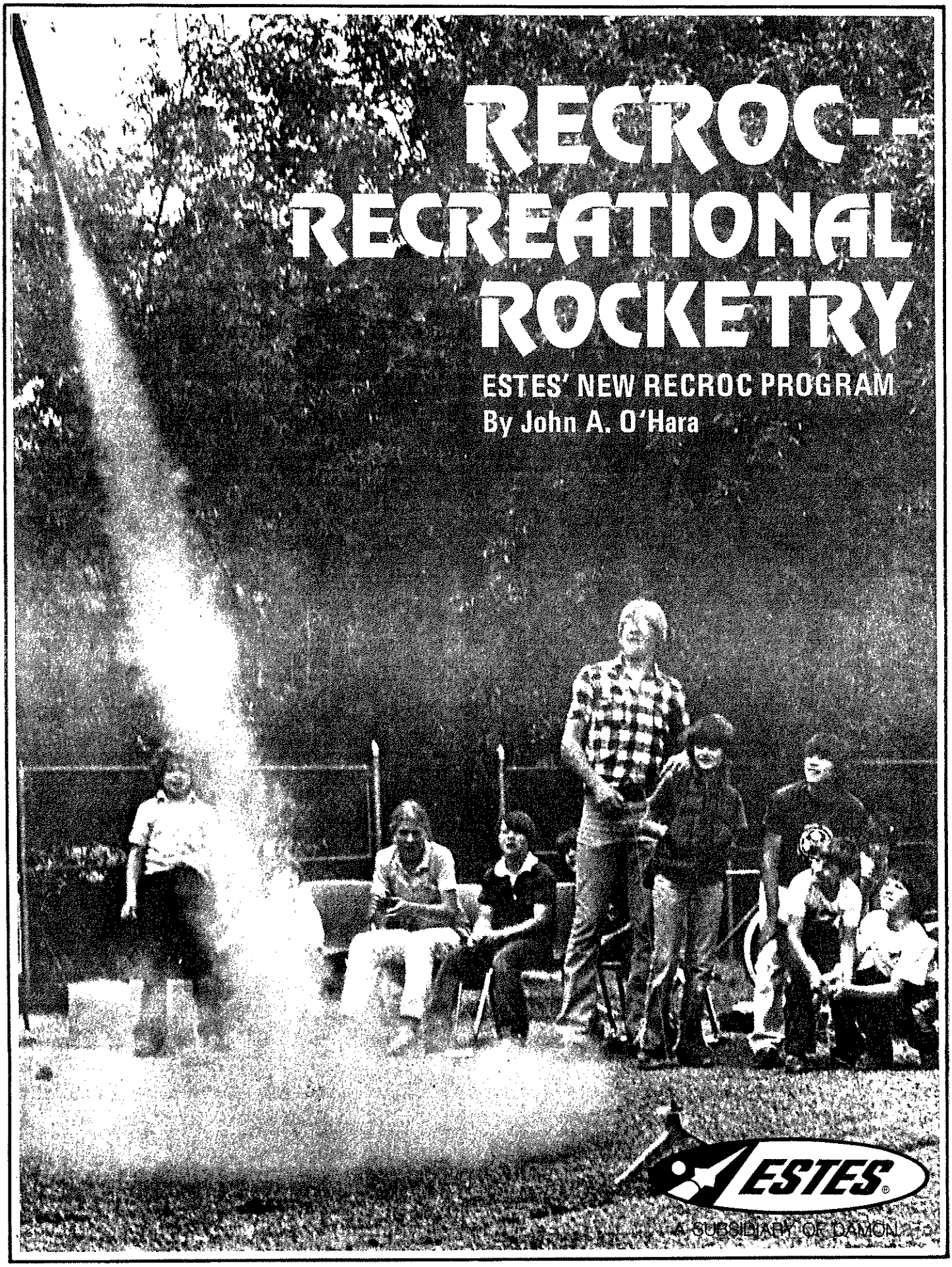

RECROC-- RECREATIONAL ROCKETRY

ESTES' NEW RECROC PROGRAM

By John A. O'Hara

ESTES®

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The author expresses special thanks to Ralph Confessore, Physics Teacher, Kearny High School, Kearny, New Jersey for assistance in writing this publication. Thanks also to Joe Davis, Executive Director of the Canon City Area Metropolitan Recreation and Park District, Canon City, Colorado; George Payne, Science Teacher, McKinley Elementary School, Canon City, Colorado and model rocketry leader for Canon City Area Metropolitan Recreation and Park Department; and Larry Armstrong, Science Teacher, Fayette High School, Fayette, Ohio, and model rocketry leader for Fayette Park-Summer Rocket Club for assistance in evaluating the RECROC program.

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RECREATION PROGRAMS IN YOUR COMMUNITY

Wherever you live, in the largest cities, or the smallest communities, there undoubtedly exist people who have an active interest in recreation programs. Recreation programming usually is handled by one of the following groups: (1) A recreation department which is usually a division of city or county government. (2) A recreation and park district which is a political subdivision and is usually controlled by a board of directors, elected by the people. (3) A committee or commission composed of interested citizens who privately organize and finance recreation programs.

Most recreation-oriented organizations try to serve all ages, but some are limited by the resources available. Recreational Rocketry is a valuable addition to any program, not only because it is new and exciting, but also because the program can be tailor-made to fit any budget or even pay for itself through low-cost participation fees.

RECROC

Estes Industries introduces a recreation program honestly for all the citizens in your community. The only prerequisites being an interest and a desire to learn something new while having fun.

STARTING A RECROC PROGRAM IN YOUR COMMUNITY

The fun of model rocketry, while appealing to all ages, has generally been more acknowledged by the young people of your community than by other groups. This is reasonable considering the youngsters have been exposed to the fun of model rocketry through educational programs in their schools, model rocket programs at camp, 4-H and Scout model rocketry programs, club programs, and watching their friends' individual model rocketry projects.

Model rocketry no longer can be claimed only by young people. Young adults, adults, and senior citizens are experiencing the fun of model rocketry in their own community as part of organized recreational programs. While many clubs incorporate model rocketry as part of a variety of planned activities, RECROC is becoming an activity field of its own in recreation programs—a brand new form of recreation.

Starting a new group or recreational activity in your community isn't as difficult or complicated as you may imagine. With some creativity, imagination, and enthusiasm, your RECROC Program may be started in a few weeks with a minimum amount of effort and little or no expense.

Following is a sample letter which you may wish to send to the "Town Fathers", Mayor and Council, Recreation Department, Parks Department, or other municipal organizations responsible for starting new recreational programs in your community. Modify the letter as necessary to be appropriate for the specific group to whom you address it.

Dear _____:

In 1980, the National Aeronautics and Space Administration (NASA), will be launching the Space Shuttle into Earth Orbit. This once again opens the doorway to space through the '80's and beyond. Anticipating the success of the Space Shuttle Program, I predict that someone from this community may be flying on the Space Shuttle as a pilot astronaut or mission specialist.

Preparing for such a mission naturally requires many hours of preparation, training, and academic study. You, our leaders, have an excellent opportunity to provide the stimulus and motivation for the people in your community to prepare for the exciting years ahead. Early preparation doesn't have to be dull and monotonous, but can be challenging and exciting. Learning by doing can be fun. This is my reason for writing to you.

The program which I am proposing for your endorsement is a program of learning through fun and recreation for young and old alike. There is little or no cost to the municipality (or other group). The program, a new type of recreational activity, is known as RECROC, Recreational Rocketry. Participants in the RECROC Program will have the opportunity to assemble, launch, track, and calculate the performance of small model rockets initially. They will then form teams, conduct contests, present awards, and enjoy model rocketry as a means of wholesome recreation and fun while learning the science of rocketry and space travel. They can progress into designing their own model rockets. The program is safe and easy to administer for all age groups. Many of the activities in the program are good spectator sports. This in turn draws in new participants to keep the program growing.

The RECROC Program, since it is a new recreational endeavor, should come under the auspices of the Department of Recreation in the community.

Your permission is requested to advertise in the community through the news media the formation of RECROC Program as a new recreational program. Announcements will also be made through school systems, clubs, etc., with their permission.

RECROC will give the citizens in the community the opportunity to participate in a healthy, wholesome, and educational aspect of recreation, not limited by age, sex, or physical ability.

I am sure you have seen the appeal model rocketry has had among the young people. With the RECROC Program, everyone can have the opportunity to enjoy model rocketry. Various teams can be organized as with any recreational program, and the team members can be taught how to safely build and launch model rockets for fun and competition. RECROC Coaches and Team Leaders will learn the art of building and flying model rockets and of conducting the program from the Estes Industries RECROC Manual. They in turn will instruct their team members.

Teams or groups may be specialized as to age of team members or degree of skill in model rocketry, but this is not essential. The RECROC program is suitable for everyone 10 years of age or older.

Contests in model rocketry can be arranged. Often local industries, service clubs, or community organizations will sponsor prizes and publicity for these activities.

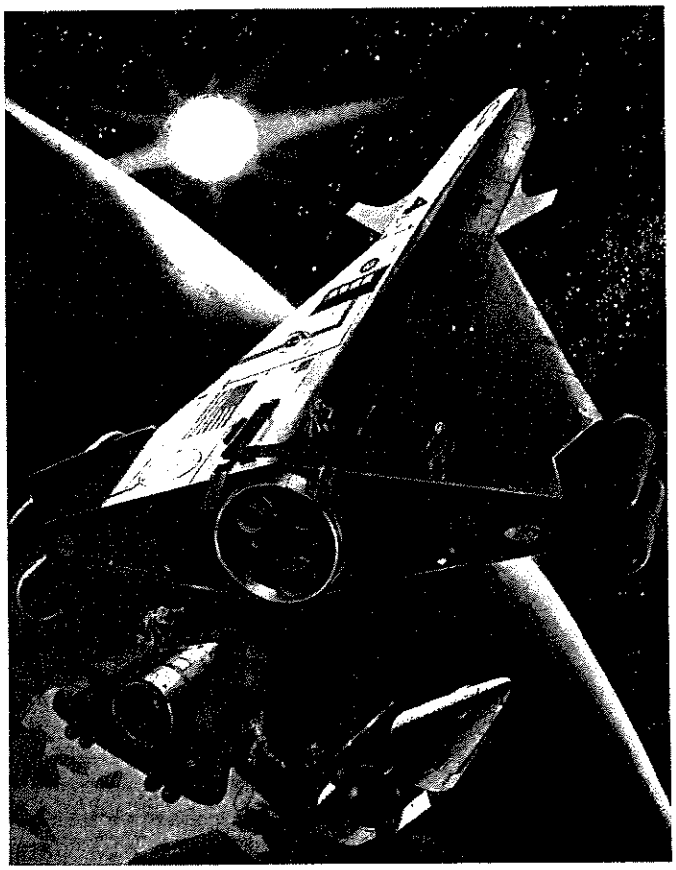
Awards, prizes, and trophies can be presented to participants as part of the RECROC Program or as part of a community activity, say country fair, block party, school awards program, etc.

Instructional material, a sample of the model rocket kit recommended for the RECROC Program, and further ideas about RECROC will be provided to the RECROC Community Director by Estes Industries, Inc., Penrose, Colorado. Kits, launch equipment, tracking gear, engines, publications, etc., may be purchased from Estes by the individuals participating in the recreational program, either individually or as a group. (Official RECROC programs with a sponsor are eligible to receive discounts.)

I would be most happy to meet with you along with the members of the Recreation Department to further discuss this project with you and show you samples of materials which we shall be using.

Anxiously awaiting your hopefully favorable response, I am, Respectfully,

The above sample letter should serve to introduce the RECROC Program to the "Town Fathers" of your municipality.



COURTESY MARTIN MARIETTA CORPORATION

DIRECTING THE RECROC PROGRAM

After receiving approval for the RECROC Program, or earlier if you anticipate a favorable response to start such a program, you should make certain that you are familiar with model rocketry, in particular the construction, launching, and safe operation of the designated RECROC rocket, the Alpha. This may be accomplished in the following manner:

1. The section of this manual entitled "RECROC Flow Chart" will show you detailed, step-by-step methods of constructing, launching, and recovering your RECROC safely, for many safe and enjoyable flights of your RECROC.
2. Communicate with Estes Industries and purchase one or more of the following publications. Study the publications.
   -PROJECTS IN MODEL ROCKETRY (2831)
   -MODEL ROCKET LAUNCH SYSTEMS (2811)
   -MODEL ROCKET CONTEST GUIDE (2815)
   -GUIDE FOR AEROSPACE CLUBS (2817)
   -THE ALPHA BOOK OF MODEL ROCKETRY (2820)
   -ESTES CATALOG (99150)
   -CAMP LEADERS' MODEL ROCKETRY MANUAL (2822)
   -MODEL ROCKETRY—THE SPACE AGE TEACHING AID (2840)
   -PUBLICATIONS BROCHURE (900435)
3. You may participate in various Aerospace Education Workshops offered, usually during the summer months, by colleges and universities. These offer expert training in various aerospace activities in addition to model rocketry.
4. You may also subscribe to model rocketry publications, join model rocket clubs, or join such professional organizations as the American Society for Aerospace Education.
5. Communicate with others in the field who have sponsored or worked with youth groups in building and launching model rockets for their ideas and suggestions. You will be surprised how willing others are to help. The exchange of information will be valuable.
6. State universities in four states have college classes in the educational uses of model rocketry for graduate or undergraduate credit. Some of these classes are offered by extension in other states. Write Bob Cannon, Education Director, Estes Industries, Dept. 123, Penrose, CO 81240 for further information on college classes.

