

NSRCA Procedures, Standards and Guidelines

for

AMA R/C Precision Aerobatic Sequence Development

October 19, 2010



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1.0 Purpose

This document establishes the procedures, standards and guidelines for the design, development, testing, and approval process for the Academy of Model Aeronautics (AMA) R/C Precision Aerobatic sequences.

2.0 Approach

The procedures presented in this document establish the process which the National Society of Radio Controlled Aerobatics (NSRCA) shall use to develop R/C Precision Aerobatic sequences in support of the four AMA classes. The four AMA classes are Sportsman (401), Intermediate (402), Advanced (403), and Masters (404). The need for developing changes to a sequence (or sequences), or to develop a brand new sequence (or sequences), and the amount of change required to the sequences, will be established by the NSRCA Board of Directors (BoD). This decision shall be based upon NSRCA membership input, Judge Committee input, along with an evaluation of the current sequence(s), and should also take into account the progression of a pilot through the established sequences. An individual assessment shall be made for each of the current classes.

The Sequence Development Committee (hereinafter referred to as “Committee”) Chairperson shall be appointed by the NSRCA President and approved by the BoD. The Committee membership shall be selected by the Chairperson and provided to the Board for their approval. There should be at least six Committee members plus the Chairperson and should contain at least one member who is currently competing in each of the AMA classes. There should be representation from as many NSRCA districts as possible on the committee. Non pilots and non NSRCA members may be committee members, provided that their qualifications meet the approval of the Chairperson and the BoD. Recommendations and guidance for the content of the sequence changes will be provided by the BoD to the committee. The Committee charter is presented in Appendix A.

Sequence changes for all classes shall conform to the criteria established in this document so that each class will maintain the desired balance between a pilot’s entrance capability, and the desired nominal exit proficiency to be gained in preparation for moving to the next higher class. The criteria shall also provide for considerations whereby additional circumstances may influence the difficulty, or complexity of the maneuvers in each class. This shall consist of, but not be limited to, flying area requirements, multiple flight stations, aircraft and equipment costs, motor performance, ability to enhance and improve the ease and consistency of judging, participant and spectator safety, and consideration for other similar influences that may arise.

3.0 Sequence Design

Sequence design criteria have been established to facilitate development of sequences that provide for logical and progressive development of a pilot’s proficiency, precision, and skills. The Sportsman class shall be considered as both an introductory and developmental class that



provides for learning of the basic maneuver elements, and precision aerobatic piloting skills. The Masters class is the destination class for AMA, and as such provides the most difficult challenge to piloting skills. The Intermediate and Advanced classes shall be structured to build on the basic maneuver elements by combining elements to provide progressive degrees of difficulty. Development of maneuvers and combinations of maneuver elements with increasing levels of difficulty, complexity, and challenge, will advance piloting skills and development of overall sequence presentation skills. The primary goal is to ensure that a logical and seamless progression is maintained during the transition from the Sportsman class to the Masters class. Detailed criteria, other considerations, design structure and maneuver catalogs for each of the classes are provided in Annex A and B.

The sequences shall be designed to be consistent with the official AMA Model Aircraft Safety Code. Care shall be taken to minimize exposure to spectators or other participants to the model track. Any cross box maneuvers will be structured and positioned to avoid direct flight at spectator or contestant locations.

3.1 General Sequence Design Criteria and Considerations

The following general criteria and considerations shall be adhered to when creating new sequences:

- Compliance with AMA Safety Criteria
- Visibility of maneuvers to aid in consistent judging
- Single box entrance and exit for Intermediate, Advanced and Masters
- Building block approach between classes
- Maneuver quantities established to get desired flight times
- Flight times comparable with slightly longer flights up through the classes, where possible
- Maneuvers selected to support reasonable and realistic transition to the next class
- Key maneuvers established for each class to aid in determining readiness of the pilot to transition to the next higher class
- Increasing degree of maneuver difficulty and complexity
- Difficulty consistent with safety of participants and spectators
- Minimum and maximum K-Factor spread defined for each class
- Increasing degree of pilot proficiency required
- Combinations of center and turnaround maneuvers that support the ability to fly the sequence with precision, allow a smooth presentation, provide for a continuous flow of the sequence, and enhance consistency in judging
- Sportsman is an introductory/basic skill development class
- Intermediate and Advanced are designed to provide progressive development of pilot skills, understanding of aerobatic maneuvers and their presentation, and enhance a competitive entry into the Masters class



- Masters is the AMA destination class. A Masters pilot may choose to move on to F3A and conversely move back to Masters from F3A at any time.
- Frequency of sequence change for Masters shall be every two years
- Frequency of sequence change for Intermediate and Advanced shall be every 4 to 6 years and 2 to 4 years, respectively, depending on demands of the pattern community and evolution of the event nationally and worldwide
- Sportsman shall be reviewed every 4 to 6 years and changed depending on the demands of the pattern community and evolution of the event nationally and worldwide

3.2 Changes to General and Specific Sequence Design Criteria and Maneuver Catalog

All sequence design criteria set forth in this document and its associated catalog of maneuvers shall be periodically reviewed for accuracy, sequence design intent, and whether they reflect the current state and needs of R/C Precision Aerobatics in the United States. This review shall be performed by the Committee. Any changes to these criteria shall, as a minimum, require approval by the BoD and the NSRCA Judging Committee. These changes shall be presented to the NSRCA membership through the K-Factor and NSRCA website. All changes shall include supporting documentation that justifies the change.

3.3 Design Sequence Tools

Listed below are some sequence design tools which may be of use in design and evaluation of a new sequence:

- **Aresti Diagrams** – A dictionary of Aresti diagrams and an article entitled “Aresti Made Simple” are readily available on the NSRCA website <http://www.nsrca.org>
- **Spreadsheets** – Spreadsheet are a useful tool for analyzing utilized elements and element quantities in a given sequence to determine if there is a good balance of elements. (i.e. Number of 45 degree lines, number of 2/4-pt rolls, number of maneuvers from a given maneuver family, etc.)
- **Other Sequences** - Previous AMA sequences and other international community sequences may be utilized in part as a baseline
- **New Maneuvers** – New maneuvers developed by other sources may be utilized and incorporated into the maneuvers catalog provided they meet the criteria of the given class they are intended to be utilized in

4.0 Sequence Development Process

The recommended approach for developing a new sequence, or integrating a change to an existing sequence, is summarized as follows:



- Identify candidate center maneuvers
- Identify compatible turnaround maneuvers
- Identify maneuvers with the desired individual levels of difficulty
- Check maneuver quantities and total K-Factor against the requirements
- Revise center maneuvers as needed and revise turnaround maneuvers accordingly
- Adjust difficulty of selected maneuvers to meet the total requirements
- Ensure good flow from maneuver to maneuver and for the overall sequence
- Test fly to find problems
- Revise as needed to develop a preliminary version
- Conduct formal testing
- Revise as required based on test input to develop a proposed version
- Present for comment and review by competitors in K-Factor and on NSRCA website
- Revise sequences based on competitor input that addresses identified deficiencies
- Test changes and confirm fixes
- Finalize changes and publish results
- Submission of sequences to the BoD for final approval

Alternately, a baseline sequence(s) may be developed by any individual in the Committee as a starting point. This baseline should encompass the first four steps above. From this baseline the sequence can be revised and tested until a final proposed sequence which meets the established design criteria is developed.

5.0 Sequence Testing

Each sequence, or change to a sequence, shall be flight tested by a combination of the current class pilots and higher class pilots to provide a thorough evaluation. Changes made to finalize the sequences shall be re-tested to the same criteria to confirm the resultant sequences meet the desired requirements. If changes are made in a proposed sequence as a result of Membership comments, or Committee/BoD review, the sequences shall be re-tested to confirm the changes provide the required results.

6.0 Approval Process

Each new sequence, or change to a sequence, shall be submitted to the General Membership and public for their review. The BoD shall approve publication of sequences in the K-Factor and on the NSRCA website for membership/public review and comment. The committee shall update their proposed sequences/changes, if required, and submit it in final form to the BoD.

The BoD shall designate the Committee to prepare any inputs necessary to support the sequence changes. Recommended changes to the maneuver descriptions and judging criteria shall be coordinated with the NSRCA Rules Committee (if necessary).



7.0 Sequence Submittal Process

The following is the recommended timeline for the development and submission of new sequences. Sequence development should always start in the year prior to when the sequence is to be replaced. For example, if the Masters sequence (2 year lifecycle) is to be replaced in 2013 (X) then work on the development of a new sequence should start in 2011 (X – 2). What follows is a timeline showing the activity (task) and the month the activity should start:

TASK

Assign and approve Committee Chairperson
 Committee Chairperson recruits Committee Membership
 BoD approves Committee Membership
 Establish development schedule
 Review design criteria/receive BoD approval for changes
 Develop preliminary changes/sequences and flight test
 Publish for public comment on NSRCA website/K-Factor
 Finalize changes/sequence selection based on comments
 Submit proposed changes/sequences to BoD for approval
 Publish approved sequences on NSRCA website/K-Factor
 New sequences in use

TIMELINE

October - year X – 2
 October – year X - 2
 November – year X - 2
 December – year X - 2
 December – year X - 2
 January through March – year X - 1
 April through May – year X - 1
 June through August – year X - 1
 September – year X - 1
 October – year X - 1
 January – year X

8.0 Submittal documentation

Submittal documentation, as a minimum, shall include:

- Sequence listing
- Sequence Aresti diagrams
- Written maneuver descriptions and optionally suggested judging downgrades which should be developed in agreement with the Judging Committee

9.0 Concluding Remarks

These NSRCA procedures, standards and guidelines have been established to readily assure that future sequences are developed in a timely manner and that such sequences are developed within logically established boundaries for each and every AMA class.



Appendix A

Sequence Development Committee Charter

1. Purpose

The NSRCA Sequence Development Committee (Committee) oversees the development and testing of a brand new sequence (or sequences), or manages the potential changes to a sequence at the request of the NSRCA Board of Directors (BoD) using established standards and guidelines.

2. Type of Committee and Program Area

This is a standing Committee that is in place for the duration of the sequence development / change process.

3. Membership

There should be at least six Committee members excluding the Chairperson and should contain at least one member who is currently competing in each of the AMA classes. There should be representation from as many NSRCA districts as possible on the committee. Non pilots and non NSRCA members may be committee members, provided that their qualifications meet the approval of the Chairperson and the BoD. All members of the Committee are voting members.

4. Chairperson

The Committee Chairperson shall be appointed by the NSRCA President and approved by the BoD. The Chairperson will serve for a term of two years and can only serve as Chairperson for two consecutive terms. After their term has completed they can remain a member of the Committee provided that it meets the approval of the new Chairperson and the BoD. A Vice Chairperson may, or may not, be selected by the Chairperson and the BoD. This is not a requirement but it will build on leadership continuity in the event the Chairperson is unable to fulfill his/her duties.

