered to takeoff setting and the gear may be extended at this point ("gear pass") or at position (4).

2. Maintain the heading until the model is past the runway. Perform two 90° turns or, alternatively, a single 180° turn.

3. Complete the turn when the model on a reciprocal heading (+/-5˚) as that at the start.

4. Lower the flaps to takeoff. Lower the landing gear (if not done at position (1).

5. As the model passes the end of the runway, lower the flaps to landing and start the descent while maintaining the heading, then perform two descending 90° turns or, alternatively, a single descending 180° turn to final.

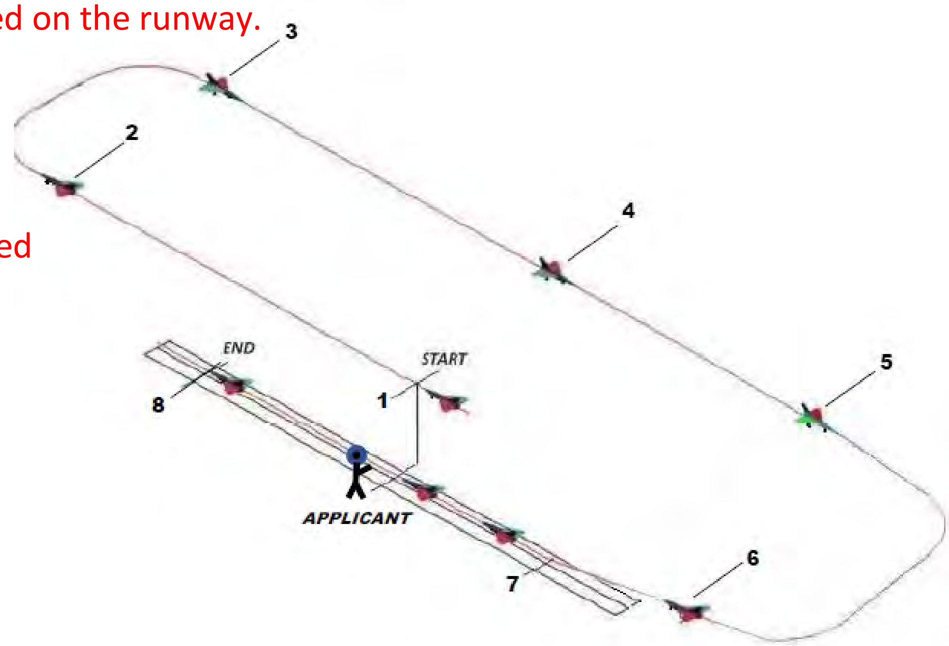
6. Complete the turn to final (+/- 5˚). Adjust the descent rate for a touchdown point ¼ to 1/3 way down the runway.

7. Start of landing zone. Make smooth controlled corrections to the model's path after touchdown.

8. The landing must be completed on the runway.

Evaluation elements written in red

At no time during the flight shall the model pass behind the designated safety line.



Post Flight – Debrief, Waiver Signoff, & Responsibilities

Following completion of the waiver qualification flight(s):
The experienced turbine pilots (supervising the waiver flight) shall debrief the Applicant by discussing the outcome of the flight(s), any areas that need improvement, and to answer any questions by the Applicant.

If the Applicant is successful in performing the waiver qualification flight, the supervising pilots shall:

- Complete and sign the attestations in the turbine waiver application.
- Remind the successful turbine Applicant that:
- He/she must submit the completed turbine waiver application to the AMA via mail or email.

A copy of the signed turbine waiver application may be used as proof of waiver status until the AMA provides an updated membership card (on which is printed the waiver status).

The first five flights following a successful waiver qualification flight: shall be supervised by an experienced turbine pilot who shall be instructed on how to perform an emergency shutdown of the turbine in flight from the pilot's transmitter and be empowered to shut the turbine down in flight in the event of a loss-of-control emergency.

- Airspeed shall be maintained under 175 mph.
- Turbine flights shall be limited to single engine turbine-powered aircraft.

Considerations for Newly Waivered Pilots

Congratulations, you passed your turbine waiver qualification!

Welcome to the brother/sisterhood of low-time turbine pilots!
Please make wise choices as to when, where, and how you fly.

As you continue to build your turbine experience, remember to reduce/eliminate risks wherever/whenever possible to increase your margin for error. Challenging conditions like strong crosswinds or short fields take away some of that margin.

It is far better for your expensive jet to be on the ground and you wishing it was in the air than for it to be in the air and you wishing that it was on the ground!

Next steps:
Send (scan then email, or copy and mail original) the signed waiver form to the AMA

Complete your 5 post-waiver sign-off flights under the supervision of an experienced turbine pilot.

Review Appendix D – Best Practices which includes information regarding flying at clubs and events as well as suggestions on how to keep your turbine-powered model happy, healthy, and in one piece!

Build your experience cautiously. You may feel the urge to immediately visit other fields or to attend a major jet meet with an extremely busy flight line. Are you really “ready for prime time”?

As a turbine “newbie”, it can be daunting to fly your jet when there are 4-5 other “fast movers” in the air with you, particularly if you are used to flying alone at your local club.

FINAL THOUGHTS – SAFETY, SAFETY, SAFETY!

It is a PRIVILEDGE (not a right) to operate a turbine-powered R/C aircraft.