DIRECTING ACTIVITIES IN THE RECROC PROGRAM

After learning more about model rocketry from any or all of the above options, the next thing to do is build a few model rockets from kits and conduct a few launches to convince the members of your community of the practicality and value of your program.

Follow the RECROC Flow Chart (See page 6.) to construct your own model rocket. Then use the program to help the participants construct their own rocket.

During the launch you will automatically attract a crowd of bystanders who will want to see what's going on. This is a good time to solicit their help and involvement and sign them up for the RECROC Program.

Appoint interested people to act as Team Leaders. Provide them with the equipment they will need and instruction in handling the equipment, so they might go out and recruit their RECROC TEAMS. Selecting enthusiastic leaders and properly training and helping them may be the key to the success or gradual failure of your program.

After RECROC Teams are organized, schedule competitive activities for the various teams based upon the guidelines in the literature you received. Competitive activities may be in construction skills, design, artistic value, proficiency in the launch itself, altitude, spot-landing, launch systems, telemetry systems, etc. As the RECROC Director, your imagination is the only limit to what is possible in competition.

Prepare press releases informing townspeople of the upcoming launches and publicize the winners of the previous launches. Launches may take place as often as feasible for the RECROC Team Leaders and the RECROC Director. Be sure to give (Mail if necessary; but hand-delivery is best.) press releases to all local papers as well as radio and TV stations. Community shipping center bulletin boards may sometimes be effectively used.

As a RECROC Director, you may wish to conduct other activities in aerospace education. Possibilities include field trips for the various teams; inviting guest speakers from the aerospace community to give a talk to the teams (This can be opened to the public and advertised.); and taking advantage of the many free loan films on aerospace education to be shown to the teams. (Model Rocketry—The Last Frontier with

William Shatner (Captain Kirk of the Star Ship Enterprise) as narrator is available for free loan from Modern Talking Picture Services, Department 123, 2323 New Hyde Park Road, New Hyde Park, NY 11040.)

WHO MAKES UP A RECROC TEAM?

Unlike conventional recreational activities which require grouping according to age, weight, height, physical ability, etc., RECROC teams do not have to be a homogeneous group. RECROC Team Leaders can use their imagination in building their teams. Among the sources of people for RECROC TEAMS are:

- Schools
- Chambers of Commerce
- P.T.A.s and P.T.O.s
- Water Dept. employees
- Optimists
- Elks
- Order of the Moose
- Y.M.C.A.
- Boy Scouts
- Boys Clubs
- Girl Scouts
- Webelos
- Cub Scouts
- Explorer Scouts
- Aerospace groups
- Senior citizens
- Golden Age Clubs
- Father and son teams
- Radio amateur clubs
- Colleges (students & faculty members)
- Fire Department employees
- Social Services Department employees
- Municipal employees (Firemen, Police, etc.)
- Rotary
- Masons
- American Legion
- Y.W.C.A
- 4-H
- Camp Fire Girls
- Civil Air Patrol
- "Town Fathers"
- Recreational Teams (i.e. Little Leagues, etc.)
- Mother and daugther teams
- CBers
- Parade Committees for local displays on RECROC programs
- Camera clubs
- Forestry Department employees
- Lions
- Kiwanis
- Eagles
- Salvation Army
- Big Brothers
- Church groups
- Merchants
- Air Cadets
- Father's Clubs
- Mother's Clubs

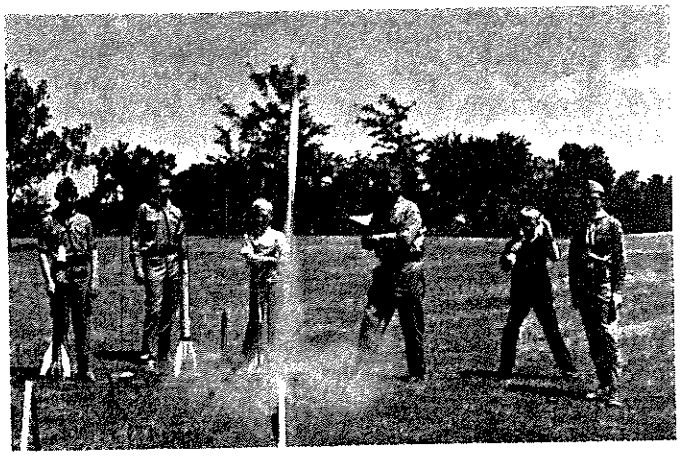
This is a partial list of possible participants for teams in the RECROC Program. It is by no means complete. Teams may be organized comprising any number of people from all walks of life. The grouping is left up to the imagination of the Team Leaders. Each team, however, should have enough people in it to successfully conduct a launch as outlined in this manual.

One of the best ways to recruit new team members is to give demonstration launches. Actually seeing model rockets launched usually caused more people to become interested in the program.

ENCOURAGING PARTICIPATION IN THE RECROC TEAMS

To start forming the RECROC Teams and encourage membership and participation, potential participants must be exposed to the RECROC PROGRAM. As RECROC Director, this is your job. Offer your services to demonstrate a launch of the "official" model rocket for the RECROC program, the Alpha. Launch of a variety of models is best. Be sure to include a few exotic (Space-ship appearance) models. Since many of the clubs and organizations meet during evening hours, making a launch impractical, having a good presentation and display is appropriate. Many groups would welcome such a program to fill a "program slot" in their activities.

Meeting places, schedules of meetings, etc. for the teams is left up to the discretion of the RECROC Director and Team Leaders.



Scouting organizations can provide excellent advisors and sponsorship for model rocket.

RECROC PROGRAM

To insure a safe and successful model rocketry program in your community under the auspices of the recreation department, the following RECROC FLOW CHART has been devised to facilitate construction, launch, and recovery of your rockets. Following this simple program, various sequenced steps will insure that your model rocket will be what its name implies, a RECREATIONAL ROCKET (RECROC). A less-structured program may be used, if desired. The Estes Alpha rocket and the Estes Deluxe Starter Outfit have been designated the official kits for the recreation program in your town or community. While any rocket in the Estes catalog may serve your purposes in RECROC, it is suggested that the Astron Alpha be the official rocket for the first flights.

The Deluxe Starter Outfit (Estes Industries kit #1407), should be purchased as the Starter Kit for each team. The Alpha rocket in this kit may serve as the instructor's demonstration rocket. Individual Alpha model rocket kits (Estes Industries kit #1225) may be purchased by the participants.

Use the ORDER BLANK at the end of this manual to place such an order.

RECROC FLOW CHART – INTRODUCTION AND INSTRUCTIONS FOR USE

To help you, your coaches, team leaders, and counselors, build, launch, track, and recover your RECROC, successfully, the following RECROC FLOW CHART should be used.

You may wish to emphasize the use of computers in our nation's aerospace efforts. Developing logical

sequences of events is very important in programming computers as well as in carrying out complex activities. The sequence of activities in each flow chart may be compared to a program for a computer.

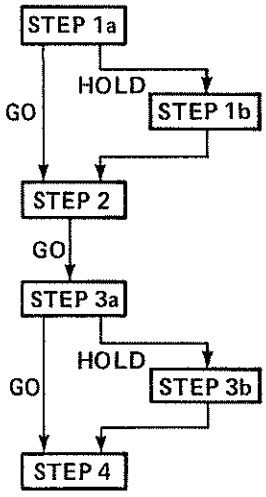
Each step or procedure to be followed is outlined by a rectangle. When that step or instruction is completed smoothly and with no difficulty, then you are ready to proceed to the next instruction.

Simply follow the GO arrow until you arrive at the next rectangle outlining the next instruction.

If you encounter a problem with a particular step or instruction, you may not proceed to the next step until the problem is corrected. Instead, follow the HOLD arrow to the corrective action step.

Then, after successfully completing the instructions outlined in the corrective action step, proceed to the next step.

Following each FLOW CHART is an explanation of the steps outlined.



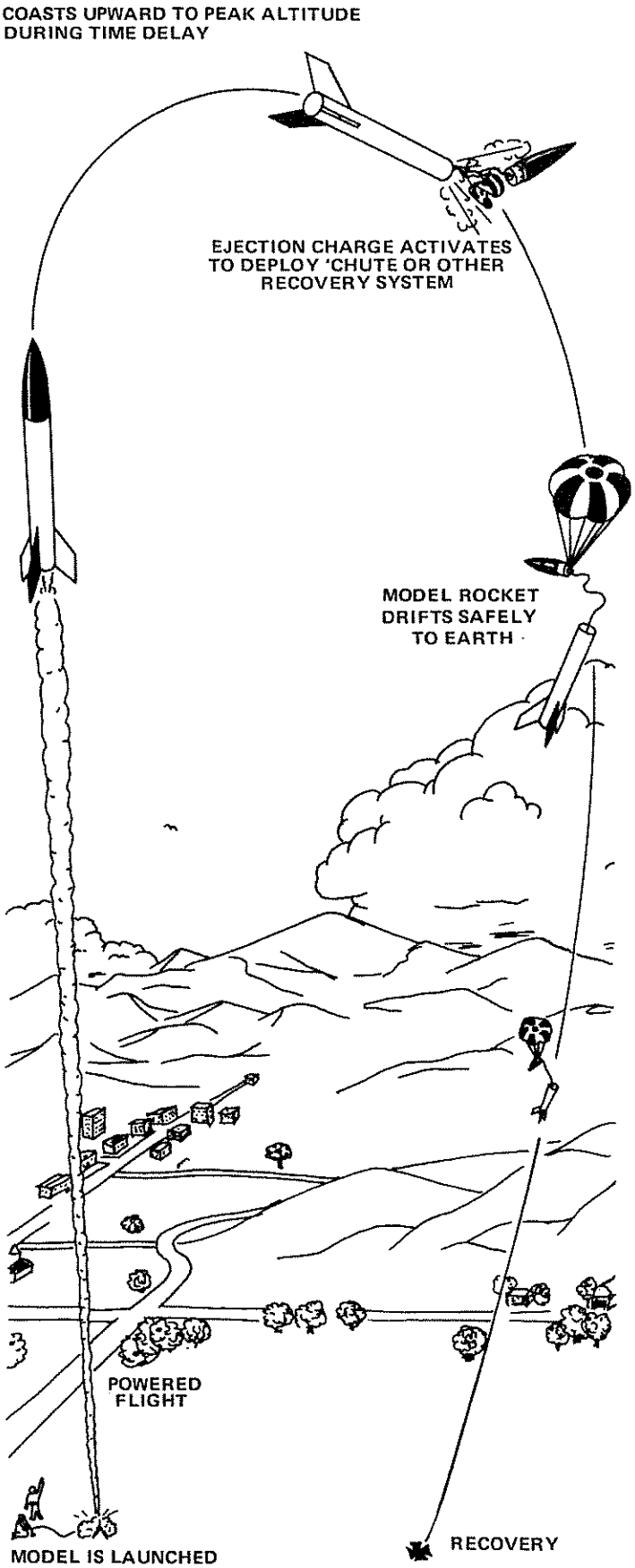
Steps 1 and 3 provide HOLD sequences for possible correction of problems before proceeding to next step.

Use the FLOW CHARTS to { Assemble / Inspect / Stabilize / Launch / Track / Recover } your rocket.

The RECROC Program is broken down into phases, each PHASE representing a particular sequence which should be followed for a successful program.

PHASE #1	ASSEMBLY PROGRAM
PHASE #2	INSPECTION PROGRAM
PHASE #3	STABILITY PROGRAM
PHASE #4	LAUNCHING PROGRAM
PHASE #5	TRACKING PROGRAM
PHASE #6	RECOVERY PROGRAM

Each phase or activity up to Phase #4 may be conducted independently. Phases 4, 5, and 6 should be conducted together by all team members or several teams together.



MODEL ROCKET FLIGHT PROFILE

RECROC FLOW CHART SUMMARY

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PHASE #1 – RECROC ASSEMBLY

STEP 1 INSPECTION OF DELUXE STARTER OUTFIT BY LEADER
GO
STEP 2 CONSTRUCTION OF IGNITION SYSTEM AND LAUNCH PAD
GO
STEP 3 DISTRIBUTION OF MODEL ROCKET KITS TO PARTICIPANTS
GO
STEP 4a INSPECTION OF KITS BY PARTICIPANTS
GO / HOLD → STEP 4b MISSING PARTS SUPPLIED TO PARTICIPANTS
STEP 5 PARTICIPANTS BEGIN CONSTRUCTION OF KITS
GO
STEP 6a CONSTRUCTION COMPLETED
GO / HOLD → STEP 6b DAMAGED PART REPAIRED OR PROBLEM DURING CONSTRUCTION SOLVED
STEP 7 MODEL ROCKETS PAINTED AND NAMED
GO
STEP 8 HOLD

END OF PHASE #1. GO TO PHASE #2.