5. Activities, Duties, and Responsibilities

Committee members should seek out input from other pilots in order to contribute valid suggestions to proposed changes/sequences for all classes which conform to the criteria established in this document so that each class will maintain the desired balance between a



pilot's entrance capability, and the desired nominal exit proficiency to be gained in preparation for moving to the next higher class. The criteria shall also provide for considerations whereby additional circumstances may influence the difficulty, or complexity of the maneuvers in each class. This shall consist of, but not be limited to, flying area requirements, multiple flight stations, aircraft and equipment costs, engine performance, ability to enhance and improve the ease and consistency of judging, participant and spectator safety, and consideration for other similar influences that may arise.

Standard Committee Procedures

- The NSRCA President shall be the primary point of contact for communications between the Committee Chairperson and the Board on all matters of directive nature, and for deliverables from the Committee
- BoD members shall not be voting members of the Committee. If they are asked to contribute to the committee, it will be in an advisory capacity only.
- The Chairperson will select members for his/her committee and propose a team to the BoD
- The BoD will review the Committee for national (District) balance and representation across Intermediate through Masters classes and provide recommendations on the Committee members to the Chairperson.
- The Chairperson and Committee members agree to work as a team and reach a consensus on the Committee's proposals. They agree to support the Committee's proposal and not submit separate proposals on these sequences to the BoD.
- The Committee shall perform their tasks within the schedule of milestones as defined by BoD.
- The Committee will produce proposed changes to sequences based on input from the membership. The sequences will be published in the K Factor and on the NSRCA website.
- The Committee will coordinate with the Rules Committee Chairperson to produce the final proposals, with supporting rationale, to be approved by the BoD.
- Sequences for Sportsman, Intermediate, Advanced and Masters class will be developed for presentation to the precision aerobatics community in the form of a survey and / or presented on the NSRCA website. New sequences may not necessarily be presented for all classes.

Date charter approved initially by the NSRCA Board of Directors:

October 19, 2010

Date updated charter was reviewed and approved by the NSRCA Board of Directors:

October 19, 2010



Annex A

AMA R/C Precision Aerobatics Class Design Criteria



Annex A1 - Sportsman Class Design Criteria (AMA event #401)

Definition

Sportsman is considered as both an introductory and development class that provides for learning of basic maneuver elements and precision aerobatic piloting skills. Sportsman is designated as event #401 in the AMA Radio Control Aerobatics Regulations.

The primary purpose of this Class is to develop a pilot's proficiency and skills to:

- Fly straight and level lines
- Fly straight path parallel to the runway
- Maintain wings level attitudes
- Fly straight vertical lines
- Understand /fly accurate angles
- Develop understanding of maneuver geometry
- Properly position maneuvers (Centering, and Turnaround locations)
- Perform standard Takeoff and Landing maneuvers
- Perform basic Aerobatic maneuvers with precision
- Fly proper entry/exit lines for maneuvers
- Become comfortable with multiple maneuver sequences and flow
- Support simple multiple control input maneuvers (elevator timing-rolls)
- Be introduced to the Turnaround environment
- Become familiar with flying in a judged, and competition environment

Airframe Considerations

Airframes utilized will be average powered .40 to .60 size sport aerobatic types (i.e. Super Sportster, 4-Star, Goldberg Tiger 2) all the way up to state-of-the-art-F3A level models. Many of these models may not be well trimmed.

Design Considerations

- Difficulty should be very low. Only K1 and K2 maneuvers utilized.
- Maneuvers chosen teach wings level.
- Teaches some basic airplane trimming. Trim demands are low. Mostly trim tabs on the transmitter. Maybe a little CG and control surface throw rate adjustment.
- Vertical maneuvers should not be power demanding. Should be able to be performed with a .40 to .60 size sport aerobatic model.
- Safely teaches use of down elevator.
- Sequence is arranged to give more time in places to setup up for the next maneuver in the sequence.
- Allow for up to at least a total of three box entries and exits.
- Stall turns should be upwind.



- Focus is on lines and shapes but no real rudder needs.
- Must introduce some rolling up high and safe.
- Any inverted flight should be up high (i.e. Double Immelmann without rolls)
- Repeating maneuvers for reinforcement of a skill.
- Sequence maintains a turnaround look. Not only center maneuvers.
- Length of sequence almost the same length as Intermediate but utilizing simpler figures.
- Goal is for a total sequence K-factor around 25.
- Goal is 17 figures total including Takeoff and Landing.

Sequence Structure and Boundaries

The following criteria define the structure and boundaries to be adhered to in designing a balanced Sportsman sequence covering the required skill sets:

Maneuvers (K-factors of 1 and 2) shall be selected from “Annex B1 – Catalog of Maneuvers for Sportsman”. New maneuvers may be added to Annex B1 provided they meet all criteria set forth for the applicable class.

- Total K-Factor range: 23 to 27.
- Total Maneuvers (including Takeoff and Landing): 17 Minimum, 19 Maximum.
- Minimum of three box entries and exits,
- Required center maneuvers:
 - Double Immelmann without Rolls
 - Straight Flight Out and Straight Flight Back
 - One horizontal roll
- Required turnaround maneuvers:
 - Immelmann Turn
 - Split “S” (half roll, half loop from top)
 - Half Cuban Eight and/or Half Reverse Cuban Eight
- Required at least one maneuver from each of the following families of maneuvers:
 - Loops (single or superimposed)
 - Stall turns (upwind)
 - Half loops
 - 45 degree up and Down Line



Annex A2 - Intermediate Class Design Criteria (AMA event #402)

Definition

Intermediate is the next class following Sportsman in the progression of AMA R/C Precision Aerobatic classes. Intermediate is designated as event #402 in the AMA Radio Control Aerobatics Regulations. Intermediate is where the basic skills presented in Sportsman (401) are further reinforced with added complexity and the pilot learns to fly in a full Turnaround environment.

The primary purpose of this class is to continue the development of the pilot's proficiency and skills to:

- Fly straight and level paths with incorporated maneuvers
- Proper wind correction - maintaining straight path flight parallel to the runway during maneuvers
- Maintain wings level attitudes
- Fly straight, wind corrected vertical lines with incorporated maneuvers
- Fly accurate up and Down Line angles
- Safely fly basic inverted flight
- Consistent positioning of maneuvers (centering and turnaround locations)
- Perform standard Takeoff and Landing maneuvers
- Perform repetitive maneuvers with precision
- Perform basic and more complex individual precision maneuvers
- Fly proper entry/exit lines for maneuvers
- Focus on flying the airplanes CG (rudder to maintain constant track)
- Learn centering of basic elements within the maneuvers
- Learn to fly in a full turnaround environment and recognize the impact of the "box" on flight pace and planning for upcoming maneuvers
- Learn the need for consistency of presentation and flow

Airframe Considerations

Airframes utilized will be older designs (hand-me-downs), ARF .60 to .90 sized models all the way up to state-of-the-art-F3A level models.

Design Considerations

- Utilize K1, K2, and K3 maneuvers basically trying to maintain simple turnarounds and more complex center maneuvers shapes
- Pilot trimming skills are not very good yet. Sequence should help continue to enforce basic airplane trimming skills.



- Utilize basic shapes in center maneuvers such as Triangles, Polygon loops, superimposed loops, and squares to build basic rudder skills. A very limited amount of rolling elements should be incorporated.
- Integrate some inverted flight whether it be straight inverted flight itself or inverted flight as part of a basic shape center maneuver such as a triangle loop, square loop or Double Immelmann at safe altitude.
- Primarily utilize no rolls, simple half roll or full rolls in turnaround maneuvers. No more than one turnaround maneuver utilizing 1/4 rolls should be introduced.
- Maneuvers stress basic rudder work to correct lines
- Teaches centering skills and box management
- No snaps or spins (introduced in Advanced).
- Vertical maneuvers should not be too power demanding. Should be able to be performed with a 60 – 90 size sport aerobatic model. Not power hungry, or airplane demanding. The idea is to focus on skill sets and not the equipment.
- Goal is for a total sequence K-factor around 40.
- Goal is 19 maneuvers total including Takeoff and Landing.

Sequence Structure and Boundaries

The following criteria define the structure and boundaries to be adhered to in designing a balanced Intermediate Sequence covering the required skill sets:

- Maneuvers (K-factors of 1 through 3) shall be selected from “Annex B2 – Catalog of Maneuvers for Intermediate”. New maneuvers may be added to Annex B1 provided they meet all criteria set forth for the applicable class.
- Total K-Factor range: 38 to 43.
- Total Maneuvers (including Takeoff and Landing): 19 Minimum, 21 Maximum
- The sequence shall have only one box entry and exit.
- All stall turns are performed upwind (center and/or turnaround)
- Minimum of one cross box maneuvers but no more than two.
- No more than two of the same family of maneuvers used in the sequence as turnarounds (i.e. no more than two stall turn variants or half square loop variants).
- No more than one of the same family of maneuvers used in the sequence as a center maneuver. Exception to this requirement is “Horizontal rolling and non-rolling maneuvers”.
- No more than one center and one turnaround maneuver utilizing 1/4 rolls.
- At least one from each grouping of center maneuver families to be utilized:
 - Loops or Square loops
 - Non-rolling triangle loops, Pyramid loops or Square Loops on Corner
 - Double Immelmann, Humpty Bump or Top Hat
 - Stall turns
 - 45 degree up and Down Lines, vertical up and Down Lines, or Cobra Rolls
 - Horizontal Rolling and Non-rolling Rolls



- At least one from each grouping of turnaround maneuver families to be utilized:
 - Immelmann turns, Half loops w/roll combinations, or Half loops
 - Half Cuban Eight, Half Reverse Cuban Eight or Sharks Tooth
 - Humpty bumps or Top Hat
 - Stall turns
 - Half square loops or Half square loops on corner



Annex A3 - Advanced Class Design Criteria (AMA event #403)

Definition

Advanced is the next class following Intermediate in the progression of AMA R/C Precision Aerobatic classes. Advanced is designated as event #403 in the AMA Radio Control Aerobatics Regulations. Advanced is where the skills presented in Sportsman (401) and Intermediate (402) are further reinforced with more added complexity and new pilot skills are presented to teach the pilot the necessary skills required to successfully fly Masters (404) and to some extent F3A (406). The pilot is honing his/her skills in the full turnaround environment with precision, presentation and flow.

The primary purpose of this class is to develop a pilot's proficiency and skills to:

- Fly straight and level wind corrected paths with incorporated maneuvers
- Fly straight path parallel to the runway
- Center maneuvers in up and Down Lines and angles
- Fly straight wind corrected up/down vertical lines with incorporated maneuvers
- Fly accurate angles in up/Down Lines and maneuvers
- Properly position maneuvers (centering and turnaround locations)
- Perform standard Takeoff and Landing maneuvers
- Perform more complex combinations of maneuvers and elements
- Perform maneuvers (center and turnaround) with inverted entries and exits
- Fly proper entry/exit lines for maneuvers
- Perform rolling maneuvers at slower rates to learn multiple stick inputs
- Capability to maintain constant track (CG) of the aircraft in all attitudes
- Perform multiple maneuver sequences in the box
- Perform more complex multiple control input maneuvers (i.e. snaps and spins)
- Develop a feel for precision and flow of the total sequence
- Understand the need for presentation and flow to obtain better scores

Airframe Considerations

Airframes utilized will typically be older top of the line through current state-of-the-art F3A level models and designs.

