GERMAN V-2

WW II BALLISTIC MISSILE
'TOUCHSTONE TO THE STARS'

On September 8, 1944, a large, streamlined object hurtled from space towards Great Britain. At 6:43 P.M., traveling nearly 2,000 miles per hour, it struck the quiet London suburb of Chiswick-on-Thames with an earth-rocking explosion. A second object fell on London just sixteen seconds later. Launched only minutes earlier from a mobile unit in German occupied Netherlands, this was the world's first encounter with Hitler's V-2 rocket, the second of his Vergeltungswaffen, or Vengeance Weapons. Two V-2 missiles had been launched unsuccessfully against Paris two days earlier.

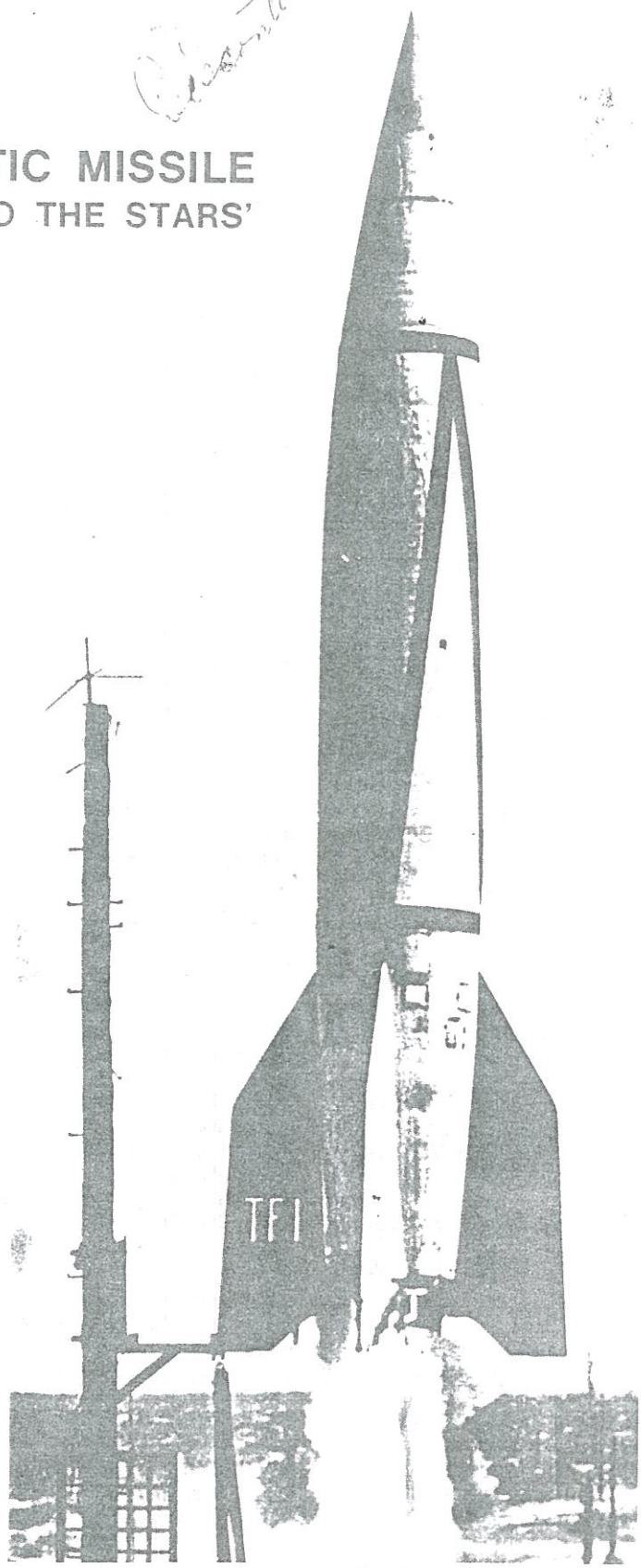
Although dwarfed by space boosters and missiles of today, it was a giant for its time. Standing 46 feet high with a diameter of 5-1/2 feet, the V-2 weighed just over 28,000 pounds. It could deliver a combined explosive payload and warhead weighing over one ton (2,200 pounds) to a target 200 miles away.