PHASE #2 – INSPECTION PROGRAM

Step 1 INSPECT COMPLETED ROCKET
GO
Step 2a CHECK ALIGNMENT OF FINS
GO / HOLD → Step 2b REMOVE FIN(S) - REALIGN
Step 3a CHECK ALL GLUED JOINTS
GO / HOLD → Step 3b REGLUE ALL LOOSE PARTS
Step 4a CHECK POSITION OF LAUNCH LUG
GO / HOLD → Step 4b REMOVE LUG, SECURE PARALLEL TO BODY TUBE
Step 5a CHECK NOSE CONE FIT
GO / HOLD → Step 5b NOSE CONE FIT CORRECTION
Step 6a EJECT PARACHUTE
GO / HOLD → Step 6b PARACHUTE CORRECTION
Step 7a SHROUD LINES
GO / HOLD → Step 7b SHROUD LINES CORRECTION
Step 8 POWDER PARACHUTE
GO
Step 9 INSERT WADDING
GO
Step 10 FOLD PARACHUTE
GO
Step 11 INSERT PARACHUTE
GO
Step 12a INSERT ENGINE
GO / HOLD → Step 12b ENGINE FIT CORRECTION
Step 13 REMOVE ENGINE
GO
Step 14 HOLD

PHASE #3 – STABILITY PROGRAM

Step 1 LOCATE CENTER OR GRAVITY OF ROCKET
GO
Step 2 COMPARISON OF BODY TUBE LENGTH TO DIAMETER
GO
Step 3 CHECK FIN SIZE
GO
Step 4 CHECK FIN LOCATION
GO
Step 5a CHECK CENTER OF GRAVITY LOCATION
GO / HOLD → Step 5b CENTER OF GRAVITY PROBLEM CORRECTED
Step 6a TEST FOR STABILITY
GO / HOLD → Step 6b ROCKET STABILITY CORRECTED
Step 7 HOLD

PHASE #4 – LAUNCHING PROGRAM

Step 1 CHOOSE LAUNCH SITE
GO
Step 2 CUT AND SHAPE IGNITER
GO
Step 3a INSERT IGNITER INTO ENGINE
GO / HOLD → Step 3b IGNITER FAILS TO GO INTO NOZZLE
Step 4a SECURE IGNITER
GO / HOLD → Step 4b REPLACE IGNITER
Step 5 INSERT ENGINE INTO ROCKET
GO
Step 6a ELECTRICAL IGNITION SYSTEM
GO / HOLD → Step 6b BULB FAILS TO LIGHT
Step 7 REMOVE SAFETY KEY
GO
Step 8 LAUNCH PAD
GO
Step 9 PUT RECOVERY WADDING INTO ROCKET
GO
Step 10 PACK THE PARACHUTE
GO
Step 11a PLACE ROCKET ON LAUNCHER
GO / HOLD → Step 11b ROCKET CANNOT BE PLACED ON LAUNCH ROD
Step 12 ATTACH MICRO-CLIPS TO IGNITER
GO
Step 13 CLEAR LAUNCH AREA
GO
Step 14 LAUNCH TEAM ASSIGNMENTS AND DUTIES
GO
Step 15a CHECK FOR CONTINUITY
GO / HOLD → Step 15b NO CONTINUITY LIGHT
Step 16a COUNTDOWN
GO / HOLD → Step 16b MISFIRE
Step 17 RECOVERY
GO / OR → Step 18b REPEAT STEPS 9 THROUGH 15 UNTIL ALL ROCKETS ARE LAUNCHED
Step 18a HOLD

PHASE #5 – TRACKING PROGRAM

Step 1 ESTES ALTISCOPE OR OTHER TRACKER
GO
Step 2 ALTISCOPE ALIGNMENT
GO
Step 3 TRACKING ROCKET
GO
Step 4 DATA ACQUISITION
GO
Step 5 REPEAT STEPS 3 & 4 FOR EACH FLIGHT

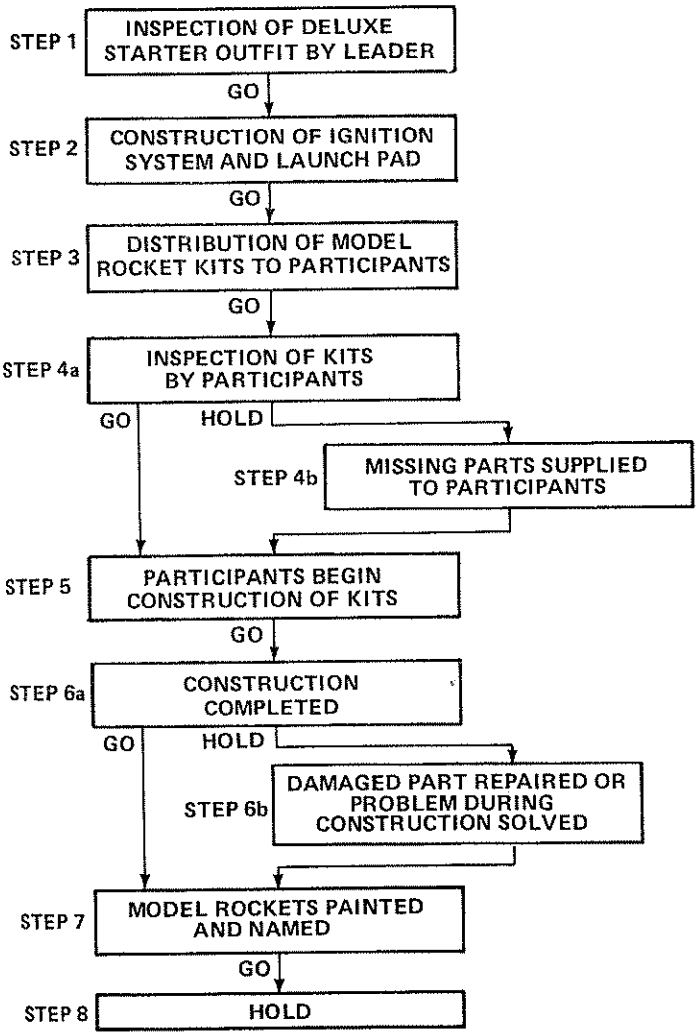
PHASE #6 – RECOVERY PROGRAM

Step 1 RECOVERY TEAM RECOVERS ROCKET
GO
Step 2 GO TO PHASE 4 AND PROCEED WITH LAUNCHES, REPEATING STEPS UNTIL ALL FLIGHTS ARE COMPLETED.

The RECROC Flow Chart Summary is a complete flow chart for all six phases of the RECROC Program. If you are new to model rocketry, or haven't practiced model rocketry for some time, follow the steps in each phase in the following pages very carefully. If you are experienced in model rocketry, perhaps you can simply use the Summary after you have once read through all of the steps.

While the RECROC Program appears to be long, you will find that it is actually easy and quick to use. It provides a reliable way to make sure everyone does every step properly. A copy of the RECROC Flow Chart Summary for copying off for your rocketeers is found at the end of this booklet.

PHASE #1 – RECROC ASSEMBLY PROGRAM



END OF PHASE #1. GO TO PHASE #2.

PHASE #1 – RECROC ASSEMBLY PROGRAM

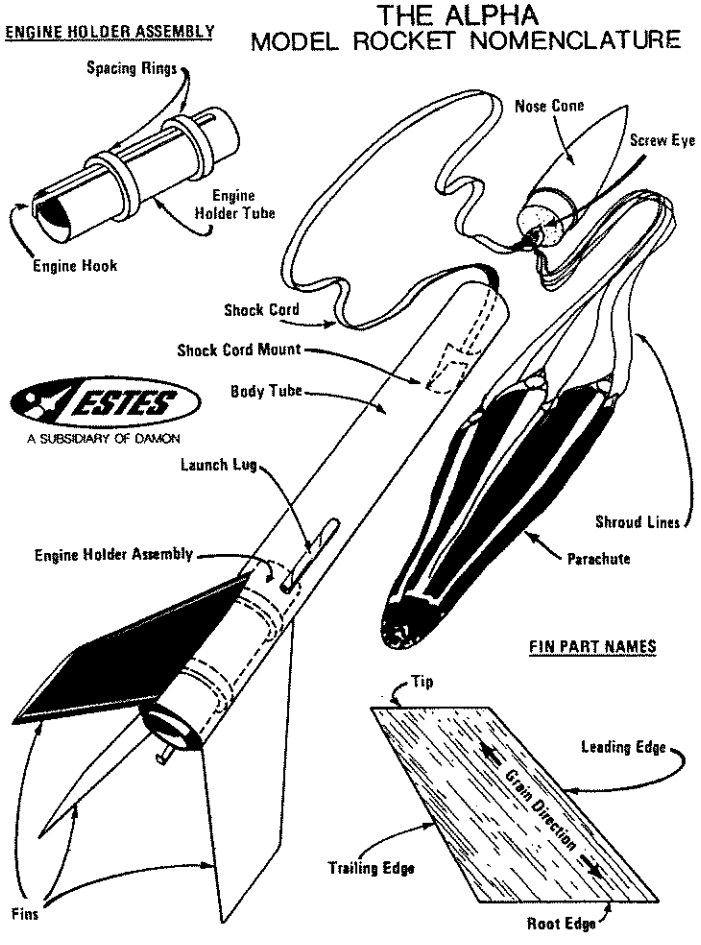
Step 1 - INSPECTION OF DELUXE STARTER OUTFIT BY LEADER - After receiving the Deluxe Starter Outfit, the leader should inspect the kit for the following items. Be certain that all parts are in each of the kits.

Alpha model rocket kit
Porta-Pad Tripod Launcher
1 Solar Launch Controller
3 NAR (National Association of Rocketry) Safety Certified Rocket Engines
Heat-resistant Recovery Wadding
Solar Igniters
Construction and finishing supplies
Alpha Book of Model Rocketry

Step 2 - CONSTRUCTION OF IGNITION SYSTEM AND LAUNCH PAD - The RECROC Director, Team Leader, or an individual appointed by the RECROC Director will build the Solar Launch Controller. This electrical ignition system requires four AA alkaline dry cells which may be secured locally. Remove the safety key from this ignition system before storing it.

The Porta-Pad launch system will be built now. Slip the three legs from the launch pad prior to storage of the pad. Remove and separate into two sections the launch rod before storing it. It may be wise to put a thin film of light-weight oil or silicone spray lubricant on the launch rod and blast deflector plate before storage. After they have been used, always clean and reoil the launch rod and the blast deflector plate to prevent rust.

Step 3 - DISTRIBUTION OF MODEL ROCKET KITS TO PARTICIPANTS - The instructor will distribute one Alpha model rocket kit to each member participating.



Step 4a - INSPECTION OF MODEL ROCKET KITS BY PARTICIPANTS - The instructor will have each participant inspect the Alpha kit making sure all the parts are enclosed and not damaged.

A parts list is enclosed with each kit.

If all materials are included participants may begin construction, GO to Step 5.

If materials are found missing in Step 4, HOLD and proceed to Step 4b.

Step 4b - MISSING PARTS SUPPLIED TO PARTICIPANTS - Step 4b is marked HOLD. This means no further activities may be done until the problem initiating the HOLD is corrected. In this step, the instructor is to provide the participants with whatever materials they may be missing to complete the model rocket.

Step 5 - PARTICIPANTS BEGIN CONSTRUCTION OF KITS - Participants should follow instructions enclosed with kit during this step. Go to Step 6 when construction completed.

After Step 5 is completed, GO to Step 6.

BASIC CONSTRUCTION TIPS

(This section is reprinted from The Alpha Book of Model Rocketry.)

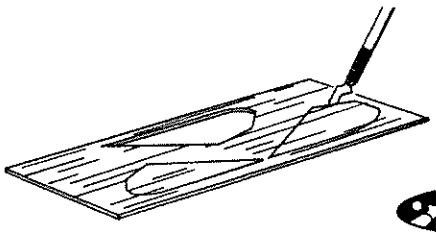
If you don't build your rocket right, it won't fly well! This simple statement takes some rocketeers a long time to learn. The best advice a beginner can receive and use is "FOLLOW THE DIRECTIONS".

Follow the directions exactly if you want your rocket to be the best! The kit designers are experts in their field. Do it their way. After you have a lot of experience, you may find ways of improving on their designs, adding little extra touches that make a fine rocket into the very best rocket of its type.

Some Basic Building Tips:

1. Follow the directions exactly.
This means just what it says.

2. Cut all parts to the right size.
Always take the few extra seconds needed to make sure that all parts will fit right. Even if the parts in the kit are die-cut, test them to be sure that you can make them fit just right.



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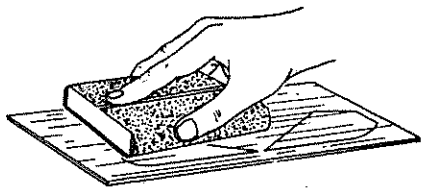
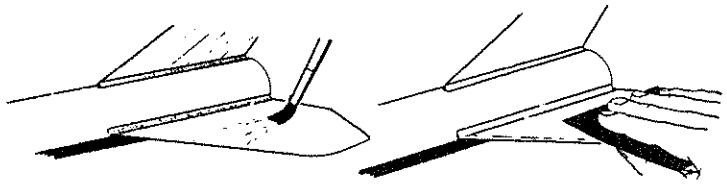
3. Sand all parts properly.
This rule sounds easy, and it is, but everyone gets in a hurry sometimes. Don't get in such a big hurry that you sand parts unevenly. While most rockets will fly OK without any sanding of the balsa parts, a good sanding job makes them look better and fly a lot better.