Design Considerations

- Build on the skills developed in Sportsman and Intermediate utilizing K1, K2, K3, and introducing some K4's to build the skills to prepare the pilot for the next class - Masters.
- Need for building the skills first - both airplane trim and flying skills
- Start utilizing more complex loop-roll combos including hesitation rolls beyond 1/2 rolls.



- Introduce basic snaps and spins. Make them easy as this is the introduction. Single snaps and full rotation spins, upright snaps and spins, but could have Avalanches that are optional positive or negative.
- Centering skills and box management for turnarounds. This includes correction maneuvers after snaps and spins.
- Utilize more complex turnarounds except some of the more complex snap, spin and figures. Complex but still maintains some sense of recovery from a poor maneuver.
- More inverted flight pushing out of figures but not a lot of inverted entries and exits down low.
- Inverted to inverted rolling should primarily be kept up high (i.e. triangle loop with full roll inverted to inverted)
- Rudder work increases to finesse rudder like slow and hesitation rolls
- Not too power hungry or airplane demanding maneuvers like in F3A and Masters.
- Utilize mainly basic shapes (Triangles, Polygon loops and squares) that build rudder skills. Adding rolls to them to teach the switching of rudder inputs as the model rolls in vertical and horizontal components.
- Introduce upwind and downwind correction elements like the downwind stall turn. However, at this new element level - keep it simple to build the skill.
- Goal is for a total sequence K-factor around 50.
- Goal is 19 maneuvers total including Takeoff and Landing.

Sequence Structure and Boundaries

The following criteria define the structure and boundaries to be adhered to in designing a balanced Advanced Sequence covering the required skill sets:

- Maneuvers shall be selected from the “Annex B3 - Catalog of Maneuvers for Advanced”. New maneuvers may be added to the Annex B3 Catalog provided they meet all criteria set forth for the applicable class.
- Total K-Factor range: 48 to 52.
- Total maneuvers (including Takeoff and Landing): 19.
- The sequence shall have only one box entry and exit.
- No more than one of the same family of maneuvers used in the sequence as a center maneuver. Exceptions to this requirement are stated below.
- No more than two of the same family of maneuvers used in the sequence as turnarounds (i.e. no more than two stall turn variants or half square loop variants). Humpty bumps shall be the exception with a maximum of three when one is being used as a cross box maneuver.
- Minimum of two cross box maneuvers but no more than three.
- Minimum of two but no more than three downwind horizontal rolling maneuvers. Two of these maneuvers are required to be the Slow Roll and Four point roll.
- Minimum of two but not more than five maneuvers with a K-factor of 4.



- Minimum of two but not more than four stall turns. Maximum of two turnaround stall turns. One downwind turnaround stall turn is required. Maximum of two turnaround stall turns in conjunction with one double stall turn type center maneuver (Double stall turns).
- Maximum of one inverted exit and one inverted entry to/from inverted flight at low altitude on turnarounds. No turnaround shall have both an inverted entry and exit.
- Maximum of two positive snap rolls. Exception is Avalanches which are optionally positive or negative.
- Maximum of one positive upright spin (center maneuver).



Annex A4 - Masters Class Design Criteria (AMA event #404)

Definition

Masters is the destination class in the progression of AMA R/C Precision Aerobatic Classes. Masters is designated as event #404 in the AMA Radio Control Aerobatics Regulations. Masters is where the skills built on in Sportsman through Advanced (401, 402, and 403) are now applied.

The primary purpose of this class is to develop and demonstrate a pilot's proficiency and skills to:

- Fly straight wind corrected vertical lines with centered maneuvers
- Fly with required geometry and accuracy of the maneuvers
- Fly accurate angles in all maneuvers
- Properly position maneuvers (centering and turnaround locations)
- Perform standard Takeoff and Landing maneuvers
- Perform combinations of difficult/complex precision maneuvers in the box
- Fly proper entry/exit lines for all maneuvers
- Fly constant entry/exit radii for all maneuvers
- Properly position all elements within a maneuver (centering in lines)
- Maintain constant aircraft track parallel to the runway in all conditions
- Perform the sequence gracefully with consistent flow and precision

Airframe Considerations

Airframes utilized will typically be current state-of-the-art F3A level models and older top of the line designs.

Design Considerations

- Should be a stepping-stone to F3A but not on an equal footing in terms of model requirements.
- Skill based maneuvers that a well-practiced and skilled pilot can use to perfect the figures, not maneuvers that are airplane based like many of the current F3A schedules.
- Should be well balanced as to cover the vast majority of skill sets.
- Includes rolling both directions and hesitation rolls.
- Includes Snaps and Spins but not the snap and roll combos seen in F3A.
- Centering skills and box management for turnarounds. This includes correction maneuvers after snaps and spins (Humpty bumps or top hat turnarounds).
- Complex figures that are possible to complete but difficult to score high marks. These being figures that have lots of elements to make mistakes are a good show of pilot preparation and skill.
- Almost equal weighting for upright or inverted entry or exits.
- Focus is on perfection of shapes and flying skills that will favor the practiced pilot.



- The skills that are built in Sportsman through Advanced are now applied in Masters with maybe some different looks.
- Level of difficulty up near the F3A Preliminary sequence. Sequence should not include any of the F3A Finals maneuvers such as rolling loops, circles or the detail and demanding snap maneuvers that are in the F3A Finals patterns. Middle ground is equal to F3A Preliminary but less airframe demanding to fewer skills required than the F3A Preliminary sequence.
- Emphasis is on pilot skill and practice and not the latest model or power requirements.
- Difficulty in judging shall be taken into account when selecting sequence maneuvers.
- Goal is for a total sequence K-factor up in the mid 60's to 70 for a 23 maneuver sequence, low to mid 60's for a 21 maneuver sequence, and low 60's for a 19 maneuver sequence.
- Goal is 19 to 23 figures total including Takeoff and Landing.

Sequence Structure and Boundaries

The following criteria define the structure and boundaries to be closely adhered to in designing a balanced Masters sequence covering the vast majority of skill sets:

- Maneuvers shall be selected from the Annex B4A and B4B Maneuver Catalogs. New maneuvers may be added to the Annex B Catalogs provided they meet all criteria set forth in the applicable class.
- Total K-Factor range: 60 to 70 depending on sequence length as stated in design considerations.
- Total maneuvers (including Takeoff and Landing): 19 Minimum, 23 Maximum
- The sequence shall have only one box entry and exit
- No more than one of the same family of maneuvers used in the sequence as a center maneuver. Exceptions to this requirement are stated below.
- No more than two of the same family of maneuvers used in the sequence as turnarounds (i.e. no more than two stall turn variants or half square loop variants). Humpty bumps shall be the exception with a maximum of three when one is being used as a cross box maneuver.
- Minimum of two cross box maneuvers but no more than three.
- Minimum of one maneuver that incorporates a 4/8 pt roll. An 8 point roll may be substituted or included in the same sequence.
- Minimum of two but no more than three downwind rolling maneuvers. These shall include a minimum of one but no more than two maneuvers that incorporate reverse rolling.
- Minimum of two but not more than four maneuvers with a K-factor of 5.
- Minimum of two but not more than four stall turns. Maximum of two turnaround stall turns. Maximum of two turnaround stall turns in conjunction with one double stall turn type center maneuver (Double stall turns or Figure M's).
- Minimum of 25% inverted exits/entries to inverted flight.



- Minimum of two Snap Rolls but no more than three (all center maneuvers).
- Minimum of one Spin (center maneuver) but no more than two (one center and one turnaround maneuver).



Annex B

AMA R/C Precision Aerobatics Maneuver Catalogs



Annex B1 - Catalog of Maneuvers for Sportsman

A. Sportsman Center Maneuvers

Takeoff (K1)

Landing (K1)

Vertical Up and Down Line's

- Vertical up Line (pull-push) (K1)
- Vertical down Line (push-pull) (K1)

Loops (single and superimposed)

- One Inside Loop(K1)
- One Inside Loop (from top) (K1)
- Two Inside Loops (K2)
- Two Inside Loops (K2)
- Two Inside Loops (from top) (K2)

Triangular Loops

- Triangular loop, non-rolling (from bottom) or Non-rolling Triangle Loop (K2)

Cobra Rolls

- Cobra roll without rolls (K1)

45 Degree Up and Down Lines

- 45 degree Down Line (K1)
- 45 degree Down Line with half roll, inverted entry (from top) (K2)
- 45 degree Down Line with full roll (K2)

- 45 degree Up Line (K1)
- 45 degree Up Line with half roll (K2)
- 45 degree Up Line with full roll (K2)

Humpty Bumps



Humpty bump, no rolls (pull-push-pull) (K2)

Double Immelmans

Double Immelmann without Rolls (K2)

Horizontal Rolling and Non-Rolling Maneuvers

Straight Flight (out) (K1)

Straight Flight (back) (K1)

Two point (2/2 pt.) Roll (K2)

One Horizontal Roll (K1)

Two Horizontal Rolls (up high) (K2)



B. Sportsman Turnaround Maneuvers

A maximum of two maneuvers from each group permitted in a sequence.

Turns

Procedure Turn (K1)
180 degree Turn (K1)

Half Square Loops

Half square loop (K1)
Half square loop from top (K1)

Half Loops

Half inside loop, exit inverted (K1)
Half loop from top, inverted entry (K1)

Half Loops with Roll Combinations

Split "S" (half roll, half loop from top) (K2)

Immelmann Turns

Immelmann turn (K2)

Half Cuban Eights

Half Cuban Eight (K2)

Half Reverse Cuban Eights

Half Reverse Cuban Eight (K2)

Stall Turns

Stall Turn without rolls (K2)

Humpty Bumps



Humpty bump (pull, pull, pull), half roll up (K2)



Annex B2 - Catalog of Maneuvers for Intermediate

A. Intermediate Center Maneuvers

Takeoff (K1)

Landing (K1)

Vertical Up and Down Line's

- Vertical Up Line (pull-push) (K1)
- Vertical Up Line (pull-pull) with half roll (K2)
- Vertical Down Line (push-pull) (K1)
- Vertical Down Line (push-push) with half roll (K2)

Loops (single and superimposed)

- One Inside Loop (K1)
- One Inside Loop (from top)(K1)
- One Outside Loop (from top) (K2)
- Two Inside Loops (K2)
- Two Inside Loops (from top) (K2)
- Three Inside Loops (K3)
- Three Inside Loops (from top) (K3)

Triangular Loops

- Triangular loop, non-rolling (from bottom) or Non-rolling Triangle Loop (K2)
- Triangular loop from top (base at top), non-rolling, inverted entry (K2)

Triangular Loops (base at bottom) or Pyramid Loops

- Triangular Loop (base at bottom) or Non-Rolling Pyramid Loop (K2)
- Triangular Loop from top (base at bottom), inverted entry (K2)

Square Loops

- Square Loop (K3)
- Square Loop from top, inverted entry (K3)



Square Loops on Corner

- Square loop on corner (K3)
- Square loop on corner, inverted entry (K3)

Cobra Rolls

- Cobra roll without rolls (K1)
- Cobra roll with 1/2 rolls (K2)
- Cobra roll with 2/4pt rolls (K3)

Cuban Eights

- Cuban Eight with half rolls (K2)
- Cuban Eight with half rolls (K2)
- Cuban Eight with 2/4pt rolls (K3)
- Cuban Eight without rolls or non-rolling Cuban Eight (K3)
- Reverse Cuban Eight with half rolls (K3)
- Reverse Cuban Eight without rolls or non-rolling Cuban Eight (K3)
- Reverse Cuban Eight with half rolls (K3)

45 Degree Up and Down Lines

- 45 degree Down Line (K1)
- 45 degree Down Line with half roll, inverted entry (K2)
- 45 degree Down Line with full roll (K2)
- 45 degree Up Line (K1)
- 45 degree Up Line with half roll (K2)
- 45 degree Up Line with full roll (K2)

Top Hats

- Top Hat with half rolls up and down (K3)

Humpty Bumps

- Humpty bump, no rolls (pull-push-pull) (K2)
- Humpty bump, full roll up (pull-push-pull) (K3)
- Humpty bump, half rolls up and down (pull-pull-pull) (K3)

Stall Turns

- Stall Turn, 1/4 rolls up and down (K3)



Stall Turn, 3/4 roll up, 1/4 roll down (K3)

Double Immelmans

Double Immelmann without Rolls (K2)

Double Immelmann with half rolls (K3)

Double Immelmann from top, half rolls, inverted entry (K3)

Horizontal Rolling and Non- Rolling Maneuvers

Straight Flight out (K1)

Straight Flight back (K1)

Straight Inverted Flight (K1)

Two point (2/2 pt.) Roll (K2)

Two half rolls reversed (pause in middle) (K3)

One Horizontal Roll (K1)

Two Horizontal Rolls (K2)



B. Intermediate Turnaround Maneuvers

A maximum of two maneuvers from each group permitted in a sequence.