SAFETY is paramount in our hobby and MUST be observed in ALL times. Turbine-powered models, with their technical complexity and higher speeds, present unique challenges to the modeler. They also require a greater financial investment than more typical model aircraft.

While we strive to eliminate risk, unforeseen events beyond your control can, and do, happen! Accordingly, each-and-every time you fly a model (including an expensive turbine-powered jet), you must ALWAYS be prepared to “dump it”, if necessary, to protect people and/or property.

Example: Your turbine-powered model is on short final and past the go-around decision point. You are committed to land. Another pilot and their spotter suddenly walk out onto the runway and are directly in the landing path of your jet.

What do you do? You have less than 2 seconds to decide and react.

Do you:
a) Continue to land (and risk hitting the pilot and/or spotter)?
b) Attempt to go-around (due to throttle lag, the turbine likely won’t spin up in time to prevent a stall and you may crash into the pilot and/or spotter)?
c) Perform an immediate emergency shut-down and push down elevator?

The correct answer is c). Yes, it’s unfortunate, but it is the safest choice.
(This is a real example. The pilot & spotter were retrieving a model that they’d landed a couple of minutes earlier in the grass on the far side of the runway. They didn’t announce their intention to cross the runway and they stepped past the safety fence without getting clearance or checking for traffic.

They crossed too far away to hear the remaining spotter urgently shout a warning. The jet that was landing was intentionally crashed into the asphalt runway and was broken into two pieces. The errant pilot & spotter walked away without a scratch (with their retrieved model).

GTP – Appendix A

Turbine Evolution

In the 1990s, a wide variety of turbines were commercially available. Examples include:

JPX
Liquid propane fuel in a pressured cylinder, spun up with compressed air,glow plug ignition, fuel metering via pressure regulator

Golden West FD3/67
Spun up with a hair dryer, propane used for manual start with glow plug ignition, manual switch over to liquid fuel (kerosene mixed with white gasoline), independent oil system, electric fuel pump.

Turbomin
Spun up with compressed air, started on kerosene with spark plug ignition, oil mixed with fuel, electric fuel pump.

Turbine Evolution (cont'd)

Because the features, functionality, and operation of early turbines were so varied, the AMA required that turbine waiver applicants receive "ground school" from the turbine manufacturer / distributor.

Training was typically offered at major trade shows or events (e.g., Toledo "Weak Signals" Expo, Florida Jets).

In many cases, ground school was a significant hurtle to overcome as it required potentially expensive travel for the waiver applicant.

However, it was the best way of ensuring appropriate training when turbines were relatively rare.

Turbine Evolution (cont'd)

As technology progressed, model turbines became increasingly more standardized in functionality and operation.

Generation	**Examples**	**Start/Fuel/Oil System**	**Spin Up**	**Starting and Ramp Up**	**Year**
1 (Pioneers)	JPX	Propane/Propane/Independent	Scuba Tank	Manual	~1993
	Golden West	Propane/Gas&Kero/Independent	Blower	Manual	
	Turbomin	Kero/Kero/Mixed with Fuel	Scuba Tank	Manual	
2 - Kero mixed with oil becomes standard fuel for running	Sophia	Propane/Kero/Mixed with Fuel	Scuba Tank	Manual	~1996
	RA Microjets				
	AMT				
3 - Integral electic starter added	JetCat	Propane/Kero/Mixed with Fuel	Integral Electric Starter	Automatic	~2000
	JetCentral				
	Kingtech				
4 – Ceramic ignitor eliminates					
	Jetcat	Kero/Kero/Mixed with Fuel	Integral Electric Starter	Automatic	~2008
	JetCentral				
	Kingtech				

This standardization decreased the need for manufacturer-specific turbine training. Additionally, turbine waiver holders were more prevalent and would be available to train new waiver applicants. As a result, the manufacturer-specific "ground school" was eliminated from the GTP in 2001.

However, the elimination of manufacturer-specific ground school DOES NOT mean that turbine training is no longer needed! Indeed, that's why we have this training package.

GTP – Appendix B

Combined Looping/Rolling Maneuver Diagrams

(Applicant shall perform TWO (2) combined looping/rolling maneuvers during the waiver flight)

GTP – Flight Skills – Combined Looping/Rolling Maneuvers

Cobra Roll

1. The model approaches in straight and level flight at an appropriate altitude and at a heading parallel to the runway.

2. Pull to a 45˚ upline. Once the upline is established, perform a half roll to inverted.

3. Maintain the upline after the half roll, then pull to a ¼ inverted loop (3) to (5).

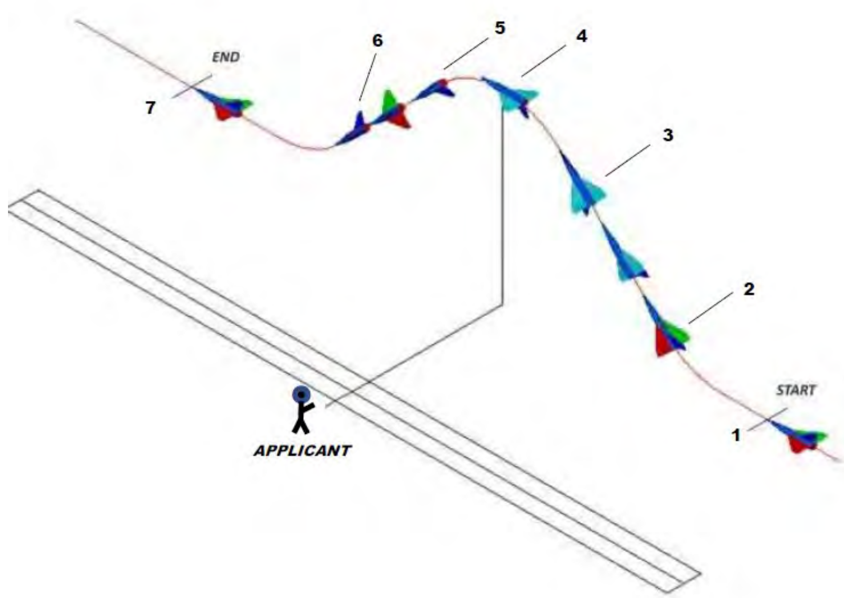
4. Model should be level and inverted as it passed the Applicant.