The guidance compartment was divided into four sections and contained radio equipment, steering gyros, batteries and compressed air cylinders. Four removable panels provided easy access for pre-launch adjustments. Two large, aluminum tanks containing the liquid fuel and oxidizer were located in the main body section. The tail section included the propulsion unit and its pumps as well as the stabilizing fins and attitude control vanes. Using turbopump-fed liquid oxygen and an alcohol-water mixture, the rocket engine produced an average sea-level thrust of 56,000 pounds. A generator which combined hydrogen peroxide and potassium permanganate provided steam to drive the turbopumps. Missile construction consisted of a 2-millimeter thick steel skin over a lightweight supporting framework.

V-2 FLIGHT PROFILE

Launched vertically, the missile climbed slowly from its stand. Four seconds after lift-off, a programmed one-degree-per-second tilt began until an angle of 47 degrees from the vertical was attained. At 25 seconds and an altitude of 2 miles, the rocket reached sonic speed, or Mach-1. (Figures given are approximate since target distances and trajectories varied.) Maximum dynamic pressure was reached at 42 seconds while traveling 1,476 mph (Mach-2) at an altitude of 6.2 miles. An engine cut-off signal was given at about 63 seconds. Following shut-down at an altitude of 15.5 miles, the missile reached a max. speed of 3,355 mph (Mach-4.5) and had traveled 13 miles from the launch site. During the powered phase, steering vanes controlled the V-2's flight path. After coasting unguided to a peak altitude of 50 miles, it began a downward arc towards the target. Upon re-entering the denser atmosphere (altitude - 18.6 miles), exterior skin temperatures often reached 1,000°F. Early missiles often broke apart due to the high speed and severe aerodynamic stresses. Slowing to a velocity of 1,800 mph at impact, the V-2 reached its target just 5-1/2 minutes after launch.

Normally used against large targets, average range was 190 miles. V-2's using beam-rider guidance achieved an impact accuracy of ± 1-mile. The long, cylindrical shape and dark green paint job earned it the nickname "Cucumber". Unlike the smaller aircraft-type V-1 robot bomb, there was literally no defense against the V-2 once it had been launched. As the world's first operational intermediate-range missile, it represented a turning point in modern warfare.



COURTESY US ARMY – WHITE SANDS MISSILE RANGE

ESTES

A SUBSIDIARY OF DAMON

V-2 DEVELOPMENT

Early in 1930 the German Army began looking for a superior weapon system which was not prohibited to them by the Treaty of Versailles. A group of four men began a small scale effort at Kummersdorf near Berlin to find out what could be done with solid and liquid-fueled rockets. In March of 1936, decisions were made which began to shape the V-2. At that time the missile was known as the A-4, or Aggregate-4, meaning "assembly number four".

Obviously, a permanent, fixed launching base would be vulnerable to enemy aircraft. It was decided that the rocket should be mobile, small enough to be shipped on normal roads, even through small villages, or on a single railroad car through all European railroad tunnels. Research reached its peak in 1943 at the Peenemunde test facility located in Northern Germany along the Baltic coast. One area was used by the Air Force for testing of the V-1 glide bombs, jato's, jet aircraft, and various guided missiles. An even larger Army Experimental Station employed almost 17,000 engineers and workers. It was commanded by General Walter Dornberger and his technical chief, Wernher von Braun. Both Dr. Dornberger and Dr. von Braun were part of the early research group formed in 1930.

The first successful A-4 launching took place on October 3rd, 1942. Following three earlier unsuccessful attempts, test vehicle number V-4 made a perfect, textbook flight. It broke all previous rocket records for speed, altitude, endurance and distance.