Turns

Procedure Turn (K1)
180 Degree Turn (K1)

Half Square Loops

Half square loop (K1)
Half square loop with half roll up (K2)
Half square loop with full roll up (K2)
Half square loop from top, inverted entry (K1)

Half Square Loops On Corner

Half square loop on corner (K1)
Half square loop on corner from top, inverted entry (K1)

Half Loops

Half inside loop, exit inverted (K1)
Half loop from top, inverted entry (K1)

Half Loops with Roll combinations

Split "S" (half roll, half loop from top) (K2)
Split "S", 2/4 pt. roll (2/4 pt. roll, half loop from top) (K2)

Immelmann Turns

Immelmann turn (K2)
Immelmann turn, 2/4 pt. roll (K2)

Half Cuban Eights

Half Cuban Eight (K2)

Half Reverse Cuban Eights



Half Reverse Cuban Eight (K2)

Stall Turns

Stall Turn without rolls (K2)

Stall Turn, full roll up (K2)

Top Hats (horizontal cross-box flight is always flown inverted)

Top hat, 1/4 roll up, 1/4 roll down (K2)

Humpty Bumps

Humpty bump (pull, pull, pull), half roll up (K2)

Humpty bump (pull, push, pull), half roll down (K2)

Humpty bump (pull, pull, pull), half roll down (K2)

Humpty bump with roll options, (half roll up or 1/4 roll up and down) (K2)

Sharks Tooth

Reverse Sharks Tooth, half roll on 45 Up Line (K3)

Sharks Tooth, half roll on 45 Down Line (K3)

Half Triangle Loop

Half Triangle Loop, half roll on 45 degree Up Line (K2)

Half Triangle Loop (K1)



Annex B3 - Catalog of Maneuvers for Advanced

A. Advanced Center Maneuvers

Takeoff (K1)

Landing (K1)

Vertical Up and Down Line's

- Vertical Up Line (pull-push) (K1)
- Vertical Up Line (pull-pull) with half roll (K2)
- Vertical Up Line (pull-pull) with 2/4 pt. roll (K2)
- Vertical Down Line (push-pull) (K1)
- Vertical Down Line (push-push) with half roll (K2)
- Vertical Down Line (push-push) with 2/4 pt. roll (K2)

Loops (single and superimposed)

- One Inside Loop (K1)
- One Inside Loop (from top) (K1)
- One Outside Loop (from bottom) (K1)
- One Outside Loop (from top) (K2)
- Two Inside Loops (K2)
- Two Inside Loops (from top) (K2)
- Two Outside Loops (from bottom) (K2)
- Two Outside Loops (from top) (K2)
- Three Inside Loops (K3)
- Three Inside Loops (from top) (K3)
- Three Outside Loops (from bottom) (K3)
- Three Outside Loops (from top) (K3)

Two Loops with Full and/or Half Roll Combinations

- Two loops with half rolls at top (from bottom) (K3)
- Two loops with half rolls at bottom (from top), inverted entry (K3)

Avalanches

- Avalanche with full snap (from bottom) (K3)



Avalanche with full snap (from bottom) inverted entry (K3)

Triangular Loops

- Triangular loop, non-rolling (from bottom) or Non-rolling Triangle Loop (K2)
- Triangular loop, non-rolling (from bottom), inverted entry (K2)
- Triangular loop with full roll (from bottom) or Triangle Rolling Loop (1 roll) (K4)
- Triangular loop with full roll (from bottom) inverted entry (K4)
- Triangular loop with 2/4pt roll (from bottom) (K4)
- Triangular loop with 2/4pt roll (from bottom) inverted entry (K4)
- Triangular loop with 1/2 rolls (from bottom) (K3)
- Triangular loop with 1/2 rolls (from bottom) inverted entry (K3)
- Triangular loop with one pos. snap roll (from bottom), inverted entry (K4)
- Triangular loop from top (base at top), non-rolling (K2)
- Triangular loop from top (base at top), non-rolling, inverted entry (K2)
- Triangular loop from top (base at top) with half rolls in 45 degree legs (K4)
- Triangular loop from top (base at top) with half rolls in 45 degree legs, inverted entry (K4)

Triangular Loops (base at bottom) or Pyramid Loops

- Triangular Loop (base at bottom) or Non-Rolling Pyramid Loop (K2)
- Triangular Loop (base at bottom), inverted entry (K2)
- Triangular loop (base at bottom) with half rolls in 45 degree legs (K3)
- Triangular loop (base at bottom) with half rolls in 45 degree legs, inverted entry (K3)
- Triangular loop (base at bottom) with 2/4pt rolls in 45 degree legs (K4)
- Triangular loop (base at bottom) with 2/4pt rolls in 45 degree legs, inverted entry (K4)
- Triangular loop from top (base at bottom) with half rolls in 45 degree legs (K4)
- Triangular loop from top (base at bottom) with half rolls in 45 degree legs, inverted entry (K4)
- Triangular loop from top (base at bottom) with 2/4pt rolls in 45 degree legs (K4)
- Triangular loop from top (base at bottom) with 2/4pt rolls in 45 legs, inverted entry (K4)
- Triangular loop from top (base at bottom) with 2/4pt roll at bottom (K4)
- Triangular loop from top (base at bottom) with 2/4pt roll at bottom, inverted entry (K4)
- Triangular loop from top (base at bottom) with full roll at bottom, inverted entry (K4)

Square Loops

- Square Loop (K3)
- Square Loop with 1/2 rolls in vertical up and Down Lines (K4)
- Square loop from top, inverted entry (K3)
- Square loop from top with 1/2 rolls in vertical up and Down Lines, inverted entry (K4)



Square Loops on Corner

- Square loop on corner (K3)
- Square loop on corner, inverted entry (K3)
- Square loop on corner with half rolls in legs 1 & 3 (K4)
- Square loop on corner from top (K3)
- Square loop on corner from top, inverted entry (K3)
- Square loop on corner from top with half rolls in legs 1 & 3 (K4)
- Square loop on corner from top with half rolls in legs 1 & 3, inverted entry (K4)

Six Sided Loops

- Six sided loop (K4)
- Six sided loop, inverted entry (K4)
- Six sided loop from top (K4)
- Six sided loop from top, inverted entry (K4)

Eight Sided Loops

- Eight sided loop (K4)
- Eight sided loop, inverted entry (K4)
- Eight sided loop from top (K4)
- Eight sided loop from top, inverted entry (K4)

Cobra Rolls

- Cobra roll without rolls (K1)
- Cobra roll with 1/2 rolls (K2)
- Cobra roll with 2/4pt rolls (K3)
- Cobra roll with 2/4pt rolls, inverted entry (K3)

Cuban Eights

- Cuban Eight with half rolls (K2)
- Cuban Eight with 2/4pt rolls (K3)
- Cuban Eight with 2/4pt rolls, inverted entry (K3)
- Cuban Eight without rolls or non-rolling Cuban Eight (K3)
- Cuban Eight with full rolls (K4)
- Cuban Eight with full rolls, inverted entry (K4)
- Reverse Cuban Eight without rolls or non-rolling Cuban Eight (K3)
- Reverse Cuban Eight with half rolls (K3)
- Reverse Cuban Eight with 2/4pt rolls (K4)
- Reverse Cuban Eight with 2/4pt rolls, inverted entry (K4)



Reverse Cuban Eight with full rolls (K4)
Reverse Cuban Eight with full rolls, inverted entry (K4)

45 Degree Up and Down Lines

45 degree Down Line (K1)
45 degree Down Line with half roll (K2)
45 degree Down Line with half roll, inverted entry (K2)
45 degree Down Line with full roll (K2)
45 degree Down Line with full roll, inverted entry (K2)
45 degree Down Line with 2/4 pt. roll (K3)
45 degree Down Line with 2/4 pt. roll, inverted entry (K3)
45 degree Down Line with one positive snap roll (K3)
45 degree Down Line with 4-point roll (K4)
45 degree Up Line (K1)
45 degree Up Line with half roll (K2)
45 degree Up Line with half roll, inverted entry (K2)
45 degree Up Line with full roll (K2)
45 degree Up Line with full roll, inverted entry (K2)
45 degree Up Line with 2/4 pt. roll (K3)
45 degree Up Line with 2/4 pt. roll, inverted entry (K3)
45 degree Up Line with 4-point roll (K4)

Figure Z

Figure Z with half roll up (K3)
Figure Z with half roll up, inverted entry (K3)
Figure Z from top with half roll down (K3)
Figure Z from top with half roll down, inverted entry (K3)

Double Stall Turns

Note: Center half loop is always flown positive (upright) with all stall turns in the upwind direction.