5. The ¼ inverted loop ends with model in a 45˚ downline, then perform a half roll to upright.

6. Maintain the 45˚ downline, then pull to level flight.

7. The maneuver ends well beyond the Applicant at the same altitude (+/- 50 feet) and heading (+/-5˚) as at the start.

Evaluation elements written in red
At no time during the flight shall the model pass behind the designated safety line.



GTP – Flight Skills – Combined Looping/Rolling Maneuvers

Cuban Eight

1. The model approaches in straight and level flight at an appropriate altitude and at a heading parallel to the runway.

2. After the model passes the Applicant, pull to a 5/8 inside loop.

3. Complete the 5/8 inside loop on a 45° downline, then perform a half roll to upright.

4. The model should roll through knife edge as it passes in front of the Applicant.

5. Pull to a ¾ inside loop. As the model passes through the bottom of the loop, it should be at the same altitude (+/- 50 feet) as at the start.

6. Complete the ¾ inside loop on a 45° downline, then perform a half roll to upright.

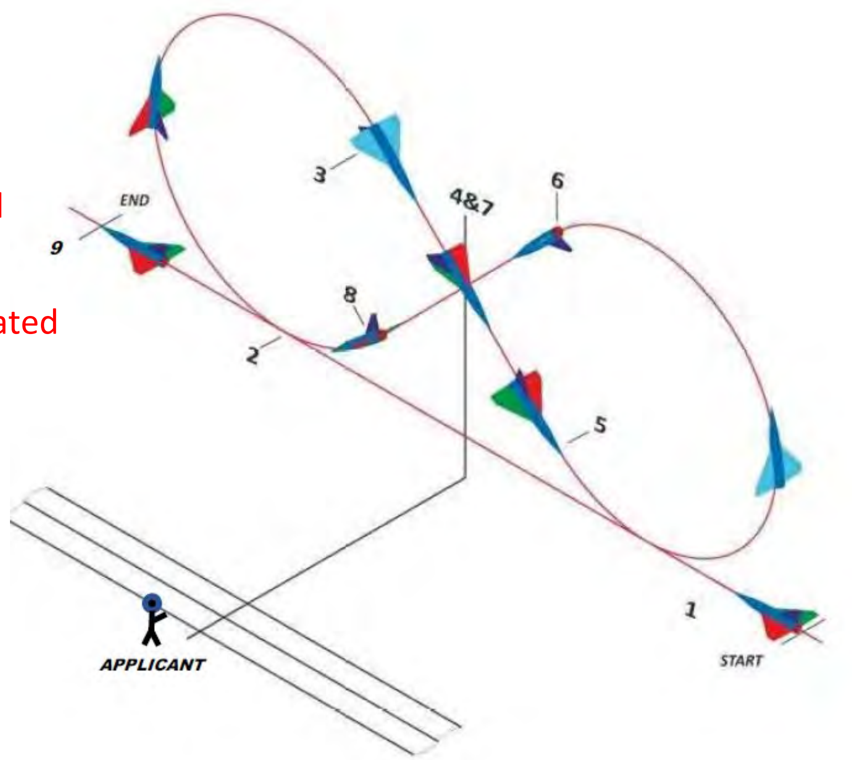
7. The model should roll through knife edge as it passes in front of the Applicant.

8. Level off at the same altitude (+/- 50 feet) as at the start.

9. The maneuver ends well beyond the Applicant at the same altitude (+/- 50 feet) and heading (+/-5˚) as at the start.

Evaluation elements written in red

At no time during the flight shall the model pass behind the designated safety line.