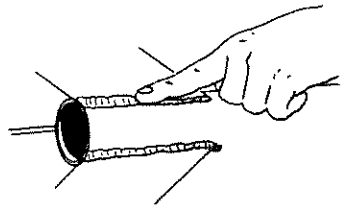


4. Don't be stingy with sanding sealer.
While you may not use sanding sealer on all of your sport (flying just for fun) models, learn to use several coats of sanding sealer and several sanding jobs on each balsa part. Building this way takes a little longer, but your rockets will fly a lot higher and look much better.



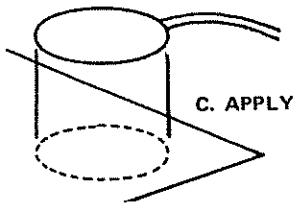
5. Use plenty of glue.
A liberal application of glue is the basis for any good joint. Ordinary white glue is best for balsa-to-balsa, balsa-to-paper, or paper-to-paper joints. When using plastic parts, use the correct type of plastic solvent or plastic cement. The kit instructions should tell you exactly what to use.

6. Apply glue fillets.
After you have made a good glue joint for each balsa and/or paper joint, let it dry thoroughly, then apply a glue fillet (thin layer of glue in joint smoothed out onto both surfaces making the joint). This makes the joint much stronger.



7. Be sure that the fins are on straight.
Unless your model is one of the few which require that the fins be mounted in an unusual way, always double-check the fin alignment for each fin before the glue dries on that fin.

8. Make the parachute very carefully.
Tape Discs
A. Put shroud line across sticky end of tape disc, as shown.
B. Fold short end back across disc to form loop.
C. Attach to parachute by pressing hard with fingernail on top of tape disc.



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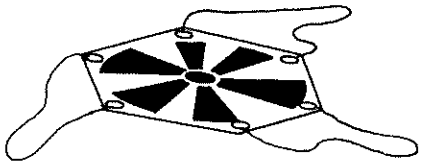
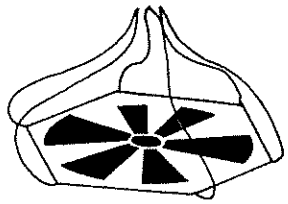
Parachutes

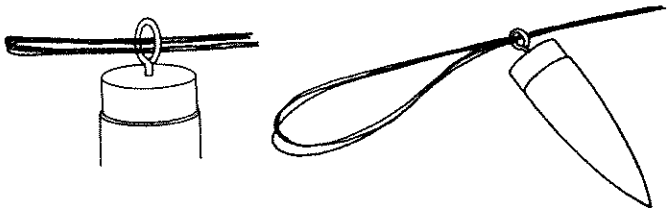
A. Attach shroud lines to parachute in the following manner: Cut shroud lines into three equal pieces, each twice the diameter of the parachute at the widest point, and attach as shown.



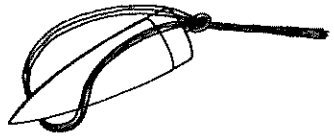
B. Find center of each of the three shroud line loops and bring these points together.



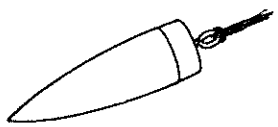
C. Fold centers of shroud line loops together and put through screw eye on nose cone. Pull through for a distance of four to five inches.



D. Open the loops again, and put the nose cone through the loops.



E. Then pull tight. This knot may easily be loosened for shroud line and parachute repair.

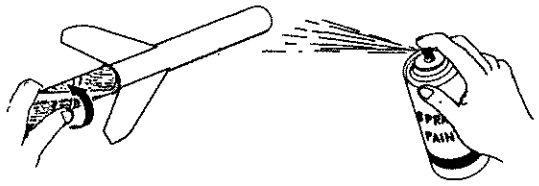


9. Check to be certain that you have done everything necessary before applying the paint.

Most of the mistakes you may make, such as forgetting to glue the launch lug in place, are fairly easy to fix before the paint is applied. After the paint goes on, the job becomes much more difficult. In addition, it is hard to paint over a repair job made after the paint has dried and not have the repair show.

10. Never apply butyrate dope over enamel paint.

It is best to use only one type of paint on a model. Spray enamel is easy to use and presents an attractive finish. Butyrate dope is inexpensive and can provide a nice-looking finish.



Step 6a - CONSTRUCTION COMPLETED - If construction is completed successfully with no problems, participants should continue on to Step 7.

If a problem arises in Step 6a, HOLD and proceed to Step 6b.

Step 6b - DAMAGED PART REPAIRED OR PROBLEM DURING CONSTRUCTION SOLVED - If either problem occurs, the instructor should help the participant correct the problem. Participant proceeds to Step 7 when Step 6b is successfully completed.

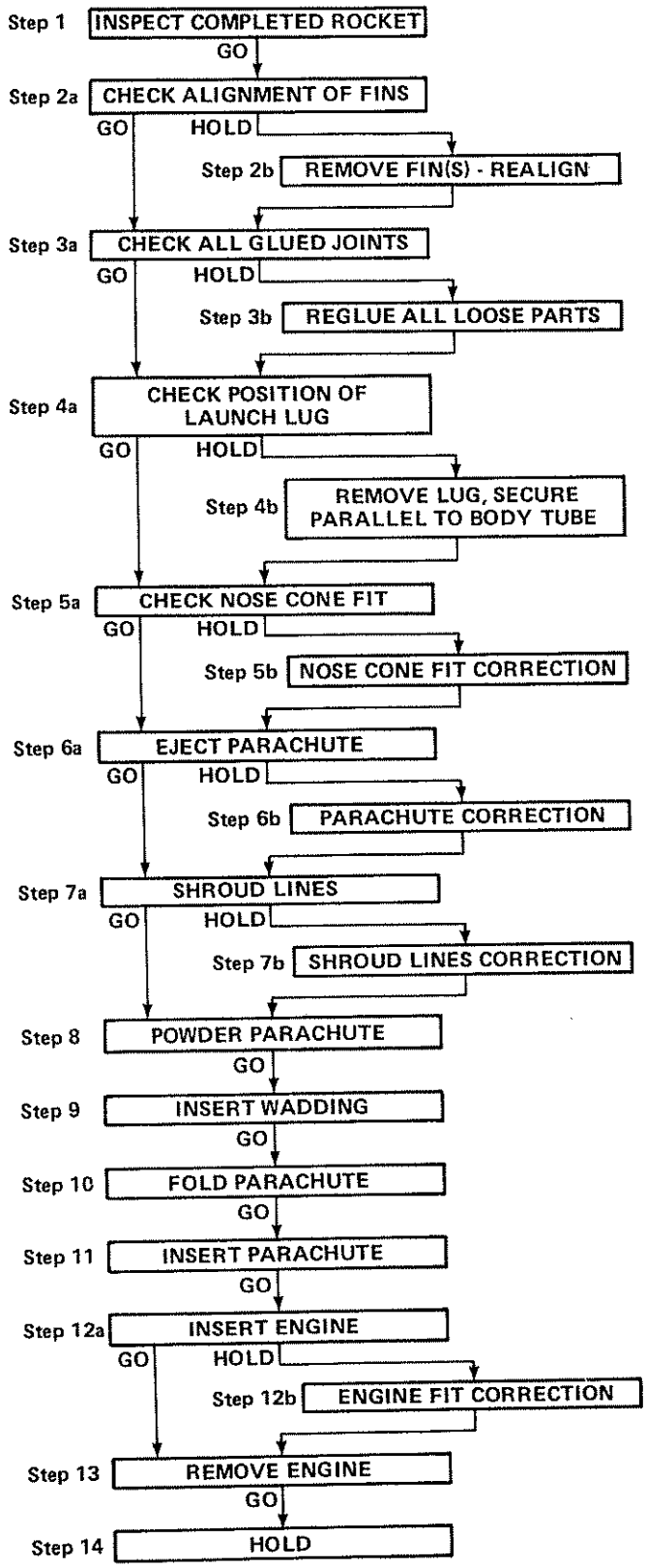
Step 7 - MODEL ROCKETS PAINTED AND NAMED - All completed model rockets should be painted and named. Each participant should also put his or her name on the rocket.

The instructor may wish to award one or more prizes, usually a different model rocket kit or a model rocketry award certificate for the best model, the most artistic decoration, and/or the most creative name.

When Step 7 is completed successfully, GO to Step 8.

Step 8 - HOLD - This step is initiated to give the instructor built-in time to take care of any items necessary. The instructor at this time may go on to Phase #2 - RECROC INSPECTION or may wish to conduct this activity another day.

PHASE #2 - INSPECTION PROGRAM



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PHASE #2 — INSPECTION

Step 1 - INSPECT COMPLETED ROCKET - The RECROC Director or a Team Leader should inspect each model rocket visually. A quick inspection of this type can reveal most defects in craftsmanship and construction.

Step 2a - CHECK ALIGNMENT OF FINS - The fins on the rocket should be glued in such a way that they are perpendicular to the body tube and equally spaced when viewed at arm's length.

If correct, GO to Step 3a.

If incorrect, HOLD and proceed to Step 2b.

Step 2b - REMOVE FIN(S) - REALIGN - If the fins are not properly aligned, carefully remove them from the body tube by cutting them off with a small model knife. Cut exactly at the fin base - body tube joints. Use extreme care as this step could, if not properly done, result in damaged fins. Sand body tube and fins to smooth, and reglue fins in proper position.

Step 3a - CHECK ALL GLUED JOINTS - Have participants pull or tug on all glued parts to see that they are secure. This step is done after glue has dried.

If correct, GO to Step 3a.

If incorrect, HOLD and proceed to Step 3b.

Step 3b - REGLUE ALL LOOSE PARTS - Remove any loose, unglued, or improperly glued parts and reglue properly. Once problem is corrected, GO to Step 4a.

Step 4a - CHECK POSITION OF LAUNCH LUG - The launch lug is the tiny "straw(s)" located on the body tube, parallel to the body tube. If model has more than one launch lug, they must be aligned exactly so model does not bind on the launch rod.

If correct, GO to Step 5a.

If incorrect, HOLD and proceed to Step 4b.

Step 4b - REMOVE LUG, SECURE PARALLEL TO BODY TUBE - Very carefully work the launch lug free from the body tube (and from the fin if it touches one) with a sharp model knife. Reglue the lug(s) in the proper position.

When correct, GO to Step 5a.

Step 5a - CHECK NOSE CONE FIT - The nose cone should fit into the body tube securely, but not tightly. Nose cone should come out from body tube when rocket's body tube is grasped in center by one hand and "snapped" forward.

If correct, GO to Step 6a.

If incorrect, HOLD and proceed to Step 5b.

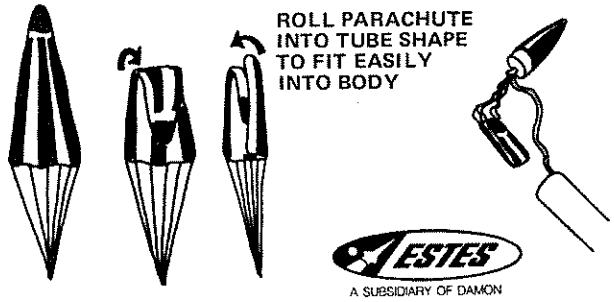
Step 5b - NOSE CONE FIT CORRECTION - If nose cone is too tight, carefully sand the shoulder of the nose cone till correct fit is obtained. If nose cone is too loose, wrap masking tape around shoulder of nose cone until desired fit is obtained.

Step 6a - EJECT PARACHUTE - Parachute should eject (come out of body tube) when nose cone is ejected in Step 5a.

If correct, GO to Step 7a.

If incorrect, HOLD and proceed to Step 6b.

Step 6b - PARACHUTE CORRECTION - If parachute fails to eject when nose cone is snapped from body tube in Step 5a, check to make sure parachute is properly folded and/or rolled to slide freely in body tube. See that all shroud lines are securely attached and not tangled. Retest to make sure parachute passes the test.



Hold the parachute at its center and pass the other hand down it to form a "spike" shape. Fold this spike in two and pack into the tube. Roll folded parachute into tube shape to fit easily into body tube. Pack the shroud lines and shock cord in on top of the parachute and slip the nose cone into place.

GO to Step 7a upon successful completion of this step.

Step 7a - SHROUD LINES - Shroud lines should be securely attached to nose cone and parachute. They should be of equal lengths and free from knots and tangles.

If correct, GO to Step 8a.

If incorrect, HOLD and proceed to Step 7b.

Step 7b - SHROUD LINES CORRECTION - Untangle shroud lines if possible. If they cannot be untangled easily, remove from nose cone assembly, untangle, and reattach. If they are too tangled, carefully remove shroud lines from parachute and tape six new lines in place with fresh tape discs.