Double stall turn with 1/4 rolls up and down (K3)
Double stall turn with 3/4 rolls up, 1/4 rolls down (K4)

Top Hats

Top Hat with half rolls up and down (K3)
Top Hat with 2/4pt rolls (K4)
Top Hat with 2/4pt rolls, inverted entry (K4)



Humpty Bumps

- Humpty bump, no rolls (pull-push-pull) (K2)
- Humpty bump, 1/2 roll up (pull-pull-push) (K3)
- Humpty bump, 1/2 roll up, inverted entry (K3)
- Humpty bump, 2/4 pt roll up (pull-pull-push) (K3)
- Humpty bump, full roll up (pull-push-pull) (K3)
- Humpty bump, 1/2 roll up, 1/2 roll down (pull-pull-pull) (K4)

Spins

- Two turn spin (K3)
- 2-1/2 turn spin, half roll exit (K3)
- Three turn spin (K3)

Stall Turns

- Stall Turn, 1/4 rolls up and down (K3)
- Stall Turn, 3/4 rolls up and 1/4 roll down (K3)
- Stall Turn, 3/4 rolls up and 1/4 roll down, exit inverted (K3)

Double Immelmans

- Double Immelmann without Rolls (K2)
- Double Immelmann with half rolls (K3)
- Double Immelmann with half rolls, inverted entry (K3)
- Double Immelmann with half roll first, full roll second, inverted entry (K4)
- Double Immelmann from top, half rolls (K3)
- Double Immelmann from top, half rolls, inverted entry (K3)
- Double Immelmann from top, half roll first, full roll second (K4)
- Double Immelmann from top, half roll first, full roll second, inverted entry (K4)
- Double Immelmann from top with full rolls, inverted entry (K4)

Horizontal Rolling and Non- Rolling Maneuvers

- Straight Flight Out (K1)
- Straight Flight Back (K1)
- Straight Inverted Flight (K1)
- Two point (2/2 pt.) Roll (K2)
- One Horizontal Roll (K1)
- Two Horizontal Rolls (K2)
- One Horizontal Snap Roll (up high in flight) (K2)



Three Horizontal Rolls (K3)
Two half rolls reversed (pause in middle) (K3)
Slow roll (K3)
Four point roll (K4)



B. Advanced Turnaround Maneuvers

A maximum of two maneuvers from each group permitted in a sequence.

Turns

Procedure Turn (K1)
180 Degree Turn (K1)

Half Square Loops

Half square loop (K1)
Half square loop, inverted entry (K1)
Half square loop with half roll up (K2)
Half square loop with 2/4pt roll up (K2)
Half square loop with full roll up (K2)
Half square loop with full roll up, inverted entry (K2)
Half square loop from top (K1)
Half square loop from top, inverted entry (K1)
Half square loop from top, half roll down (K2)

Half Square Loops on Corner

Half square loop on corner (K1)
Half square loop on corner from top (K1)

Half Loops

Half inside loop, exit inverted (K1)
Half outside loop, inverted entry (K1)
Half outside loop from top (K1)
Half loop from top, inverted entry (K1)

Half Loops w/roll combinations

Split "S" (half roll, half loop from top) (K2)
Split "S", 2/4 pt. roll (2/4 pt. roll, half loop from top) (K2)
Full Roll, half outside loop from top (K2)
Half inside loop, half roll, from top, inverted entry (K2)
Half inside loop, full roll, from top, inverted entry (K2)
Half outside loop, 1/2 roll, from top (Bunt with 1/2 roll out) (K2)



Half outside loop, 2/4 pt. roll, from top (Bunt with 2/4 pt. roll out) (K2)
Half roll, half outside loop, half roll (K2)

Immelmann Turns

Immelmann turn (K2)
Immelmann turn, inverted entry (K2)
Immelmann turn, full roll (K2)
Immelmann turn, 2/4 pt roll (K2)
Immelmann turn, 2/4 pt roll, inverted entry (K2)

Figure 9's

Figure 9 from bottom (K1)
Figure 9 from middle (top first) (K1)
Figure 9 from middle (top first), inverted entry (K1)
Figure 9 from middle (top first), half roll down (K2)(upright entry)

Half Cuban Eights

Half Cuban Eight (K2)
Half Cuban Eight, 2/4pt roll (K2)
Half Cuban Eight with full roll (K2)

Half Reverse Cuban Eights

Half Reverse Cuban Eight (K2)
Half Reverse Cuban Eight, 2/4pt roll (K2)
Half Reverse Cuban Eight with full roll (K2)
Half Reverse Cuban Eight with full roll, inverted entry (K2)

Stall Turns

Stall Turn without rolls (K2)
Stall Turn, half rolls up and down (K2)
Stall Turn, half rolls up and down, inverted entry (K2)
Stall Turn, full roll up (K2)
Stall Turn, full roll up, Inverted entry (K2)

Top Hats (horizontal cross-box flight is always flown inverted)

Top hat, 3/4 roll up, 1/4 roll down (K2)
Top hat, 3/4 roll up, 1/4 roll down, inverted entry (K2)



Top hat, 1/4 roll up, 1/4 roll down (K2)
Top hat, 1/4 roll up, 1/4 roll down, inverted entry (K2)
Top hat, 1/4 roll up, 1/4 roll down, inverted exit (K2)

Humpty Bumps

Humpty bump (pull, pull, pull), half roll up (K2)
Humpty bump (pull, pull, pull), 2/4 pt roll up (K2)
Humpty bump (pull, push, pull) exit inverted (K2)
Humpty bump (push, pull, pull), inverted entry (K2)
Humpty bump (push, pull, pull), full roll up, inverted entry (K2)
Humpty bump (pull, push, pull), half roll down (K2)
Humpty bump (pull, pull, pull), half roll down (K2)
Humpty bump (push, pull, pull) full roll up, inverted entry (K3)
Humpty bump with roll options, (half roll up or 1/4 roll up and down) (K2)

Sharks Tooth

Reverse Sharks Tooth, half roll on 45 Up Line (K3)
Reverse Sharks Tooth, 2/4 pt. roll on 45 Up Line (K3)
Reverse Sharks Tooth, 2/2-pt roll on 45 degree Up Line, inverted entry (K3)
Reverse Sharks Tooth, 2/2-pt roll on 45 degree Up Line (K3)
Sharks Tooth, half roll on 45 Down Line (K3)
Sharks Tooth, 2/4 pt. roll on 45 Down Line (K3)

Half Triangle Loop

Half Triangle Loop, 2/4-pt roll on 45 degree Up Line (K2)
Half Triangle Loop, half roll on 45 degree Up Line (K2)
Half Triangle Loop (K1)



Annex B4A - Complete Catalog of Center Maneuvers

Takeoff (K1)

Landing (K1)

Vertical Up and Down Line's

- Vertical Up Line (pull-push) (K1)
- Vertical Up Line (pull-pull) with half roll (K2)
- Vertical Up Line (pull-pull) with 2/4 pt. roll (K2)
- Vertical Down Line (push-pull) (K1)
- Vertical Down Line (push-push) with half roll (K2)
- Vertical Down Line (push-push) with 2/4 pt. roll (K2)

Loops (single and superimposed)

- One Inside Loop (K1)
- One Inside Loop (from top) (K1)
- One Outside Loop (from bottom) (K1)
- One Outside Loop (from top) (K2)
- Two Inside Loops (K2)
- Two Inside Loops (from top) (K2)
- Two Outside Loops (from bottom) (K2)
- Two Outside Loops (from top) (K2)
- Three Inside Loops (K3)
- Three Inside Loops (from top) (K3)
- Three Outside Loops (from bottom) (K3)
- Three Outside Loops (from top) (K3)

Two Loops with Full and/or Half Roll Combinations

- Two loops with half rolls at top (from bottom) (K3)
- Two loops with half rolls at top (from bottom) inverted entry (K4)
- Two loops with half rolls at bottom (from top) (K4)
- Two loops with half rolls at bottom (from top) inverted entry (K3)
- Two loops with full roll first top, half roll second (from bottom) (K4)
- Two loops with full roll first top, half roll second, inverted entry (from bottom) (K4)
- Two loops with half roll first top, full roll second (from bottom) (K4)
- Two loops with half roll first top, full roll second, inverted entry (from bottom) (K4)
- Two loops with full roll first bottom, half roll second (from top) (K4)
- Two loops with full roll first bottom, half roll second (from top) inverted entry (K4)



- Two loops with half roll first bottom, full roll second (from top) (K4)
- Two loops with half roll first bottom, full roll second (from top) inverted entry (K4)

Avalanches

- Avalanche with full snap (from bottom) (K3)
- Avalanche with full snap (from bottom) inverted entry (K3)
- Avalanche with 1-1/2 snap (from bottom) (K4)
- Avalanche with 1-1/2 snap, inverted entry (from bottom) (K4)
- Avalanche with 1 negative snap (from top) (K4)
- Avalanche with 1 positive snap (from top) inverted entry (K3)

Triangular Loops

- Triangular loop, non-rolling (from bottom) or Non-rolling Triangle Loop (K2)
- Triangular loop, non-rolling (from bottom), inverted entry (K2)
- Triangular loop with full roll (from bottom) or Triangle Rolling Loop (1 roll) (K4)
- Triangular loop with full roll (from bottom) inverted entry (K4)
- Triangular loop with 2/2pt roll (from bottom) (K4)
- Triangular loop with 2/2pt roll (from bottom) inverted entry (K4)
- Triangular loop with 2/4pt roll (from bottom) (K4)
- Triangular loop with 2/4pt roll (from bottom) inverted entry (K4)
- Triangular loop with snap roll (from bottom) or Triangle Snap Loop (1 snap) (K4)
- Triangular loop with snap roll (from bottom) inverted entry (K4)
- Triangular loop with 1-1/2 snap roll (from bottom) inverted entry (K4)
- Triangular loop with 1/2 rolls (from bottom) (K3)
- Triangular loop with 1/2 rolls (from bottom) inverted entry (K3)
- Triangular loop from top (base at top), non-rolling (K2)
- Triangular loop from top (base at top), non-rolling, inverted entry (K2)
- Triangular loop from top (base at top) with half rolls in 45 degree legs (K4)
- Triangular loop from top (base at top) with half rolls in 45 degree legs, inverted entry (K4)
- Triangular loop from top (base at top) with 2/4pt rolls in 45 degree legs (K4)
- Triangular loop from top (base at top) with 2/4pt rolls in 45 degree legs, inverted entry (K4)
- Triangular Loop, 1/2 rolls in 45 degree legs, 1-1/2 positive snap roll on top leg, exit inverted (K5)

Triangular Loops (base at bottom) or Pyramid Loops

- Triangular Loop (base at bottom) or Non-Rolling Pyramid Loop (K2)
- Triangular Loop (base at bottom), inverted entry (K2)
- Triangular loop (base at bottom) with half rolls in 45 degree legs (K3)



- Triangular loop (base at bottom) with half rolls in 45 degree legs, inverted entry (K3)
- Triangular loop (base at bottom) with 2/4pt rolls in 45 degree legs (K4)
- Triangular loop (base at bottom) with 2/4pt rolls in 45 degree legs, inverted entry (K4)
- Triangular loop (base at bottom) with 2/2pt rolls in 45 degree legs (K4)
- Triangular loop (base at bottom) with 2/2pt rolls in 45 degree legs, inverted entry (K4)
- Triangular loop (base at bottom) with half rolls on 45 degree legs, snap roll on base leg (K5)
- Triangular loop from top (base at bottom) with half rolls in 45 degree legs (K4)
- Triangular loop from top (base at bottom) with half rolls in 45 degree legs, inverted entry (K4)
- Triangular loop from top (base at bottom) with 2/4pt rolls in 45 degree legs (K4)
- Triangular loop from top (base at bottom) with 2/4pt rolls in 45 legs, inverted entry (K4)
- Triangular loop from top (base at bottom) with 2/4pt roll at bottom (K4)
- Triangular loop from top (base at bottom) with 2/4pt roll at bottom, inverted entry (K4)
- Triangular loop from top (base at bottom) with full roll (K4)
- Triangular loop from top (base at bottom) with full roll, inverted entry (K4)
- Triangular loop from top (base at bottom) w/ 1/2-rolls on 45 degree legs, snap roll on base leg (K5)