GTP – Flight Skills – Combined Looping/Rolling Maneuvers
Reverse Cuban Eight

1. The model approaches in straight and level flight at an appropriate altitude and at a heading parallel to the runway.

2. Pull to a 45° upline, then perform a half roll to inverted.

3. The model should roll through knife edge as it passes in front of the Applicant.

4. Maintain the upline, then pull to a ¾ inside loop.

5. Complete the ¾ inside loop on a 45° upline, then perform a half roll to inverted.

6. The model should roll through knife edge as it passes in front of the Applicant.

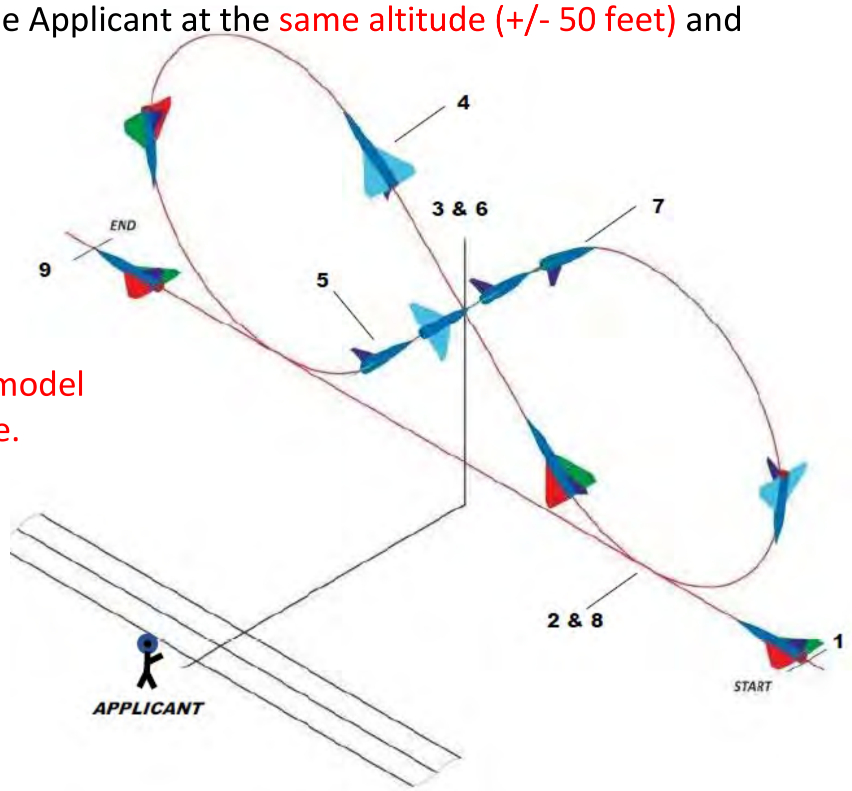
7. Maintain the upline, then pull to a 5/8 inside loop.

8. Level off at the same altitude (+/- 50 feet) as at the start.

9. The maneuver ends well beyond the Applicant at the same altitude (+/- 50 feet) and heading (+/-5˚) as at the start.

Evaluation elements written in red

At no time during the flight shall the model pass behind the designated safety line.



GTP – Flight Skills – Combined Looping/Rolling Maneuvers

Humpty Bump

1. The model approaches in straight and level flight at an appropriate altitude and at a heading parallel to the runway.

2. Pull to a vertical upline in front of the Applicant, then perform a half roll.

3. Maintain the upline, then pull to a 1/4 inside loop to inverted flight.

4. Maintain inverted level flight, then pull a 1/4 inside loop to a vertical downline.

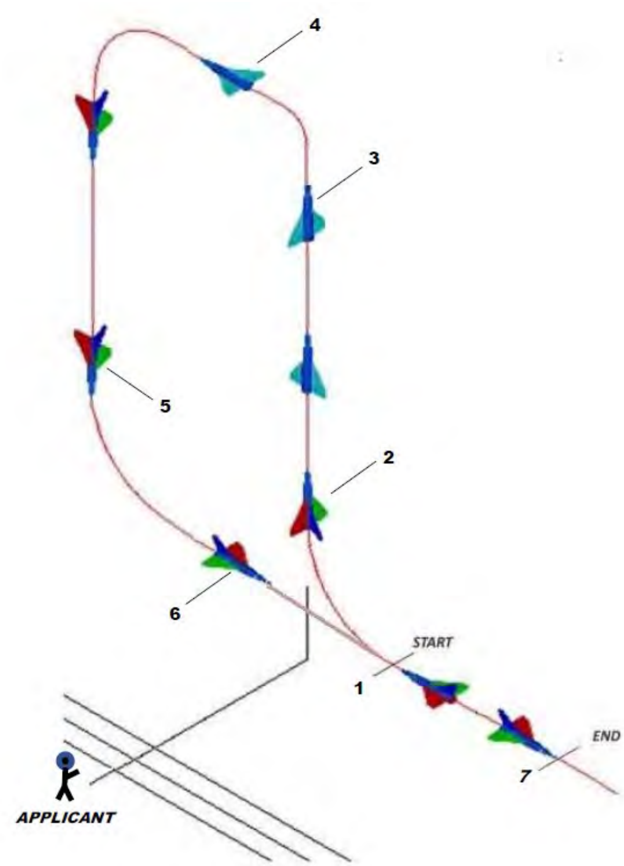
5. Maintain the vertical downline, then pull a ¼ inside loop.

6. Level off at the same altitude (+/- 50 feet) as at the start.

7. The maneuver ends beyond the start point at the same altitude (+/- 50 feet) and reciprocal heading (+/-5˚) to the heading at the start.

Evaluation elements written in red

At no time during the flight shall the model pass behind the designated safety line.