GO to Step 8a.

Step 8 - POWDER PARACHUTE - Unfold the parachute and sprinkle a small amount of ordinary talcum powder or baby powder on both sides of the parachute. This will prevent parachute from sticking together and failing to open properly during recovery.

Step 9 - INSERT WADDING - Secure the amount of recovery wadding called for in the instructions. Remove nose cone and pull parachute and all folded shock cord from body tube. Insert wadding into body tube between parachute and engine. Do not tangle recovery wadding with shock cord. The wadding is used to protect the parachute during the operation of the ejection charge in the rocket engine.

Step 10 - FOLD PARACHUTE - The parachute should be folded properly to insure a safe recovery. Fold the parachute according to the directions in Step 6b. The parachute must open properly if it is to do its job.

Step 11 - INSERT PARACHUTE - Insert folded parachute into rocket body tube being careful not to tangle parachute or damage shock cord or wadding previously inserted. Parachute, shroud lines, and shock cord should rest above recovery wadding. The shroud lines may be folded loosely around parachute before inserting parachute into rocket body tube or may be wrapped around two slightly spread fingers (index and middle) into a loop and then inserted into body tube along with shock cord. Re-insert nose cone making certain it does not trap a shroud line or shock cord against body tube.

Step 12a - INSERT ENGINE - Engine should be inserted into engine holder tube which is located inside rear of body tube. The engine's nozzle should be pointed outward.

If correct, GO to Step 13.

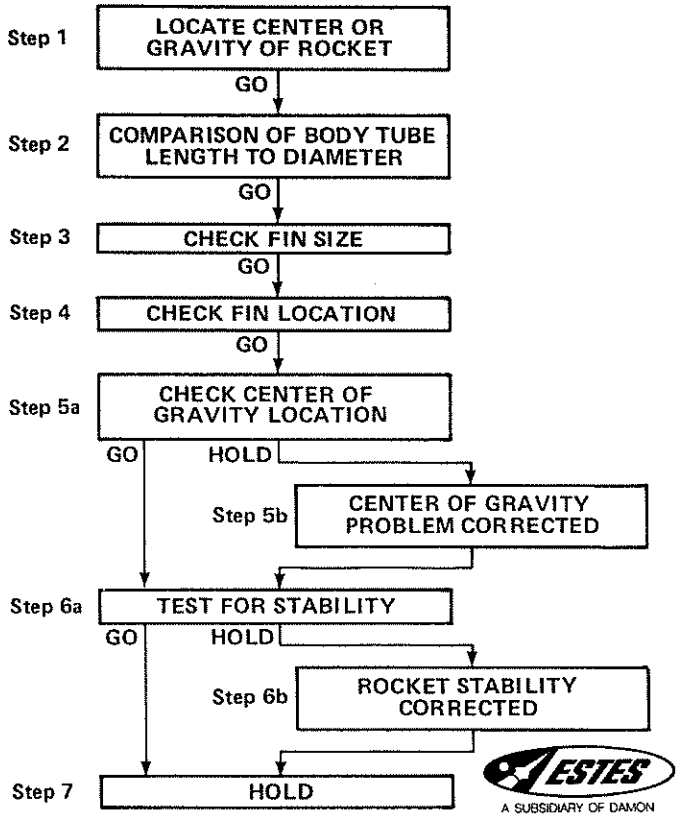
If incorrect, HOLD and proceed to Step 12b.

Step 12b - ENGINE FIT CORRECTION - If engine is too loose, wrap masking tape around engine until it is secure. If engine does not fit into engine holder tube, check engine holder tube for obstructions. Correct any obstructions and re-insert engine properly.

Step 13 - REMOVE ENGINE - Engines may be removed by grasping engine and pulling gently, making sure engine hook is "retracted" first.

Step 14 - HOLD - This is a built in HOLD so the leader may insert any special steps needed or as a good stopping point for a session's activities.

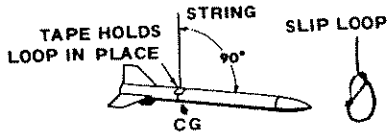
PHASE #3 – STABILITY PROGRAM



PHASE #3 - STABILITY

Step 1 - LOCATE CENTER OF GRAVITY OF ROCKET - The Center of Gravity (CG) is the point at which all the weight of the rocket is balanced. This test is made with an unused model rocket engine in place. It is found by taking a piece of string (should be at least six feet long), putting a loop in the string large enough to slide over the body tube, and placing the loop over the body tube. Move the loop forward and backward until the point at which the rocket is balanced is found. This is the rocket's Center of Gravity. Mark this point CG.

Make the test on your model by forming a loop in the end of a six to ten foot string. Install an engine in the rocket. (The center of gravity is always determined with an engine in place.) Slide the loop to the proper position around the rocket so the model balances horizontally. Apply a small piece of masking tape to hold the string in place.



Step 2 - COMPARISON OF BODY TUBE LENGTH TO DIAMETER - The length of the body tube should be at least 10 times the diameter of the body tube to give your rocket maximum stability.

Step 3 - CHECK FIN SIZE - The fins on the model rocket should be large. Large fins provide better stability. The fins should be the size specified in the kit.

Step 4 - CHECK FIN LOCATION - Fins are normally located at the rear of the rocket. Fins should be placed as far aft (to the rear) as possible to assure stability in flight.

Step 5a - CHECK CENTER OF GRAVITY LOCATION - The CG should be at least 1/2 of an inch in front of the fins

If it isn't, HOLD and proceed to Step 5b.

If it is, GO to Step 6a.

Step 5b - CG PROBLEM CORRECTED - If the CG is behind the specified location, it may be moved forward by adding small weights (washers under screw eye or clay inside hollow plastic nose cone) to the nose cone assembly. When a retest shows CG inproper place, GO to Step 6a.

Step 6a - TEST FOR STABILITY - When the CG is in the right place, proceed to test for stability. Stability means that a rocket will keep its nose pointed in the same direction throughout its upward flight. The easiest way to test for stability is to fly the rocket overhead attached to the string used to find the CG. Use the same string you used to find the CG secured in place at the CG with a small piece of masking tape. Carefully whirl the rocket above and around your head. This must be done in a large open area to avoid hitting anything or anyone.

The rocket should fly overhead straight and level with the nose pointed forward at all times.

If successful, GO to 7a.

If unsuccessful, GO to 6b.

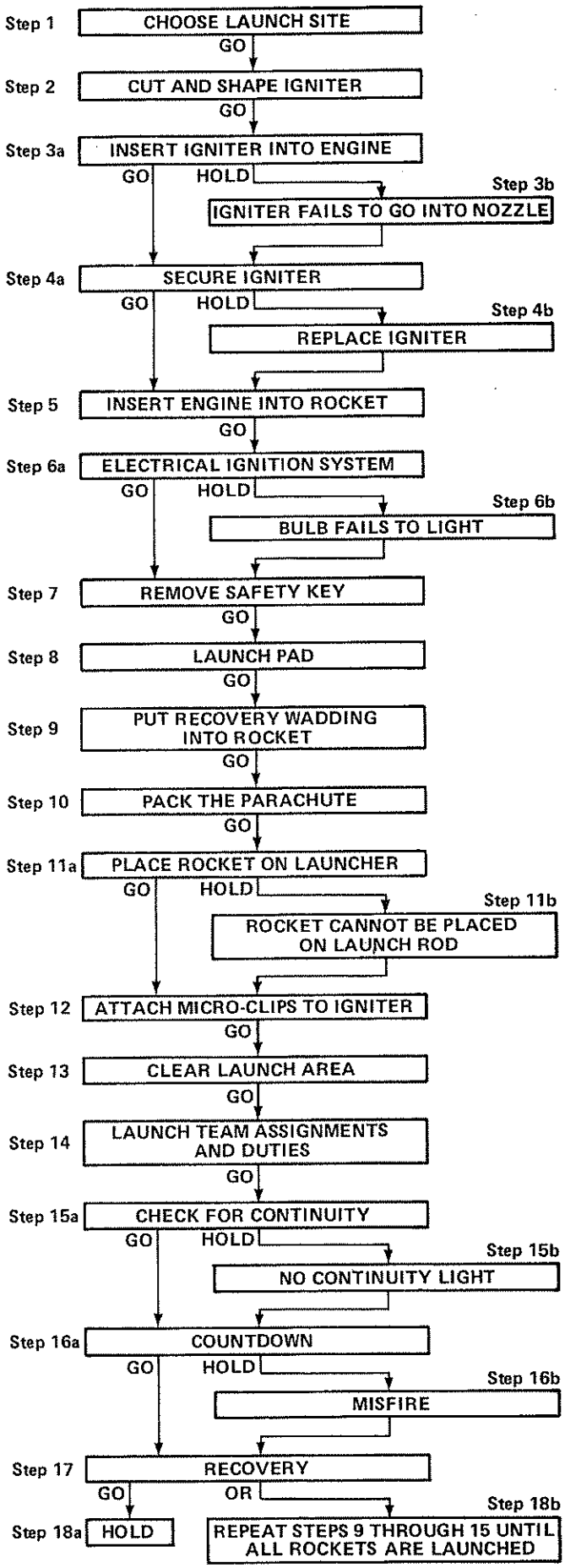
Step 6b - ROCKET STABILITY CORRECTED - If the nose fails to maintain a forward and level direction throughout the overhead flight test, change the CG by adding additional weight to the nose cone. Repeat the stability test.

If successful, GO to 7.

If unsuccessful, the rocket may need larger fins, a time-consuming operation. The rocket must not be flown until it passes this stability test.

Step 7 - HOLD - Proceed to Phase #4, LAUNCHING PROGRAM.

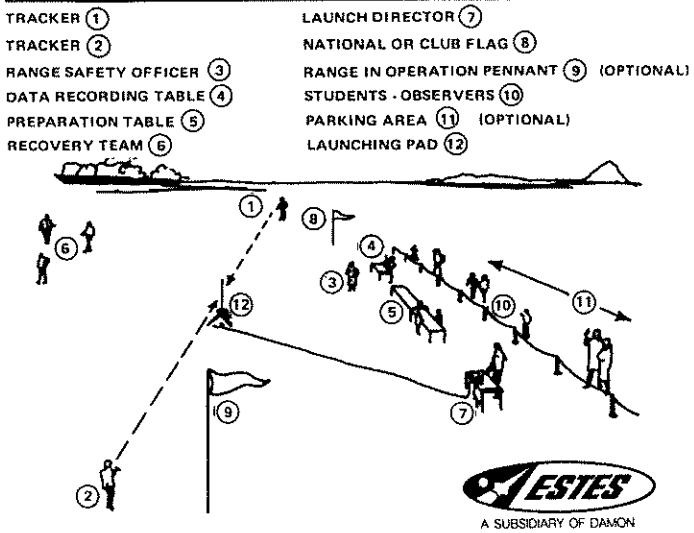
PHASE #4 LAUNCHING PROGRAM

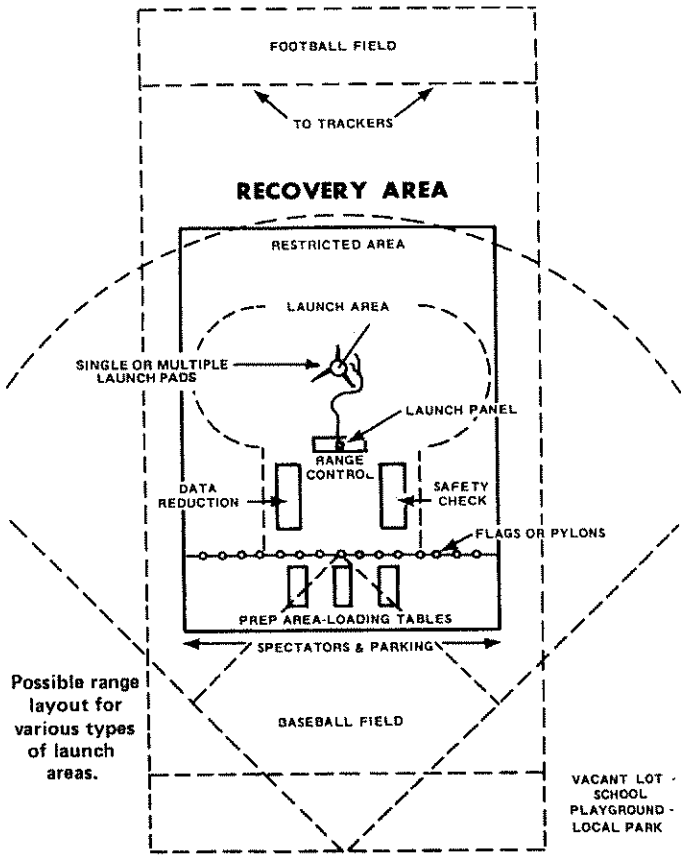


PHASE #4 - LAUNCHING

Step 1 - CHOOSE LAUNCH SITE - Choose an appropriate area for launching your model rocket. An open field, free from homes, power lines, airports, and aircraft is suitable.