Square Loops

- Square Loop (K3)
- Square Loop with 1/2 rolls in vertical up and Down Lines (K4)
- Square loop with half rolls (K5)
- Square loop with half rolls, inverted entry (K5)
- Square loop with 2/4pt rolls (K5)
- Square loop with 2/4pt rolls, inverted entry (K5)
- Square loop with full snap over top (K4)
- Square loop with full snap over top, inverted entry (K4)
- Square loop with 1-1/2 snap over top, inverted entry (K4)
- Square loop from top, inverted entry (K3)
- Square loop from top with 1/2 rolls in vertical up and Down Lines, inverted entry (K4)
- Square loop from top with half rolls (K5)
- Square loop from top with half rolls, inverted entry (K5)
- Square loop from top with 2/4pt rolls (K5)
- Square loop from top with 2/4pt rolls, inverted entry (K5)

Square Loops on Corner

- Square loop on corner (K3)
- Square loop on corner, inverted entry (K3)
- Square loop on corner with half rolls in legs 1 & 3 (K4)
- Square loop on corner with half rolls in legs 1 & 3, inverted entry (K4)



- Square loop on corner with full roll in leg 1, half roll in leg 3 (K4)
- Square loop on corner with full roll in leg 1, half roll in leg 3, inverted entry (K4)
- Square loop on corner with four half rolls (K5)
- Square loop on corner with four half rolls, inverted entry (K5)
- Square loop on corner from top (K3)
- Square loop on corner from top, inverted entry (K3)
- Square loop on corner from top with half rolls in legs 1 & 3 (K4)
- Square loop on corner from top with half rolls in legs 1 & 3, inverted entry (K4)
- Square loop on corner from top with full roll in leg 1, half roll in leg 3 (K4)
- Square loop on corner from top with full roll in leg 1, half roll in leg 3, inverted entry (K4)
- Square loop on corner from top with four half rolls (K5)
- Square loop on corner from top with four half rolls, inverted entry (K5)

Six Sided Loops

- Six sided loop (K4)
- Six sided loop, inverted entry (K4)
- Six sided loop from top (K4)
- Six sided loop from top, inverted entry (K4)
- Six sided loop with 2/4 pt roll on top, inverted entry (K4)

Eight Sided Loops

- Eight sided loop (K4)
- Eight sided loop, inverted entry (K4)
- Eight sided loop from top (K4)
- Eight sided loop from top, inverted entry (K4)

Cobra Rolls

- Cobra roll without rolls (K1)
- Cobra roll with 1/2 rolls (K2)
- Cobra roll with 2/4pt rolls (K3)
- Cobra roll with 2/4pt rolls, inverted entry (K3)
- Cobra roll with 2/2pt rolls (K3)
- Cobra roll with 2/2pt rolls, inverted entry (K3)
- Cobra roll from top with half rolls (K3)
- Cobra roll from top with half rolls, inverted entry (K3)
- Cobra roll from top with 2/4pt rolls (K3)
- Cobra roll from top with 2/4pt rolls, inverted entry (K3)
- Cobra roll from top with 2/2pt rolls (K3)
- Cobra roll from top with 2/2pt rolls, inverted entry (K3)



Golfball

- Golf ball (45 degrees up, 3/4 inside loop, 45 degrees down, pull to level), (K3)
- Golf ball, inverted entry (K3)
- Golf ball with half rolls (K3)
- Golf ball with half rolls, inverted entry (K3)
- Golf ball with 2/4pt rolls (K3)
- Golf ball with 2/4pt rolls, inverted entry (K3)
- Reverse Golf ball from top with 1/2 rolls (K4)
- Reverse Golf ball from top with 2/4 pt. rolls (K4)

Cuban Eights

- Cuban Eight with half rolls (K2)
- Cuban Eight with 2/4pt rolls (K3)
- Cuban Eight with 2/4pt rolls, inverted entry (K3)
- Cuban Eight without rolls or non-rolling Cuban Eight (K3)
- Cuban Eight with full rolls (K4)
- Cuban Eight with full rolls, inverted entry (K4)
- Reverse Cuban Eight with half rolls (K3)
- Reverse Cuban Eight without rolls or non-rolling reverse Cuban Eight (K3)
- Reverse Cuban Eight with 2/4pt rolls (K4)
- Reverse Cuban Eight with 2/4pt rolls, inverted entry (K4)
- Reverse Cuban Eight with full rolls (K4)
- Reverse Cuban Eight with full rolls, inverted entry (K4)
- Reverse Cuban Eight, 4/8 pt roll first, 2/2 pt roll second, exit inverted (K4)
- Cuban Eight from top with half rolls (K3)
- Cuban Eight from top with half rolls, inverted entry (K3)
- Cuban Eight from top with 2/4pt rolls (K4)
- Cuban Eight from top with 2/4pt rolls, inverted entry (K4)
- Cuban Eight from top with full rolls (K4)
- Cuban Eight from top with full rolls, inverted entry (K4)
- Reverse Cuban Eight from top with half rolls (K3)
- Reverse Cuban Eight from top with half rolls, inverted entry (K3)
- Reverse Cuban Eight from top with 2/4pt rolls (K4)
- Reverse Cuban Eight from top with 2/4pt rolls, inverted entry (K4)
- Reverse Cuban Eight from top with full rolls (K4)
- Reverse Cuban Eight from top with full rolls, inverted entry (K4)

45 Degree Up and Down Lines

- 45 degree Down Line (K1)



- 45 degree Down Line with half roll (K2)
- 45 degree Down Line with half roll, inverted entry (K2)
- 45 degree Down Line with full roll (K2)
- 45 degree Down Line with full roll, inverted entry (K2)
- 45 degree Down Line with 2/4 pt. roll (K3)
- 45 degree Down Line with 2/4 pt. roll, inverted entry (K3)
- 45 degree Down Line with one positive snap roll (K3)
- 45 degree Down Line with one negative snap roll, inverted entry (K3)
- 45 degree Down Line with 4-point roll (K4)
- 45 degree Down Line with 4-point roll, inverted entry (K4)
- 45 degree down with 1-1/2 positive snap roll (K4)
- 45 degree down with two 2/4 pt rolls reversed (K4)
- 45 degree down with two 2/4 pt rolls reversed, inverted entry (K4)
- 45 degree down with two 4/8 pt rolls reversed (K4)
- 45 degree down with two 4/8 pt rolls reversed, inverted entry (K4)

- 45 degree Up Line (K1)
- 45 degree Up Line with half roll (K2)
- 45 degree Up Line with half roll, inverted entry (K2)
- 45 degree Up Line with full roll (K2)
- 45 degree Up Line with full roll, inverted entry (K2)
- 45 degree Up Line with 2/4 pt. roll (K3)
- 45 degree Up Line with 2/4 pt. roll, inverted entry (K3)
- 45 degree Up Line with one positive snap roll (K3)
- 45 degree Up Line with one negative snap roll, inverted entry (K3)
- 45 degree Up Line with 4-point roll (K4)
- 45 degree Up Line with 4-point roll, inverted entry (K4)
- 45 degree up with two 2/4 pt rolls reversed (K4)
- 45 degree up with two 2/4 pt rolls reversed, inverted entry (K4)
- 45 degree up with two 4/8 pt rolls reversed (K4)
- 45 degree up with two 4/8 pt rolls reversed, inverted entry (K4)

Figure Z

- Figure Z with half roll up (K3)
- Figure Z with half roll up, inverted entry (K3)
- Figure Z with 2/4pt roll up (K4)
- Figure Z with 2/4pt roll up, inverted entry (K4)
- Figure Z with 2/2pt roll up (K4)
- Figure Z with 2/2pt roll up, inverted entry (K4)
- Figure Z from top with half roll down (K3)
- Figure Z from top with half roll down, inverted entry (K3)
- Figure Z from top with 2/4pt roll down (K4)



Figure Z from top with 2/4pt roll down, inverted entry (K4)

Figure Z from top with 2/2pt roll (K4)

Figure Z from top with 2/2pt roll, inverted entry (K4)

Hourglass

Hourglass (K4)

Hourglass, inverted entry (K4)

Hourglass with half rolls up and down (K4)

Hourglass with half rolls up and down, inverted entry (K5)

Hourglass with 2/4pt rolls up and down (K5)

Hourglass with 2/4pt rolls up and down, inverted entry (K5)

Hourglass (middle entry, top first) (K4)

Hourglass (middle entry, top first) inverted entry (K4)

Hourglass (middle entry, top first), half roll down (K4)

Hourglass (middle entry, top first) half roll down, inverted entry (K4)

Hourglass (middle entry, top first) 2/4pt roll down (K5)

Hourglass (middle entry, top first) 2/4pt roll down, inverted entry (K5)

Hourglass (middle entry, bottom first) (K4)

Hourglass (middle entry, bottom first), inverted entry (K4)

Hourglass (middle entry, bottom first) half roll up (K4)

Hourglass (middle entry, bottom first) half roll up, inverted entry (K4)

Hourglass (middle entry, bottom first) 2/4pt roll up (K4)

Hourglass (middle entry, bottom first) 2/4pt roll up, inverted entry (K4)

Hourglass (top entry) (K4)

Hourglass (top entry), inverted entry (K4)

Hourglass (top entry) with half rolls down and up (K5)

Hourglass (top entry) with half rolls down and up, inverted entry (K5)

Hourglass (top entry) with 2/4pt rolls down and up (K5)

Hourglass (top entry) with 2/4pt rolls down and up, inverted entry (K5)

Vertical Eights

Vertical eight (from bottom) (K3)

Vertical eight (from bottom) inverted entry (K3)

Vertical eight (from bottom) with half rolls (K4)

Vertical eight (from bottom) with half rolls, inverted entry (K4)

Vertical eight (from bottom) with half roll after first half loop (K4)

Vertical eight (from bottom) with half roll after first half loop, inverted entry (K4)

Vertical eight (from middle) (K3)

Vertical eight (from middle) inverted entry (K3)

Vertical eight (from middle) with half roll (K3)

Vertical eight (from middle) with half roll, inverted entry (K3)



- Vertical eight (from top) (K3)
- Vertical eight (from top) inverted entry (K3)
- Vertical eight (from top) with half rolls (K4)
- Vertical eight (from top) with half rolls, inverted entry (K4)
- Vertical eight (from top) with half roll after first half loop (K4)
- Vertical eight (from top) with half roll after first half loop, inverted entry (K4)

Square Horizontal Eights

- Square horizontal eight (K5)
- Square horizontal eight, inverted entry (K5)
- Square horizontal eight (from top) (K5)
- Square horizontal eight (from top) inverted entry (K5)

Square Vertical Eights

- Square vertical eight (from bottom) (K5)
- Square vertical eight (from bottom) inverted entry (K5)
- Square vertical eight (from bottom) with half rolls (K5)
- Square vertical eight (from bottom) with half rolls, inverted entry (K5)
- Square vertical eight (from middle) (K5)
- Square vertical eight (from middle) inverted entry (K5)
- Square vertical eight (from middle) with half roll (K5)
- Square vertical eight (from middle) with half roll, inverted entry (K5)
- Square vertical eight (from top) (K5)
- Square vertical eight (from top) inverted entry (K5)
- Square vertical eight (from top) with half rolls (K5)
- Square vertical eight (from top) with half rolls, inverted entry (K5)

Figure M's

Note: Center half-loop is always flown negative (inverted)

- Figure M with 3/4 rolls (K5)
- Figure M with 3/4 rolls, inverted entry (K5)
- Figure M with 3/4 pt rolls (K5)
- Figure M with 3/4 pt rolls, inverted entry (K5)
- Figure M with 3/4 pt rolls up, 1/4 rolls down (K5)
- Figure M with 3/4 pt rolls up, 1/4 rolls down, inverted entry (K5)

Double Stall Turns



Note: Center half loop is always flown positive (upright) with all stall turns in the upwind direction.