GTP – Flight Skills – Combined Looping/Rolling Maneuvers

Immelmann

1. The model approaches in straight and level flight at an appropriate altitude and at a heading parallel to the runway.

2. When then model is directly in front of the Applicant, pull to a ½ inside loop.

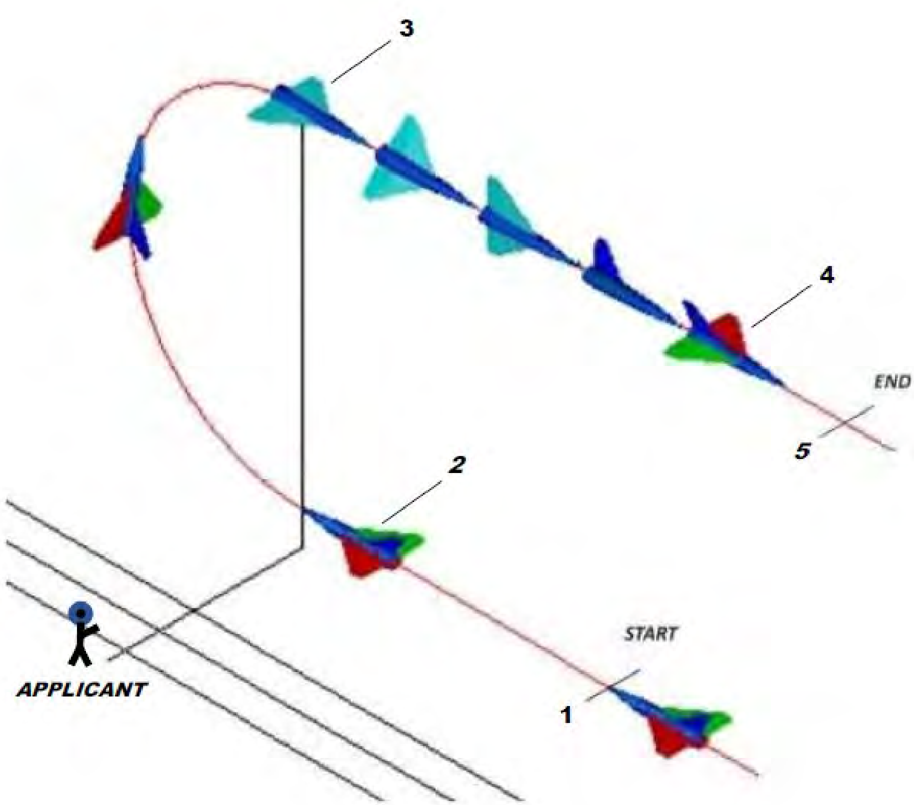
3. When the model is directly in front of the Applicant, level off to inverted level flight, then perform a ½ roll.

4. Complete the ½ roll and maintain upright level flight.

5. The maneuver ends above the start point at the reciprocal heading (+/-5˚) to the heading at the start.

Evaluation elements written in red

At no time during the flight shall the model pass behind the designated safety line.



GTP – Flight Skills – Combined Looping/Rolling Maneuvers

Loop with Roll

1. The model approaches in straight and level flight at an appropriate altitude and at a heading parallel to the runway.

2. When then model is directly in front of the Applicant, perform and ascending ½ inside loop.

3. As the model approaches the top of the loop, start a full roll.

4. The model should be upright as it passes directly in front of the Applicant.

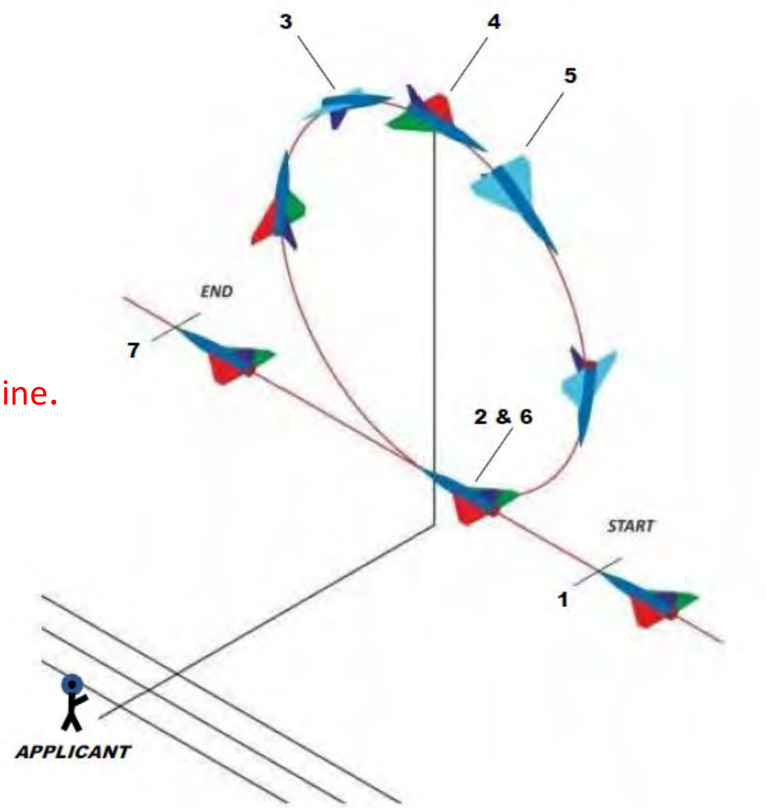
5. As the full roll completes with the model inverted, perform a descending ½ inside loop.

6. At the bottom of the loop, return to upright level flight.

7. The maneuver ends beyond the Applicant at the same altitude (+/- 50 feet) and same heading (+/-5˚) as at the start.

Evaluation elements written in red

At no time during the flight shall the model pass behind the designated safety line.



GTP – Flight Skills – Combined Looping/Rolling Maneuvers

Split S

NOTE: ENSURE THE MODEL HAS SUFFICIENT ALTITUDE AT THE START TO COMPLETE THE MANEUVER.