Engine Size	Altitude Range (depending on rocket size and weight)	Approximate Altitude in a typical 1 oz. model
1/4A3-2	50' to 250'	100'
1/2A6-2	100' to 400'	190'
A8-3	200' to 650'	450'
B6-4	300' to 1000'	750'
C6-5	350' to 1500'	1000'
(Some high performance models will reach higher altitudes than shown above.)		





Possible range layout for various types of launch areas.

At this time, review with the participants the National Association of Rocketry (NAR) Model Rocket Safety Code. Read each rule aloud. Insist that all rocketeers learn each rule. Make sure that all rocketeers follow the safety code.

1. **CONSTRUCTION** – My model rockets will be made of lightweight materials such as paper, wood, plastic, and rubber, without any metal as structural parts.
2. **ENGINES** – I will use only pre-loaded factory made model rocket engines in the manner recommended by the manufacturer. I will not change in any way nor attempt to reload these engines.
3. **RECOVERY** – I will always use a recovery system in my model rockets that will return them safely to the ground so that they may be flown again.
4. **WEIGHT LIMITS** – My model rocket will weigh no more than 453 grams (16 ozs.) at liftoff and the engines will contain no more than 113 grams (4 ozs.) of propellant.
5. **STABILITY** – I will check the stability of my model rockets before their first flight except when launching models of already proven stability.
6. **LAUNCHING SYSTEM** – The system I use to launch my model rockets must be remotely controlled and electrically operated and will contain a switch that will return to "off" when released. I will remain at least 10 feet away from any rocket that is being launched.
7. **LAUNCH SAFETY** – I will not let anyone approach a model rocket on a launcher until I have made sure that either the safety interlock key has been removed or the battery has been disconnected from my launcher.
8. **FLYING CONDITIONS** – I will not launch my model rocket in high winds, near buildings, power lines, tall trees, low flying aircraft, or under any conditions which might be dangerous to people or property.
9. **LAUNCH AREA** – My model rockets will always be launched from a cleared area, free of any easy to burn materials, and I will only use non-flammable recovery wadding in my rockets.
10. **JET DEFLECTOR** – My launcher will have a jet deflector device to prevent the engine exhaust from hitting the ground directly.
11. **LAUNCH ROD** – To prevent accidental eye injury I will always place the launcher so the end of the rod is above eye level or cap the end of the rod with my hand when approaching it. I will never place my head or body over the launching rod. When my launcher is not in use I will always store it so that the launch rod is not in an upright position.
12. **POWER LINES** – I will never attempt to recovery my rocket from a power line or other dangerous places.
13. **LAUNCH TARGETS & ANGLE** – I will not launch rockets so their flight path will carry them against targets on the ground, and will never use an explosive warhead nor a payload that is intended to be flammable. My launching device will always be pointed within 30 degrees of vertical.
14. **PRE-LAUNCH TEST** – When conducting research activities with unproven designs or methods, I will, when possible, determine their reliability through pre-launch tests. I will conduct launchings of unproven designs in complete isolation from persons not participating in the actual launching.

Step 2 - CUT AND SHAPE IGNITER - Igniters are usually sold in strips of three. For Astron igniters, carefully cut igniters between the brown chemical coatings on metal wire. Cut the bare metal wire only in the center between coating sections. Do not cut near the brown coating as this section of the igniter must be inserted completely into the rocket engine nozzle for proper ignition. Carefully fold the igniter into a "V" shape with the center of the "V" in the center of the coating.

Solar igniters come pre-formed and taped into strips of three. Cut igniters apart by cutting tape strip midway between igniters. Leave the tape attached.

Step 3a - INSERT IGNITER INTO ENGINE - Place the bent igniter into the nozzle, making sure the bend in the igniter touches the bottom of the nozzle. The igniter must be inserted into the nozzle as far as possible. Only the bare metal wires should be visible extending from the nozzle.

If ok, GO to Step 4a.

If not ok, HOLD and proceed to Step 3b.

IGNITER INSTALLATION

Push the igniter into the engine as far as it will go. To operate properly the igniter must touch the propellant grain. Apply a square of masking tape to the nozzle and leads as shown. Attach micro clips to igniter as close to nozzle as possible.

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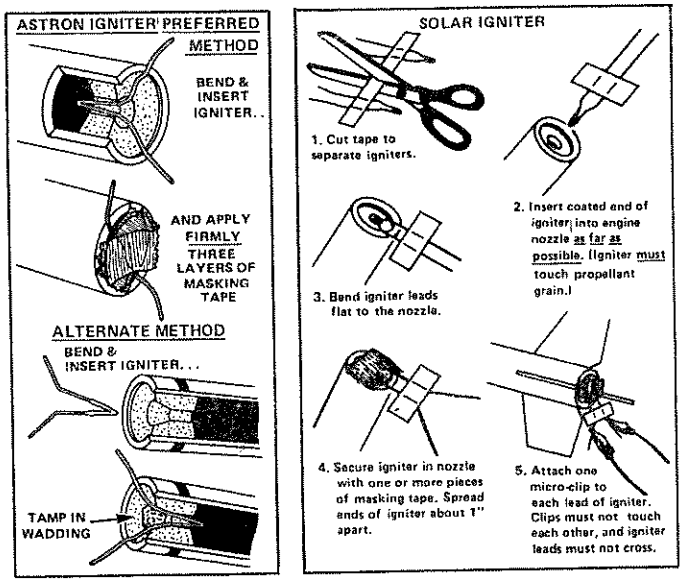


Step 3b - IGNITER FAILS TO GO INTO NOZZLE - If igniter fails to go into nozzle opening easily, check igniter and nozzle for obstructions. Fold igniter wire tighter, if using Astron igniter, make sure "V" shape is maintained. Be sure the igniter "V" makes contact at bottom of nozzle.

Step 4a - SECURE IGNITER - Two 1/2 inch squares of masking tape may be very firmly pressed into place, one securing the igniter to the engine and the other re-enforcing it, to hold the spread igniter wires securely to the rear of the nozzle. Another method is to roll a piece of wadding about 1/2 inch square into a small ball. Place this wadding behind the igniter and press down firmly into the nozzle with pen or pencil point. If inserted securely, wadding will hold igniter inside engine ready for launch.

If all right, GO to Step 5.

HOLD and proceed to Step 4b if the igniter do not appear to be securely held in place.

Step 4b - REPLACE IGNITER - If igniter fails to stay in engine, or breaks, remove igniter and old wadding. Repeat Steps 3a and 4a. Use a new igniter if necessary being sure to press firmly with pen or pencil. A larger piece of wadding may be indicated, or the igniter may be secured in place using masking tape.

Step 5 - INSERT ENGINE INTO ROCKET - Follow same procedure as Phase #2 Step 12a. Engine should be inserted into engine holder tube which is located inside rear of body tube. The engine's nozzle (with igniter securely in place) should be pointed outward.

Step 6a - ELECTRICAL IGNITION SYSTEM - The rocket engine will be ignited electrically using the Electrical Ignition System (Launch Control System) provided in the Deluxe Starter Kit.

Launch Control System should have been assemblied earlier. In this step you will recheck to be sure it functions properly.

Before connecting the ignition system to the rocket engine, the following components should be checked:

Batteries - The batteries should be new with contact points clean. Always use alkaline batteries (dry cells).

Micro-clips - Connect the micro-clips together. They should be clean and should attach securely to each other.

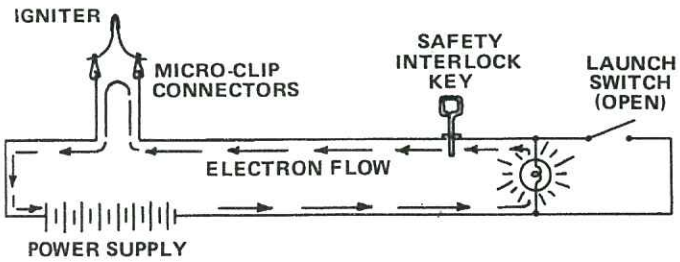
Safety Key - Insert Safety Key into its opening in the Launch Control System.

Continuity Light (small light bulb on unit) - This bulb should light when micro-clips touch and safety key is inserted. Remove key immediately as soon as bulb lights brightly.

If bulb fails to light, HOLD and proceed to Step 6b.

Step 6b - BULB FAILS TO LIGHT - Check all wire leads for short circuits or breaks. Check connections of wire leads to micro-clips. Check micro-clip pressure and cleanliness. Check batteries. Check light bulb. Repeat Step 6a. Do not proceed to Step 7 until Step 6a checks out properly.

IGNITION SYSTEM IN "READY" CONDITION



Step 7 - REMOVE SAFETY KEY - The Safety Key is a built-in safety feature of all Estes ignition systems. When removed, it is impossible for a model rocket to accidently be launched. The RECROC Director or Team Leader (the adult in charge) may be the Range Safety Officer. He or she is responsible for the safe and successful launchings of all model rockets. The Range Safety Officer is the only person authorized to insert and remove the Safety Key prior to and concluding each launch.

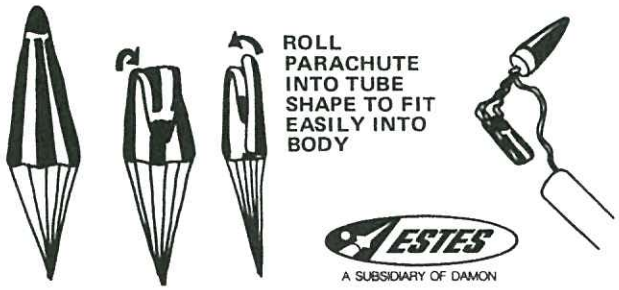
TURN OVER SAFETY KEY TO LEADER.

Step 8 - LAUNCH PAD - Rockets must be launched from a launch stand or launch pad to provide aerodynamic stability during the initial phase of flight. Reassemble the Porta-Pad launch pad which was constructed earlier.

Step 9 - PUT RECOVERY WADDING INTO ROCKET - Insert the required number of sheets (individual squares) of recovery wadding into the rocket body tube. The required number of sheet is stated in the kit instructions. The wadding should fill the body tube for a thickness of about twice the body tube diameter. The wadding should be slightly compressed to make a good seal, but not tight enough to completely block the body tube. If the wadding blocks the body tube, the wadding will prevent the ejection charge from ejecting the parachute and the model rocket may crash.

Step 10 - PACK THE PARACHUTE - Fold and carefully insert the parachute. You may follow the instructions in the kit. The following system works very well.

Hold the parachute at its center and pass the other hand down it to form a "spike" shape. Fold this spike in two and roll parachute into tube shape. Pack parachute into the tube on top of the wadding. Pack the shroud lines and shock cord in on top of the parachute and slip the nose cone into place.



Insert the nose cone after the parachute is inserted. Make sure the nose cone fits properly, not too tight or too loose.

Step 11a - PLACE ROCKET ON LAUNCHER - Carefully insert the 1/8" launch rod on the launch pad through the launch lug(s) glued on the rocket. The rocket should slide easily down the 1/8" launch rod to the base plate.

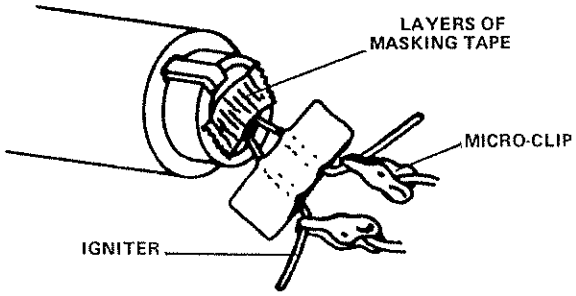
If ok, GO to Step 12.

If not, HOLD and proceed to Step 11b.

Step 11b - ROCKET CANNOT BE PLACED ON LAUNCH ROD - If rocket fails to slide up and down easily on standard launch rod, check launch lug(s) for obstruction. Make sure launch lug is parallel to the rocket body tube. Using some extra-fine sandpaper remove any debris which may have accumulated on the launch rod.

When rocket slides freely on launch rod, GO to Step 12.

Step 12 - ATTACH MICRO-CLIPS TO IGNITER - The micro-clips should be clean and should grasp the igniter securely. Be careful that the clips and the igniter wires are not shorted out by touching each other or the blast deflector plate. If necessary, use a engine casing from a used engine to raise the base of the rocket off the deflector plate to facilitate hookup of the micro-clips to the igniter. The micro-clips should be attached to the igniter leads as close to the engine nozzle as possible.



Step 13 - CLEAR LAUNCH AREA - Launch area should be cleared of all unnecessary personnel. Following the launch site drawings in Step 1, only the necessary people should be located at and around the launch site.

Step 14 - LAUNCH TEAM ASSIGNMENTS AND DUTIES - While each person will take a turn launching his or her own rocket, all participants should assist in the flight activities.

Range Safety Officer - The adult responsible for the launch is the Range Safety Officer. The Range Safety Officer will insert the safety key into the launch control unit to "arm" the ignition system after (1) seeing that all personnel are at their assigned locations and (2) making an inspection of the launch area for safety.

Launch Control Officer - Responsible for launch control unit and responsible for familiarizing participants with its operation. The Launch Control Officer may be authorized by the Range Safety Officer to insert and remove the safety key.