- Double stall turn with 1/4 rolls up and down (K3)
- Double stall turn with 3/4 rolls up, 1/4 rolls down (K4)
- Double stall turn with 3/4 pt. rolls up, 1/4 rolls down (K4)
- Double stall turn with 3/4 rolls up and down (K4)
- Double stall turn with 3/4 pt. rolls up, 3/4 rolls down (K4)

Top Hats

- Top Hat with half rolls up and down (K3)
- Top Hat with 2/4pt rolls (K4)
- Top Hat with 2/4pt rolls, inverted entry (K4)
- Top Hat with 2/2pt rolls (K4)
- Top Hat with 2/2pt rolls, inverted entry (K4)
- Top Hat from top with 2/4pt rolls (K4)
- Top Hat from top with 2/4pt rolls, inverted entry (K4)
- Top Hat from top with 2/2pt rolls (K4)
- Top Hat from top with 2/2pt rolls, inverted entry (K4)

Humpty Bumps

- Humpty bump, no rolls (pull-push-pull) (K2)
- Humpty bump, 1/2 roll up (pull-pull-push) (K3)
- Humpty bump, 1/2 roll up, inverted entry (K3)
- Humpty bump, 2/4 pt roll up (pull-pull-push) (K3)
- Humpty bump, full roll up (pull-push-pull) (K3)
- Humpty bump, 1/2 roll up, 1/2 roll down (pull-pull-pull) (K4)
- Humpty bump, full roll up, half roll down (pull-push-pull) (K4)
- Humpty bump, full roll up, half roll down (push-pull-pull), inverted entry (K4)
- Humpty bump, 2/4 pt roll up, half roll down (K4)
- Humpty bump, 2/4 pt roll up, half roll down, inverted entry (K4)
- Humpty bump from top, half roll down, 2/4pt roll up (K4)
- Humpty bump from top, half roll down, 2/4pt roll up, inverted entry (K4)
- Humpty bump from top, 2/4pt roll down, full roll up (K4)
- Humpty bump from top, 2/4pt roll down, full roll up, inverted entry (K4)

Spins

- Two turn spin (K3)
- 2-1/2 turn spin, inverted exit (K3)
- 2-1/2 turn spin, half roll exit (K3)



Three turn spin (K3)
Inverted 2-1/2 turn spin, upright exit (K3)
Inverted three turn spin, half roll exit (K3)
Inverted three turn spin, inverted exit (K3)
2 turn opposite spin (K4)

Stall Turns

Stall Turn, 1/4 rolls up and down (K3)
Stall Turn, 3/4 rolls up and 1/4 roll down (K3)
Stall Turn, 3/4 rolls up and 1/4 roll down, exit inverted (K3)
Stall Turn, 3/4 rolls up and down (K3)
Stall Turn 3/4 roll up, 3/4pt roll down (K3)
Stall Turn, 3/4 roll up, 3/4pt roll down, inverted entry (K3)
Stall Turn 3/4 roll up, 3/4 pt roll down, inverted exit (K3)
Stall Turn, 1-1/4 roll up, 3/4 roll down (K4)
Stall Turn, 1-1/4 roll up, 3/4 snap roll down (K5)

Double Immelmans

Double Immelmann without Rolls (K2)
Double Immelmann with half rolls (K3)
Double Immelmann with half rolls, inverted entry (K3)
Double Immelmann with half roll first, full roll second (K4)
Double Immelmann with half roll first, full roll second, inverted entry (K4)
Double Immelmann with full rolls (K3)
Double Immelmann with full rolls, inverted entry (K3)
Double Immelmann from top, half rolls (K3)
Double Immelmann from top, half rolls, inverted entry (K3)
Double Immelmann from top, half roll first, full roll second (K4)
Double Immelmann from top, half roll first, full roll second, inverted entry (K4)
Double Immelmann from top with full rolls (K4)
Double Immelmann from top with full rolls, inverted entry (K4)

Figure N's

Figure N, 1/2 rolls on verticals, 2/4 pt roll on the 45, exit inverted (K5)
Figure N, 2/4 pt rolls on verticals, half roll on the 45, exit inverted (K5)

Diamond Eights

Inside Outside Diamond Eight, full rolls on 45 degree center line (K5)



Inside Outside Diamond Eight, 2/2 pt rolls on 45 degree center line (K5)

Half Cloverleaves

Half Cloverleaf, 2/4 pt. roll up, 1/2 roll down (K4)

Half Cloverleaf, full roll up, 2/4 pt. roll down, inverted entry (K5)

Half Cloverleaf, 2/2 pt. roll up, 2/4 pt. roll down, inverted entry (K5)

Horizontal Rolling and Non- Rolling Maneuvers

Straight Flight Out (K1)

Straight Flight Back (K1)

Straight Inverted Flight (K1)

Two point (2/2 pt.) Roll (K2)

One Horizontal Roll (K1)

Two Horizontal Rolls (K2)

One Horizontal Snap Roll (up high in flight) (K2)

Three Horizontal Rolls (K3)

Two half rolls reversed (pause in middle) (K3)

Slow roll (K3)

Slow roll, inverted entry (K3)

1-1/2 rolls reversed (K4)

1-1/2 rolls reversed, inverted entry (K4)

Two rolls reversed (K4)

Two rolls reversed, inverted entry (K4)

Four point roll (K4)

Four point roll, inverted entry (K4)

4/8 pt. roll (K4)

4/8 pt. roll, inverted entry (K4)

Eight point roll (K4)

Eight point roll, inverted entry (K4)

Two 3/4 pt. rolls reversed (K4)

Two 3/4 pt. rolls reversed, inverted entry (K4)

Two 2/2 pt. rolls reversed (K4)

Two 2/2 pt. rolls reversed, inverted entry (K4)

Two 2/4 pt. rolls reversed (K4)

Two 2/4 pt. rolls reversed, inverted entry (K4)

2/2 pt roll, slow roll reversed (K4)

Knife edge flight (K4)

Knife edge flight, inverted entry (K4)

Quarter, Half, Quarter Roll (K4)

Six of Four Point Roll, exit inverted (K4)

Six of Four Point Roll, inverted entry (K4)



Reverse knife edge flight (K5)
Reverse knife edge flight, inverted entry (K5)
Reverse knife edge flight, exit inverted (K5)
4/8 pt roll, slow roll reversed, inverted entry (K5)



Annex B4B - Complete Catalog of Turnaround Maneuvers

A maximum of two maneuvers from each group permitted in a sequence.

Turns

- Procedure Turn (K1)
- 180 Degree Turn (K1)

Half Square Loops

- Half square loop (K1)
- Half square loop, inverted entry (K1)
- Half square loop with half roll up (K2)
- Half square loop with half roll up, inverted entry (K2)
- Half square loop with 2/4pt roll up (K2)
- Half square loop with 2/4pt roll up, inverted entry (K2)
- Half square loop with 2/2pt roll up (K2)
- Half square loop with 2/2pt roll up, inverted entry (K2)
- Half square loop with full roll up (K2)
- Half square loop with full roll up, inverted entry (K2)
- Half square loop with 4/8-pt roll up (K3)
- Half square loop from top (K1)
- Half square loop from top, inverted entry (K1)
- Half square loop from top, half roll down (K2)
- Half square loop from top, half roll down, inverted entry (K2)
- Half square loop from top, 2/4pt roll down (K2)
- Half square loop from top, 2/4pt roll down, inverted entry (K2)
- Half square loop from top, 2/2pt roll down (K2)
- Half square loop from top, 2/2pt roll down, inverted entry (K2)
- Half square loop from top, full roll down (K2)
- Half square loop from top, full roll down, inverted entry (K2)

Half Square Loops on Corner

- Half square loop on corner (K1)
- Half square loop on corner with 1/2 rolls, exit inverted (K2)
- Half square loop on corner from top (K1)

Half Loops

- Half inside loop, exit inverted (K1)



Half outside loop, inverted entry (K1)
Half outside loop from top (K1)
Half loop from top, inverted entry (K1)

Half Loops with Roll Combinations

Split "S" (half roll, half loop from top) (K2)
Split "S", 2/4 pt. roll (2/4 pt. roll, half loop from top) (K2)
Full Roll, half outside loop from top (K2)
Full Roll, half inside loop from top, inverted entry (K2)
Half inside loop, half roll, from top, inverted entry (K2)
Half outside loop, full roll, from top (Bunt with full roll out) (K2)
Half inside loop, full roll, from top, inverted entry (K2)
Half outside loop, 1/2 roll, from top (Bunt with 1/2 roll out) (K2)
Half outside loop, 2/4 pt. roll, from top (Bunt with 2/4 pt. roll out) (K2)
Half roll, half outside loop, half roll (K2)
2/2-pt roll, half loop (K2)

Immelmann Turns

Immelmann turn (K2)
Immelmann turn, inverted entry (K2)
Immelmann turn, full roll (K2)
Immelmann turn, full roll, inverted entry (K2)
Immelmann turn, 2/4 pt roll (K2)

Spins

1-1/2 Turn Spin (K2)
Inverted 1-1/2 Turn Spin (K2)
Two turn spin (K2)
Inverted Two turn spin (K2)
2 1/2 turn spin (K2)
Inverted 2 1/2 turn spin (K2)

Figure 9's

Figure 9 from bottom (K1)
Figure 9 from bottom, inverted entry (K1)
Figure 9 from bottom, half roll up (K2)
Figure 9 from bottom, half roll up, inverted entry (K2)
Figure 9 from bottom, 2/4pt roll up (K2)
Figure 9 from bottom, 2/4pt roll up, inverted entry (K2)



- Figure 9 from bottom, 2/2pt roll up (K2)
- Figure 9 from bottom, 2/2pt roll up, inverted entry (K2)
- Figure 9 from bottom, full roll up (K2)
- Figure 9 from bottom, full roll up, inverted entry (K2)
- Figure 9 from middle (top first) (K1)
- Figure 9 from middle (top first), inverted entry (K1)
- Figure 9 from middle (top first), half roll down (K2)
- Figure 9 from middle (top first), half roll down, inverted entry (K2)
- Figure 9 from middle (top first), 2/4pt roll down (K2)
- Figure 9 from middle (top first), 2/4pt roll down, inverted entry (K2)
- Figure 9 from middle (top first), 2/2pt roll down (K2)
- Figure 9 from middle (top first), 2/2pt roll opposite down (K3)
- Figure 9 from middle (top first), 2/2pt roll down, inverted entry (K2)
- Figure 9 from middle (top first), full roll down (K2)
- Figure 9 from middle (top first), full roll down, inverted entry (K2)