1. The model approaches in straight and level flight at an appropriate altitude and at a heading parallel to the runway.

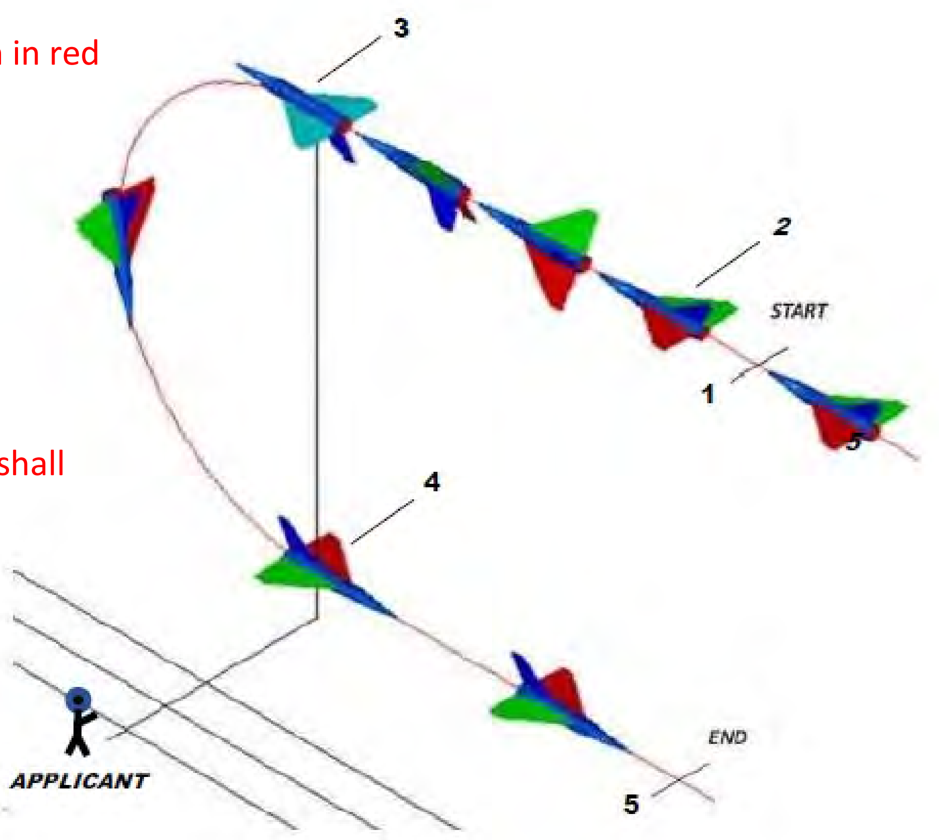
2. Initiate a ½ roll to complete when the model is directly in front of the Applicant.

3. Pull to a descending ½ inside loop.

4. When the model is directly in front of the Applicant, level off into upright level flight.

5. The maneuver ends below the start point at the reciprocal heading (+/-5˚) to the heading at the start.

Evaluation elements written in red



At no time during the flight shall the modelpass behind the designated safety line.

GTP – Flight Skills – Combined Looping/Rolling Maneuvers

Vertical Roll

1. The model approaches in straight and level flight at an appropriate altitude and at a heading parallel to the runway.

2. Pull to a vertical upline directly in front of the Applicant.

3. Perform a full roll while maintaining the vertical upline.

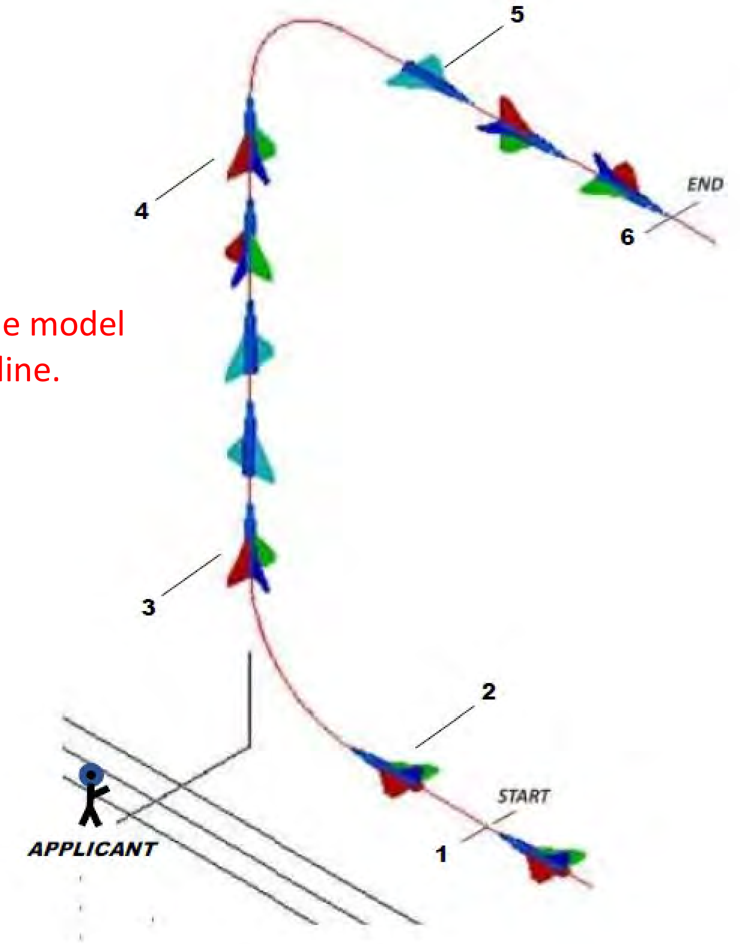
4. Pull a 1/4 inside loop to level inverted flight.