Launch Pad Supervisor - Supervises placement of rockets on pad and micro-clips on igniters. Each participant places his/her own rocket on the pad and connects the micro-clips to the igniters. The Launch Pad Supervisor checks rocket placement on pad and placement of micro-clips on igniters. He or she helps participants when necessary on these tasks.

Data Reduction Team- Communicates with Tracking Team by walkie-talkies. Receives reports from Tracking Team and uses tracking information to calculate apogee (highest point) for each flight and records this height along with name of each participant, name of each rocket, time of flight, and/or other needed data.

Tracking Team - Uses Altiscopes or other altitude tracking devices to determine data to compute height of each rocket's flight.

Recovery Team - Recovers rocket after flights, returning each to its owner. If practical, each rocket should be returned to launch area before the next rocket is launched.

Step 15a - CHECK FOR CONTINUITY - The Range Safety Officer will, after making sure Step 14 has been successfully completed, insert the safety key in launch control unit. If rocket is properly armed, the continuity light in the launch control unit should glow brightly.

If ok, GO to Step 16a.

If bulb does not light brightly, HOLD and proceed Step 15b.

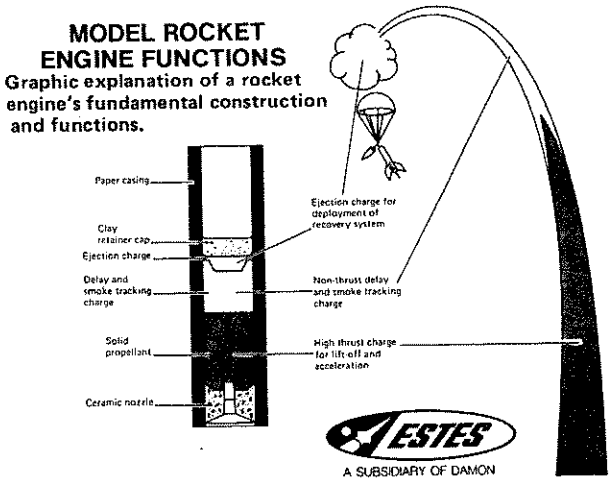
Step 15b - NO CONTINUITY LIGHT - If no continuity is indicated by failure of bulb to light, remove safety key. Have the Launch Pad Supervisor go and inspect the igniter and micro-clips. Reinsert Safety Key and check for continuity after Launch Pad Supervisor returns from pad area.

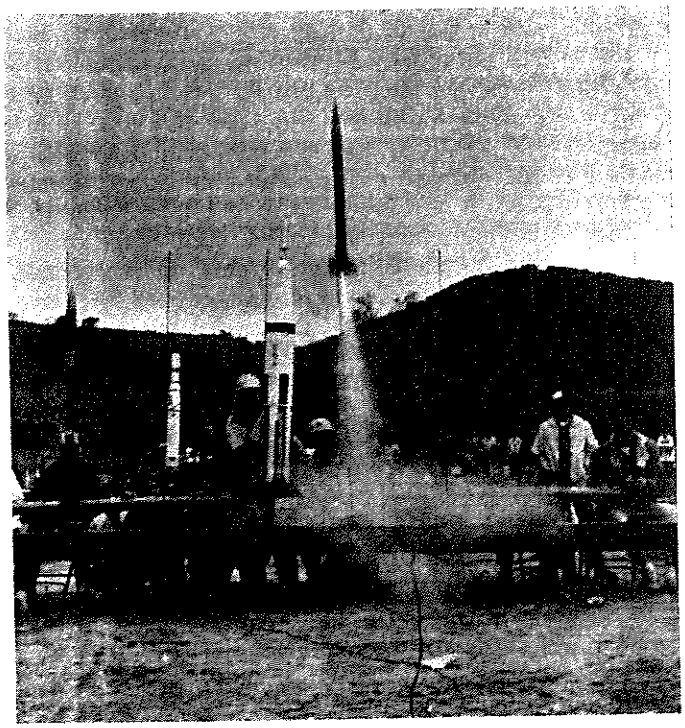
If bulb now lights, GO to Step 16a.

Step 16a - COUNTDOWN - The Safety Range Officer, using appropriate voice and hand signals, will lead the countdown and launch. Each participant will launch his or her own rocket.

If rocket fails to lift off, HOLD and proceed to Step 16b.

If rocket launches successfully, GO to Step 17.





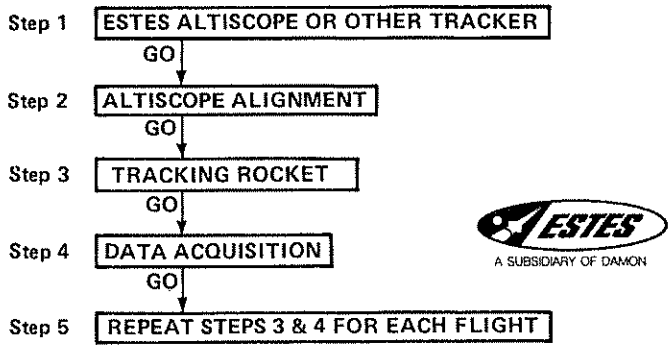
Step 16b - MISFIRE - *REMOVE SAFETY KEY. WAIT ONE MINUTE BEFORE GOING TO INSPECT ROCKET.* Check for burned out igniter. Replace igniter with a new one, if necessary. Check for loose connections. Go to necessary steps to correct problem, then resume and repeat countdown. Rocketeers who experience misfires may have to go to the end of the line to get another chance to launch.

Step 17 - RECOVERY - The Recovery Team will recover the launched rockets, returning each rocket to its owner at the pad before the next launch takes place. A long bamboo pole may be helpful in recovering rockets from trees. Never attempt to recover model rockets which become entangled in power or telephone lines. The proper municipal agency can be contacted for retrieval of models which become caught on electric or telephone lines.

Step 18a - HOLD - If this was the last RECROC launched.

Step 18b - REPEAT STEPS 9 THROUGH 15 UNTIL ALL ROCKETS ARE LAUNCHED - Go to Step 9 repeating each step for each rocket until all are launched. Two or three launch pads with their ignition systems may be used if they are properly spaced. Each one is used in rotation. This can greatly speed up launch operations, but requires extra care by everyone, especially by the Safety Officer, Launch Control Officer, and Launch Pad Supervisor.

PHASE #5 - TRACKING PROGRAM



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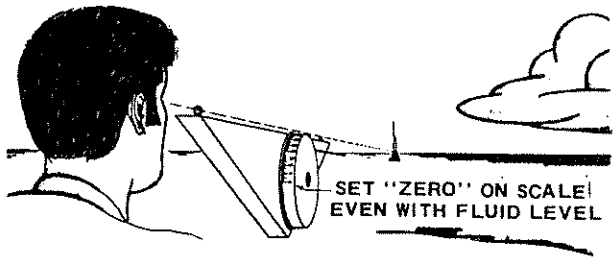
Phase #5 TRACKING

Step 1 - ESTES ALTISCOPE OR OTHER TRACKER - To compute the altitude (height) reached by each model rocket it will be necessary to use the Estes Altiscope or another altitude-measuring device.

Step 2 - ALTISCOPE ALIGNMENT - The Altiscope must be "zeroed in" or aligned. If it is a one-function, elevation-only tracking device, the reading should be zero when looking at the tip of the rocket on the pad. It should read 90 degrees (90°), when looking straight up. If there is a two-function altitude-measuring device, both the elevation-measuring part (vertical measurement) and the azimuth-measuring part (horizontal measurement) should be set at zero relative to the rocket on the launch pad.



"ZEROING IN" ON THE ROCKET WITH AN ALTISCOPE

Step 3 - TRACKING ROCKET - For each launch, either one or two tracking stations will determine and record the elevation (and possibly azimuth) data for the launch. Rocket should be tracked until it reaches apogee (its maximum height). Record the angle on the data acquisition records.

Step 4 - DATA ACQUISITION - The Data Acquisition Team will receive data from the tracking team and compute the height in the following manner: Using the Tangent Table, look up the tangent of the elevation angle. Multiply this number by the distance between the launch pad and the tracking station. This measurement is carefully made when the launch field is first

laid out and the launch pad and tracking stations marked. The result of multiplying the tangent of the tracked angle by the distnace between the launch pad and the tracking station is the height reached by the rocket. If the distance from the observer to the launch pad was measured in feet, the height will be in feet; if meters, the height will be in meters, etc. When more than one tracking station is used, an average of the altitudes determined may be used. If there is a variation of over 10% between the tracked altitudes calculated, the results should be discarded as unreliable and the rocket relaunched after all others rockets have been launched.

$$\text{Height} = \text{Tangent of tracked angle} \times \text{Distance between launch pad and tracking station}$$

Repeat Step 3 and 4 for each flight.

TABLE OF TANGENTS

Angle	Tan.	Angle	Tan.	Angle	Tan.	Angle	Tan.	Angle	Tan.
1°	.02	17	.31	33	.65	49	1.15	65	2.14
2	.03	18	.32	34	.67	50	1.19	66	2.25
3	.05	19	.34	35	.70	51	1.23	67	2.36
4	.07	20	.36	36	.73	52	1.28	68	2.48
5	.09	21	.38	37	.75	53	1.33	69	2.61
6	.11	22	.40	38	.78	54	1.38	70	2.75
7	.12	23	.42	39	.81	55	1.43	71	2.90
8	.14	24	.45	40	.84	56	1.48	72	3.08
9	.16	25	.47	41	.87	57	1.54	73	3.27
10	.18	26	.49	42	.90	58	1.60	74	3.49
11	.19	27	.51	43	.93	59	1.66	75	3.73
12	.21	28	.53	44	.97	60	1.73	76	4.01
13	.23	29	.55	45	1.00	61	1.80	77	4.33
14	.25	30	.58	46	1.04	62	1.88	78	4.70
15	.27	31	.60	47	1.07	63	1.96	79	5.14
16	.29	32	.62	48	1.11	64	2.05	80	5.67

A Flight Data Sheet such as this may be used to keep records on the flights made by team members.

ESTES

Model Rocket
FLIGHT DATA SHEET

USE ONE FLIGHT DATA SHEET FOR EACH MODEL. FOUR FLIGHTS MAY BE RECORDED ON EACH SHEET

PREFLIGHT INFORMATION

Rocket Name
Rocket Number
Date Completed
Type of Rocket
No. of Stages
Nose Cone Type
Fin Type
No. of Fins
Color Scheme
Weight Empty

COUNTDOWN CHECKLIST

Parachute or Streamer

- ☐☐☐☐ 12) Pack flameproof recovery wadding into the body tube. Insert the parachute or streamer.
- ☐☐☐☐ 11) Install the nose cone or payload section. Check condition of the payload (if any).
- ☐☐☐☐ 10) Apply masking tape to the engine(s) to achieve a tight friction fit in the body tube(s). When launching a multi-stage rocket be sure that the engines are in their proper relative positions and that a layer of cellophane tape is wrapped tightly around each engine joint.
- ☐☐☐☐ 9) Install an igniter in the engine
- ☐☐☐☐ 8) Place the rocket on the launcher. Clean and attach the micro-clips.
- ☐☐☐☐ 7) Clear the area, check for low flying aircraft, alert recovery crew and trackers.
- ☐☐☐☐ 6) Arm the launch panel.
- ☐☐☐☐ 5)
- ☐☐☐☐ 4)
- ☐☐☐☐ 3)
- ☐☐☐☐ 2)
- ☐☐☐☐ 1)
- ☐☐☐☐ LAUNCH!

Feather-weight or Tumble

- ☐☐☐☐ 10) Fit the engine in the body tube carefully so that the recovery system will function properly.
- ☐☐☐☐ 9) Install an igniter in the engine
- ☐☐☐☐ 8) Place the rocket on the launcher. Clean and attach the micro-clips.
- ☐☐☐☐ 7) Clear the area, check for low flying aircraft, alert recovery crew and trackers.
- ☐☐☐☐ 6) Arm the launch panel.
- ☐☐☐☐ 5)
- ☐☐☐☐ 4)
- ☐☐☐☐ 3)
- ☐☐☐☐ 2)
- ☐☐☐☐ 1)
- ☐☐☐☐ LAUNCH!

Boost-Glide

- ☐☐☐☐ 12) Check payload section (if used) and slide it into position.
- ☐☐☐☐ 11) Set trim adjustments for desired flight path and for existing weather conditions.
- ☐☐☐☐ 10) Check engine for proper fit in body tube.
- ☐☐☐☐ 9) Install an igniter in the engine
- ☐☐☐☐ 8) Place the rocket on the launcher. Clean and attach the micro-clips.
- ☐☐☐☐ 7) Clear the area, check for low flying aircraft, alert recovery crew and trackers.
- ☐☐☐☐ 6) Arm the launch panel.
- ☐☐☐☐ 5)
- ☐☐☐☐ 4)
- ☐☐☐☐ 3)
- ☐☐☐☐ 2)
- ☐☐☐☐ 1)
- ☐☐☐☐ LAUNCH!