Figure 6's

- Figure 6 from middle (bottom first) (K1)
- Figure 6 from middle (bottom first), inverted entry (K1)
- Figure 6 from middle (bottom first), half roll up (K2)
- Figure 6 from middle (bottom first), half roll up, inverted entry (K2)
- Figure 6 from middle (bottom first), 2/4pt roll up (K2)
- Figure 6 from middle (bottom first), 2/4pt roll up, inverted entry (K2)
- Figure 6 from middle (bottom first), 2/2pt roll up (K2)
- Figure 6 from middle (bottom first), 2/2pt roll up, inverted entry (K2)
- Figure 6 from middle (bottom first), full roll up (K2)
- Figure 6 from middle (bottom first), full roll up, inverted entry (K2)
- Figure 6 from top (K1)
- Figure 6 from top, inverted entry (K1)
- Figure 6 from top, half roll down (K2)
- Figure 6 from top, half roll down, inverted entry (K2)
- Figure 6 from top, 2/4pt roll down (K2)
- Figure 6 from top, 2/4pt roll down, inverted entry (K2)
- Figure 6 from top, 2/2pt roll down (K2)
- Figure 6 from top, 2/2pt roll down, inverted entry (K2)
- Figure 6 from top, full roll down (K2)
- Figure 6 from top, full roll down, inverted entry (K2)

Half Cuban Eights

- Half Cuban Eight (K2)
- Half Cuban Eight, inverted entry (K2)



Half Cuban Eight, 2/4pt roll (K2)
Half Cuban Eight, 2/4pt roll, inverted entry (K2)
Half Cuban Eight, 2/2pt roll (K2)
Half Cuban Eight, 2/2pt roll, inverted entry (K2)
Half Cuban Eight with full roll (K2)
Half Cuban Eight with full roll, inverted entry (K2)
Half Cuban Eight from top (K2)
Half Cuban Eight from top, inverted entry (K2)
Half Cuban Eight from top, 2/4pt roll up (K2)
Half Cuban Eight from top, 2/4pt roll up, inverted entry (K2)
Half Cuban Eight from top, 2/2pt roll up (K2)
Half Cuban Eight from top, 2/2pt roll up, inverted entry (K2)
Half Cuban Eight from top, full roll up (K2)
Half Cuban Eight from top, full roll up, inverted entry (K2)

Half Reverse Cuban Eights

Half Reverse Cuban Eight (K2)
Half Reverse Cuban Eight, inverted entry (K2)
Half Reverse Cuban Eight, 2/4pt roll (K2)
Half Reverse Cuban Eight, 2/4pt roll, inverted entry (K2)
Half Reverse Cuban Eight, 2/2pt roll (K2)
Half Reverse Cuban Eight, 2/2pt roll, inverted entry (K2)
Half Reverse Cuban Eight with full roll (K2)
Half Reverse Cuban Eight with full roll, inverted entry (K2)
Half Reverse Cuban Eight from top (K2)
Half Reverse Cuban Eight from top, inverted entry (K2)
Half Reverse Cuban Eight from top, 2/4pt roll down (K2)
Half Reverse Cuban Eight from top, 2/4pt roll down, inverted entry (K2)
Half Reverse Cuban Eight from top, 2/2pt roll down (K2)
Half Reverse Cuban Eight from top, 2/2pt roll down, inverted entry (K2)
Half Reverse Cuban Eight from top, full roll down (K2)
Half Reverse Cuban Eight from top, full roll down, inverted entry (K2)

Stall Turns

Stall Turn without rolls (K2)
Stall Turn, half rolls up and down (K2)
Stall Turn, half rolls up and down, inverted entry (K2)
Stall Turn, half roll up, 2/4pt roll down (K2)
Stall Turn, half roll up, 2/4pt roll down, inverted entry (K2)
Stall Turn, full roll up (K2)
Stall Turn, full roll up, Inverted entry (K2)



Stall Turn, full roll up, half roll down (K2)
Stall Turn, full roll up, half roll down, Inverted entry (K2)
Stall Turn, 2/4pt roll up, half roll down (K2)
Stall Turn, 2/4pt roll up, half roll down, inverted entry (K2)
Stall Turn, 2/2pt roll up, 2/4pt roll down (K2)
Stall Turn, 2/2pt roll up, 2/4pt roll down, inverted entry (K2)
Stall Turn, 4/8 pt. roll up, 1/2 roll down (K3)
Stall Turn, 4/8 pt. roll up, 1/2 roll down, inverted entry (K3)

Top Hats (horizontal cross-box flight is always flown inverted)

Top hat, 3/4 roll up, 1/4 roll down (K2)
Top hat, 3/4 roll up, 1/4 roll down, inverted entry (K2)
Top hat, 3/4 pt. roll up, 1/4 roll down (K2)
Top hat, 3/4pt roll up, 3/4 roll down (K2)
Top hat, 3/4pt roll up, 3/4 roll down, inverted entry (K2)
Top hat, 3/4pt roll up, 3/4 pt roll down, inverted exit (K2)
Top hat, 3/4pt roll up, 3/4pt roll down, inverted entry and exit (K2)
Top hat, 1/4 roll up, 1/4 roll down (K2)
Top hat, 1/4 roll up, 1/4 roll down, inverted entry (K2)
Top hat, 1/4 roll up, 1/4 roll down, inverted exit (K2)
Top hat, 1/4 roll up, 1/4 roll down, inverted entry and exit (K2)
Top Hat from top, 3/4 roll down, 3/4pt roll up (K3)
Top Hat from top, 3/4 roll down, 3/4pt roll up, inverted entry (K3)
Top Hat from top, 3/4 roll down, 1/4 roll up (K2)
Top Hat from top, 3/4 roll down, 1/4 roll up, inverted entry (K2)
Top Hat from top, 1/4 roll down, 3/4pt roll up (K2)
Top Hat from top, 1/4 roll down, 3/4pt roll up, inverted entry (K2)

45 degree Up Line, half loop, 45 degree Down Line

45 degree up, 2/4pt roll, half loop (inside or outside), full roll down (K3)
45 degree up, 2/4pt roll, half loop (inside or outside), full roll down, inverted entry (K3)
45 degree up, 2/2pt roll, half loop (inside or outside), 2/4pt roll down (K3)
45 degree up, 2/2pt roll, half loop (inside or outside), 2/4pt roll down, inverted entry (K3)
45 degree up, full roll, half loop (inside or outside), 2/4pt roll down (K3)
45 degree up, full roll, half loop (inside or outside), 2/4pt roll down, inverted entry (K3)

Humpty Bumps

Humpty bump (pull, pull, pull), half roll up (K2)
Humpty bump (pull, pull, pull), 2/4 pt roll up (K2)
Humpty bump (pull, push, pull) exit inverted (K2)



- Humpty bump (push, pull, pull), inverted entry (K2)
- Humpty bump (push, pull, pull), full roll up, inverted entry (K2)
- Humpty bump (pull, push, pull), half roll down (K2)
- Humpty bump (pull, pull, pull), half roll down (K2)
- Humpty bump (pull, pull, push) half roll up, 2/4pt roll down (K3)
- Humpty bump (push, push, pull) half roll up, 2/4pt roll down, inverted entry (K3)
- Humpty bump (pull, pull, pull) half roll up, 2/2pt roll down (K3)
- Humpty bump (push, push, push) half roll up, 2/2pt roll down, inverted entry (K3)
- Humpty bump (pull, pull, push) 2/4pt roll up, half roll down (K3)
- Humpty bump (push, push, pull) 2/4pt roll up, half roll down, inverted entry (K3)
- Humpty bump (pull, pull, push, or pull, push, push) 1/4 roll up, 3/4 roll down (K3)
- Humpty bump (push, pull, pull, or push, push, pull) 1/4 roll up, 3/4 roll down, inverted entry (K3)
- Humpty bump (pull, pull, pull) 3/4pt roll up, 1/4 roll down (K3)
- Humpty bump (push, pull, pull) 3/4pt roll up, 1/4 roll down, inverted entry (K3)
- Humpty bump (push, pull, pull) full roll up, inverted entry (K3)
- Humpty bump with roll options, (half roll up or 1/4 roll up and down) (K2)
- Humpty bump with roll options, (half roll up or 1/4 roll up and down) inverted entry (K2)

Humpty Bumps (from top)

- Humpty bump from top, half roll down (push, push, push) (K3)
- Humpty bump from top, half roll down, inverted entry (pull, pull, pull) (K2)
- Humpty bump from top, 2/4pt roll down, half roll up (push, push, pull) (K3)
- Humpty bump from top, 2/4pt roll down, half roll up, inverted entry (pull, pull, push) (K3)
- Humpty bump from top, 2/4pt roll down, 2/2pt roll up (push, push, push) (K3)
- Humpty bump from top, 2/4pt roll down, 2/2pt roll up, inverted entry (pull, pull, pull) (K3)
- Humpty bump from top, 1/4 roll down, 3/4 roll up (push, push, push) (K3)
- Humpty bump from top, 1/4 roll down, 3/4 roll up, inverted entry (pull, push, push) (K3)
- Humpty bump from top, 1/4 roll down, 3/4 roll up, inverted entry and exit (pull, push, pull) (K3)
- Humpty bump from top, 1/4 roll down, 3/4 roll up, inverted exit (push, push, pull) (K3)
- Humpty bump from top with roll options, inverted entry, upright exit (1/4 or 1/2 rolls up and down) (K3)

Sharks Tooth

- Reverse Sharks Tooth, half roll on 45 Up Line (K3)
- Reverse Sharks Tooth, 2/4 pt. roll on 45 Up Line (K3)
- Reverse Sharks Tooth, 2/2-pt roll on 45 degree Up Line, inverted entry (K3)
- Reverse Sharks Tooth, 2/2-pt roll on 45 degree Up Line (K3)



Reverse Sharks Tooth, 4/8-pt roll on 45 degree Up Line (K3)
Sharks Tooth, half roll on 45 Down Line (K3)
Sharks Tooth, 2/4 pt. roll on 45 Down Line (K3)
Sharks Tooth, 4/8-pt roll on 45 degree Down Line (K3)

Half Horizontal Hourglass

Half horizontal hour glass, 1/2 roll up first, 2/2 pt. roll opposite second (K3)
Half horizontal hour glass, 1/2 roll up first, full roll second (K3)
Half horizontal hour glass, 1/2 roll up first, 1/2 roll second, exit inverted (K3)
Half horizontal hour glass, 2/4 pt roll up first, 2/4 pt. roll second, exit inverted (K3)

Goldfish

Goldfish, with half rolls, exit inverted (K2)
Goldfish, 2/4 pt rolls, exit inverted (K2)
Goldfish, 2/4 pt roll first, full roll second (K2)
Goldfish (from top), with half rolls, inverted entry (K2)

Half Triangle Loop, 4-pt roll on 45 degree Up Line (K4)
Half Triangle Loop, 2/4-pt roll on 45 degree Up Line (K2)
Half Triangle Loop, half roll on 45 degree Up Line (K2)
Half Triangle Loop (K1)