5. Perform a ½ roll to upright level flight.

6. The maneuver ends above the start point at the reciprocal heading (+/-5˚) to the heading at the start.

Evaluation elements written in red

At no time during the flight shall the model pass behind the designated safety line.



GTP – Flight Skills – Combined Looping/Rolling Maneuvers

Victory Roll (IJMC)

1. The model approaches in straight and level flight at an appropriate altitude and at a heading parallel to the runway.

2. Pull to a 45° upline directly in front of the Applicant.

3. Perform a full roll while maintaining the vertical upline.

4. The model should be inverted as it passes directly in front of the Applicant.

5. Maintain the upline, then perform a ½ roll to inverted.

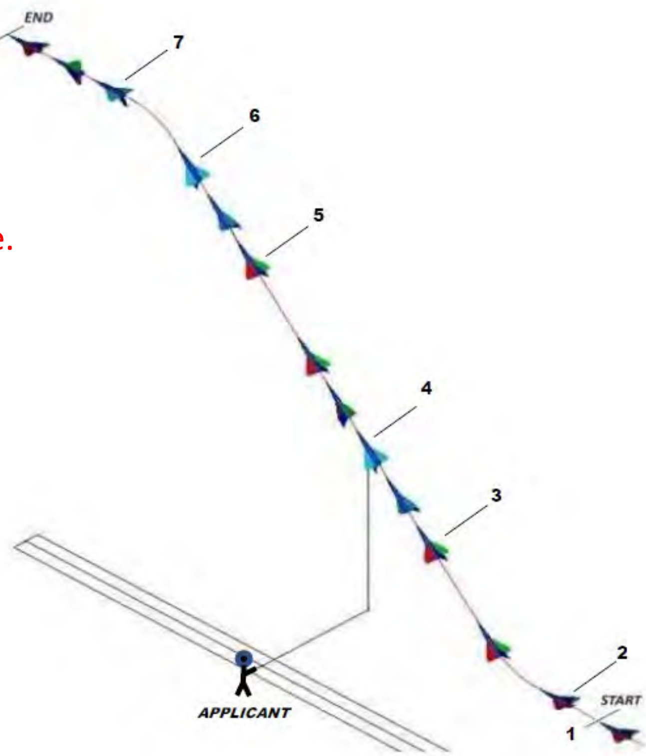
6. Pull a ¼ loop to inverted level flight.

7. Perform a ½ roll to upright level flight.

8. The maneuver ends well beyond and above the Applicant and at the same heading (+/-5˚) as at the start.

Evaluation elements written in red

At no time during the flight shall the model pass behind the designated safety line.



GTP – Appendix C

Turbine Inspection & Maintenance

Typical Turbine Maintenance

Check tightness of "clamshell" turbine mount – Mount should not move (axial or rotational movement). Tighten clamshell fasteners as needed. If the clamshell still can move when the fasteners are tight, install strips of stainless-steel shim stock between the clamshell and the turbine housing.

Replacement of starter motor worn O-rings – Procedure varies with turbine manufacturer and manufacturing date. Some turbines allow for easy removal of starter motor or its motor mount. Others require unsoldering of starter motor wires.

Preparation and replacement of glow plugs, if applicable – Using a dental probe or fine screwdriver, CAREFULLY pull two coils from within the glow plug core so that extend past the base of the plug. Typically, the glow plug's copper washer is not used (consult turbine manual).

Clamshell turbine mount

Starter motor O-ring sandwiched between compressor "spinner" and starter motor clutch.

Two coils pulled clear of base and into "slipstream".

Inlet/Compressor Inspection

The Applicant shall explain (cont'd):
Typical turbine maintenance (cont'd):

- Inspection of the compressor for damage (especially if turbine is NOT equipped with a FOD screen)

Inlet and compressor should be clean and free of nicks.

Coked fuel unbalances compressor

Hairline crack in compressor blade

Crash Damage - Starter motor mount and inlet bent

Extensive inlet and compressor damage due to front bearing failure

Turbine, Exhaust Cone, & Bearings Inspection

Inspect the turbine wheel and exhaust nozzle for damage or irregular discoloration (hot spot).

Check the external temperature probe depth, if applicable.

Use a “soft probe” to spin the turbine wheel to check for free spinning of turbine and any abnormal sound of the bearings (indicating contamination/wear)

If any abnormalities are found, the turbine (along with it’s ECU and fuel pump) should be removed from the model and returned for service. It is usually not necessary to remove/return other components such as cables or manual valves.

Contact the manufacturer or service center, as needed.

Turbine blades should show no damage.

Use a plastic or wood probe to spin turbine. Listen for grit in bearings or rubbing of parts.

Consult manual for depth the external temperature probe extends into nozzle. Adjust depth by GENTLY bending the thermocouple.

Hotspot on nozzle due to compressor damage (likely FOD or crash loading)

Missing turbine blade

Fuel Filter Inspection and Cleaning

Fuel filters are typically installed downstream of the pump and serve to protect internal components of the turbine from FOD (dirty fuel, pump debris) which can lead to costly repairs.