LAUNCH

Flight Number		Flight #1	Flight #2	Flight #3	Flight #4
Date of Launch					
Launch Location					
Payload	Description				
	Weight				
Recovery System	Type				
	Color				
Engines	1st Stage				
No. of / Type	2nd Stage				
	3rd Stage				
Total Weight					
Method of Launch					
Launch Angle					
Predicted Altitude					

WEATHER

Wind Direction				
Wind Velocity				
Humidity				
Temperature				
Visibility				
Remarks				

FLIGHT DATA

Altitude	Estimated				
	Tracking Information				
	Computed Alt.				
Flight Duration					
Stability Information					
Flight Performance					

PHASE #6 - RECOVERY PROGRAM

Step 1 RECOVERY TEAM RECOVERS ROCKET

GO

Step 2 GO TO PHASE 4 AND PROCEED WITH LAUNCHES, REPEATING STEPS UNTIL ALL FLIGHTS ARE COMPLETED.

No further explanation necessary!

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FUTURE RECROC PROGRAMS

Obviously the difficult task of organizing, planning, and conducting any new program in the community is convincing the "Town Fathers" or those who will sponsor the program of its merit so that the program may be formally offered. The next major problem is attracting new prospects into the program to get it started. Once established, growth and expansion of RECROC Programs is up to the imagination of the RECROC Director and the enthusiasm of the municipality, Team Leaders, and Team Members.

Directors of the RECROC Program are advised to contact other people in the field who have done similar projects for their comments and suggestions. Likewise, it is suggested that the people responsible for the success of the RECROC Program be given recognition. Such recognition is mutually beneficial for the "Town Fathers" and the participants in the program and will give witness of the success of the on going RECROC program in the community.

Suggestions for future, more advanced activities are contained in many publications. Among the publications which will be especially useful are the following Estes Industries publications:

Aerospace Education and Model Rocketry, Second Edition (2816) (A detailed guide for leaders and teachers.)
Model Rocketry — The Space Age Teaching Aid (2840) (Basic leader's and teacher's guide.)
Model Rocketry Technical Manual (2819) (An excellent reference on almost everything.)
Model Rocket Contest Guide (2815) (How to plan and conduct contests.)
Estes Guide for Aerospace Clubs (2817) (How-to book for organizing and operating a model rocket club; many useful ideas.)
Alpha Book of Model Rocketry (2820) (Excellent beginner's guide.)
Camp Leader's Model Rocketry Manual, Second Edition (2822) (Provides many good ideas on operating a model rocketry program.)
Model Rocket News Library Collection (84775) (Back issues of Model Rocket News magazine in a binder.)
Model Rocketry Library Collection (2818) (Copies of most Estes publications except Model Rocket News in a binder.)
Projects in Model Rocketry (2831) (Idea book for model rocketry projects.)
Model Rocketry Study Guide TR-8 (84728) (A sequenced learning guide for becoming an expert model rocketeer)
Technical Reports and Technical Notes - An excellent series of references on advanced topics in model rocketry.
Other helpful publications are available from Estes Industries.

The authors of this manual and Estes Industries welcome your criticisms and suggestions. Please send all comments to us in care of Bob Cannon, Education Director, Department 123, Estes Industries, Box 227, Penrose, CO 81240, or to John A. O'Hara, Kearny Space and Science Center, 65 Seeley Avenue, Kearny, NJ 07032.

Note: Through a similar RECROC Program in the Town of Kearny, NJ in 1975, the Mayor and Council of the Town of Kearny through a Capitol Improvement Bond provided funds for the townspeople, primarily the young people in this instance, to begin construction on their own space and science center in and for the townspeople of Kearny, NJ. The center will give the townspeople of Kearny and neighboring communities the opportunity to participate to an even greater extent in the RECROC Program and the other Aerospace Education Programs which RECROC Director John O'Hara has provided for his town.

Perhaps your community, once a successful RECROC Program is established, will undertake a similar project. You are welcomed to contact John O'Hara for a more detailed description of the Kearny Space and Science Center.

RECROC FLOW CHART SUMMARY

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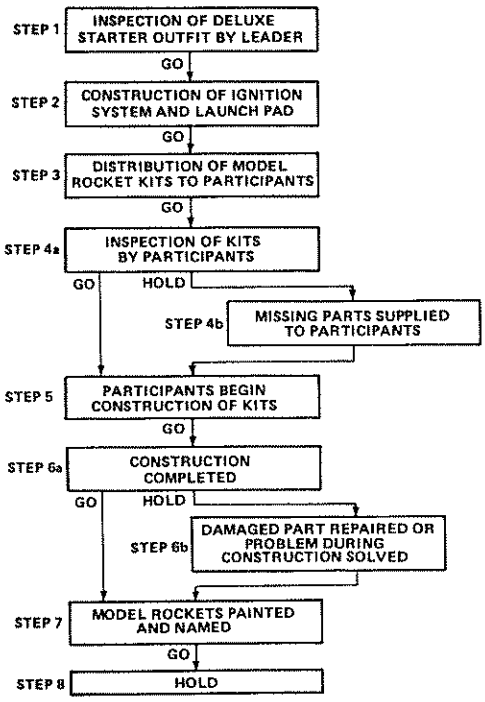
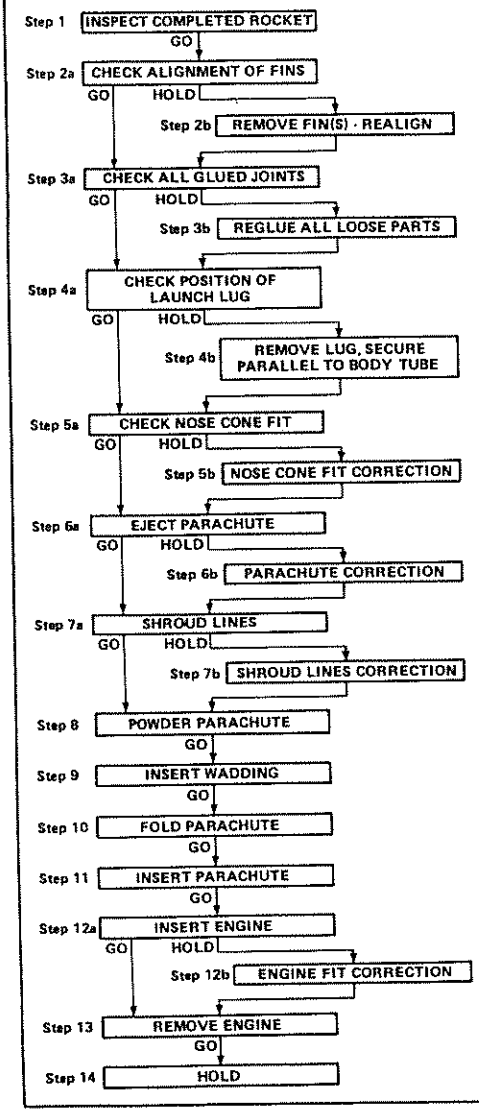
PHASE #1 – RECROC ASSEMBLY

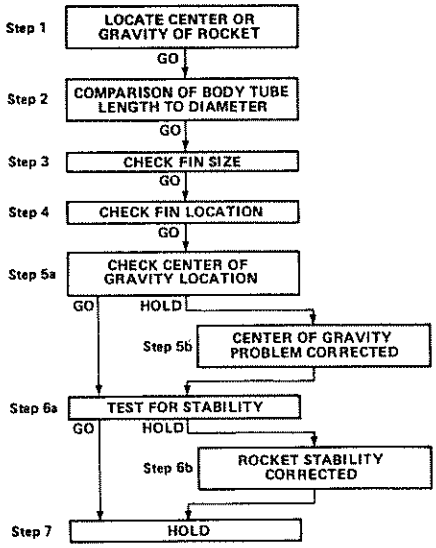


END OF PHASE #1. GO TO PHASE #2.

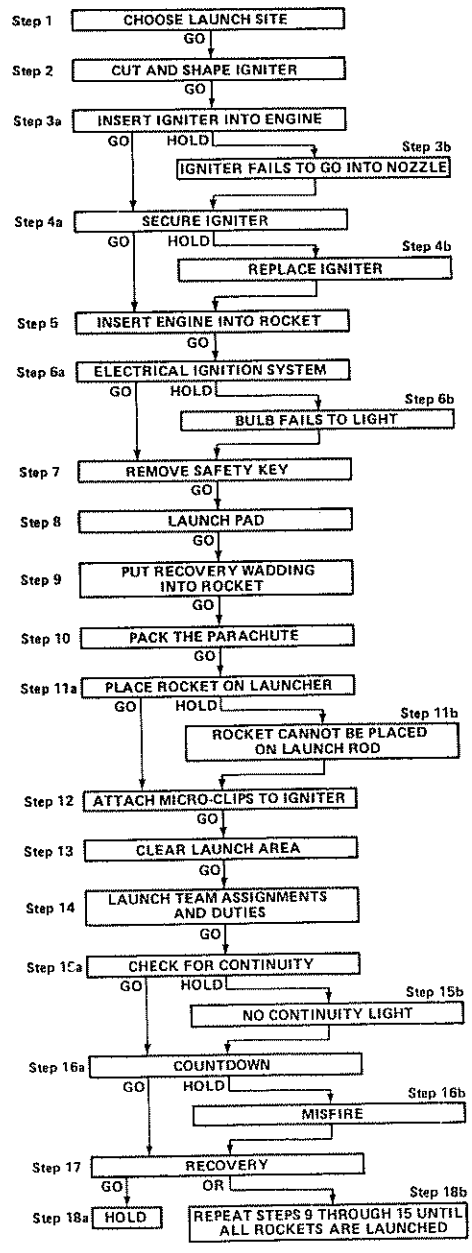
PHASE #2 – INSPECTION PROGRAM



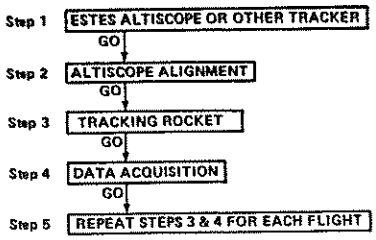
PHASE #3 – STABILITY PROGRAM



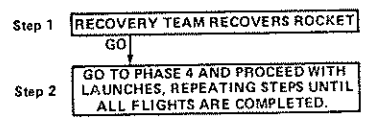
PHASE #4 – LAUNCHING PROGRAM



PHASE #5 – TRACKING PROGRAM



PHASE #6 – RECOVERY PROGRAM



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PENROSE, COLO. 81240

SCHOOL & CLUB ORDER FORM

Dept. 123

FOR OFFICE USE ONLY	
Customer No.	Estes Order No.
Processed By:	Date
1.	3.
2.	SC Dept. 123

SHIP TO _____

School or Organization _____

Address _____

City _____ State _____ Zip _____

SOLD TO _____

Billing Address _____

City _____ State _____ Zip _____

Purchase Order # _____

IMPORTANT – BE SURE TO READ!
If any item listed on this order is out-of-stock, you are authorized to substitute with a suitable replacement of equal or greater value.

_____
Authorized Signature

OPEN ACCOUNT REQUIREMENTS: Minimum Order $50.00. Purchase Order or Letterhead required on first order and where needed by Estes to obtain payment. Additional credit may not be extended on past due accounts. Open account payment terms net 30 days.

Is this your first order? ☐ Yes ☐ No Last order over one year ago? ☐ Yes ☐ No

OFFICE USE	QTY.	CAT. NO.	DESCRIPTION	PRICE EA.	TOTAL

SHIPPING TERMS:
ORDERS ARE SHIPPED F.O.B. PENROSE, COLORADO. FREIGHT OR POSTAGE USUALLY AVERAGES 8%. FULL SHIPPING CHARGES BILLABLE ON OPEN ACCOUNT ORDERS. PREPAID ORDERS OF OVER $20.00 WILL BE SHIPPED POSTPAID.

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Less _____ Discount _____
Add Estimated Postage (8%) _____
TOTAL $

"Estes is an equal opportunity employer."

"Prices subject to change without notice."

SCHOOL ORDERS:

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PREPAID SCHOOL ORDERS (PAYMENT SENT WITH ORDER) WILL BE SHIPPED POSTPAID. PREPAID SCHOOL ORDERS WILL RECEIVE DISCOUNTS AS FOLLOWS:

Amount (gross) of order	Discount
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$50-99.99	20%
$100 +	25%

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THE MINIMUM OPEN ACCOUNT ORDER IS $50. OPEN ACCOUNT ORDERS MUST BE SUBMITTED ON SCHOOL REQUISITION FORMS OR PURCHASE ORDER FORMS. Open account privileges are available to all public and private schools in the continental USA on orders of $50 or more. ALL OPEN ACCOUNT ORDERS ARE SHIPPED FOB PENROSE. SHIPPING CHARGES BILLABLE ON OPEN ACCOUNT ORDERS. Open account school orders will receive discounts as follows:

Amount (gross) of order	Discount
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Club and youth group orders receive the same discount, open account, and shipping charge policies as apply to schools. All club orders must be accompanied by a purchase order or be placed on the sponsor's letterhead stationery with authorized signature. Clubs must be school-sponsored or associated with a recognized civic or national organization (such as Boy Scouts of America, National Association of Rocketry, YMCA, Boys Clubs, 4-H, church group, recreation dept., Kiwanis, Lions Club, Optimists, or similar group).

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EFFECTIVE JANUARY 1978

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