Fuel filters can become sufficiently clogged with debris or “gummed up” (from oil in the fuel) to affect the operation of the turbine (reduction in max RPM/thrust, unstable idle RPM, start-up difficulties). In many cases, a clogged filter can be detected by reviewing the GSU data (e.g., pump voltage, max RPM).

Regular cleaning of the fuel filter is recommended (monthly/quarterly depending on how often the model is flown). This is facilitated by mounting the fuel filter in an accessible location in the model such that the fuel line can be disconnected (without dripping fuel. Using a filter with compression or quick-release fittings (not barbs) facilitates its removal from the model.

Some fuel filters (Festo) cannot be disassembled for cleaning and must be replaced. Others can be disassembled (JetCat, Kingtech) and cleaned by backflushing the filter element with WD-40.


Festo fuel filter (and mounts)


JetCat fuel filter (and mount)


Kingtech fuel filter (and mount)

GTP – Appendix D

Best Practices

Turbine Best Practices

Regularly inspect your turbine AND your model for wear, damage, loose items, leaks, FOD (dirt and grass).

Cycle your Rx and ECU batteries periodically to check for performance degradation.

Several modern radio systems and turbines have telemetry capabilities which monitor and log engine performance on the ground and in the air. A simple current/capacity sensor (installed in the positive wire between the ECU and battery) can be used to measure remaining fuel or indicate if the turbine has flamed out. This is particularly handy at jet events when flying with multiple people.

Use checklists whenever possible (packing equipment, assembling plane at field, turbine start-up/shut-down) to help ensure you don't forget something.

USE YOUR GSU CONSISTENTLY!!!

Do not fly your turbine model with a dissimilar aircraft such as:

- Slower models (closing speed will make avoiding the slower model problematic)
- Smaller models fly a smaller pattern and may suddenly move in/out of your pattern (collision hazard).
- Note: Turbines (200 mph max) and EDF "foamies" (up to 120 mph max) have been proven not to mix well. The jury came back on this issue many years ago when a foamy suddenly turned in front of an approaching a twin turbine world class model. The result, as usual, was the loss of BOTH models.

Some regions of the country have "No Burn" periods when turbine models cannot be flown due to an elevated fire risk (from drought). Check with your local authorities.

When flying at events, reduce your timer by 1 minute to give added fuel margin in case of delays in landing or if a go-around is needed due to unfamiliarity with approach landmarks or local features (e.g., sloped runway, obstacles).

Best Practices – Spotter

Although not required by the GTP, essentially all events (and many clubs) require the use of a spotter during turbine flight operations.

The spotter assists the pilot in the safe operation of the turbinepowered model. Typically, the spotter is a waiver holder. Spotters must be AMA members to be allowed on the flight line.

Responsibilities of the spotter typically include:

- Assisting during turbine start-up by physically preventing the model from moving.
- Act as another set of eyes to survey the start up area for issues
- Retain physical control of the model as it is being taxied to the pit exit (runway entry) while the pilot walks to the flight station.
- Upon a signal from the pilot (typically a downwards jerk of the arm/fist), disconnect the taxi-tank from the model.
- Communicate with the flight line coordinator (aka "Air Boss") as necessary (e.g., take-off and landing clearances).
- The pilot CANNOT take their eyes off their model when it is moving. The spotter MUST inform the pilot of items of interest particularly any potential safety issues (such as other models in proximity).

Best Practices – Spotter (cont'd)

Responsibilities of the spotter typically include (cont'd):

- Advise the pilot (during the flight), of nearby aircraft (to avoid a potential collision) or issues in the overfly area (e.g., downed aircraft and response personnel).
- Provide information to the pilot as required (e.g., wind strength/direction before landing).
- Communication with the pilot should be simple and concise (e.g., "Cleared to land", "Pull up", "Go around", "Add power") especially during urgent situations. When giving wind information, use "Wind from left, blowing in at 20 degrees" not "Wind from the North-East" which is confusing as the pilot can't consult a compass or map while flying.
- Get to know a pilot's preferences. Most prefer only vital information, but others want a running litany of what is going on (perhaps to assure them that their spotter hasn't fallen asleep).
- During contests, the spotter also acts as a caller (advising the pilot of the next maneuver).
- After the flight, the spotter should assist in recovering the model and retrieving the taxi tank.

The spotter's primary role IS TO WATCH EVERYTHING except their model and to advise their pilot as needed. The spotter's role IS NOT to fixate on their model and tell their pilot what an awesome job he/she is doing!

Best Practices - Flight Line Director ("Air Boss")

Turbine events typically use an Air Boss to coordinate flight operations and related activities. Large events may have Mini Bosses to assist the Air Boss.

Responsibilities of the Air Boss/Mini Boss typically include:

- Monitoring/controlling the flight line and start-up areas for safe and efficient operation.
- Providing clearances (e.g., permission to start-up, taxi out, take off, land, back taxi).

Hand signals are often used to supplement verbal commands as follows:

- One arm/fist raised overhead to signal a gear pass is underway
- Two arms/fists raised overhead to signal an approach/landing is underway
- Coordinating aircraft recovery efforts with the flight line. This includes clearance for any recover team to cross the runway and directions to the pilots/spotters to maintain altitude and adjust speed to conserve fuel.
- Advise pilots/spotters as necessary.
- Typically, the Air Boss/Mini Boss communicates with the spotter who relays messages to/from their pilot as needed and when safe.