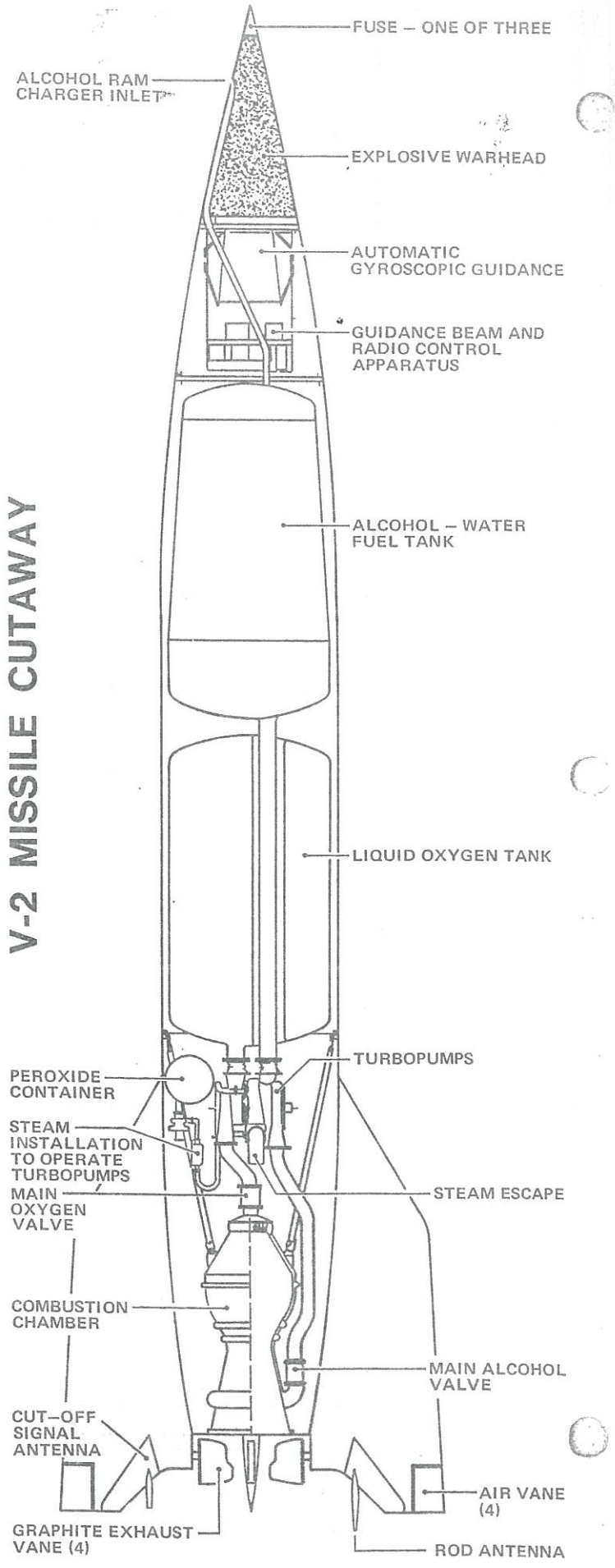
An enormous underground factory in the Harz Mountains eventually produced up to 30 missiles per day. It was commonly referred to as Mittlewerk meaning "Center Plant" so as not to reveal the location. Had Hitler supported efforts at Peenemunde prior to 1943, improved V-2 rockets plus operational Wasserfall antiaircraft missiles would have made Allied air supremacy over Germany more difficult. Altogether, 3,745 V-2's were launched between September 6, 1944 and March 27, 1945. Approximately 1,115 fell on England, 2,050 on Allied targets in Europe and 580 rockets were used for research and launch crew training.

PROJECT BUMPER

Following World War II, captured V-2 rockets were brought to the United States. They served as experimental vehicles at the nation's first missile testing center at White Sands Missile Range, New Mexico. From a five-year experimental program conducted at WSMR emerged the first of America's large missiles. By 1951, a total of 67 modified V-2's had been sent aloft over the New Mexico Desert. Between 1948 and 1950, the Bumper Project fired eight spectacular two-stage rockets. The V-2 nose was modified to accomodate a 16 foot long WAC Corporal rocket. Bumper-WAC No. 5 sent its upper stage to an altitude of 250 miles and a speed of 5,510 miles per hour -- the world's record at that time.

DOORWAY TO OUTER SPACE

Although the wartime V-2 suffered from many operational problems, it was a missile of many "firsts". The forerunner of today's intercontinental missiles, it proved to be the cornerstone of man's research into outer space. Following the first successful A-4 flight, Dornberger remarked, "We have invaded space with our rocket and for the first time --- have used space as a bridge between two points on the earth; we have proven rocket propulsion practicable for space travel. To land, sea and air may now be added infinite empty space as an area of future intercontinental traffic...This...is the first of a new era in transportation, that of space travel..." Under the circumsances, these words were indeed interesting for a miltary officer. But it did show that the rocket scientists were not thinking strictly in terms of weaponry. Continuing the pioneering efforts of Robert Goddard and Hermann Oberth, they knew that Peenemunde would someday be recognized as the birthplace of spaceflight.



ABOUT THE MODEL:

Your giant-sized rocket kit is a 1/16 scale model of the historic German ground-to-ground ballistic missile used during World War II. As the world's first operational intermediate-range missile, it represented a turning point in modern warfare. Although dwarfed by space boosters and missiles of today, the V-2 was a giant for its time. Standing 46 feet high, this technological marvel could deliver a 1 ton warhead to a target up to 200 miles away. Germany's "wonder weapon" became the forerunner of modern intercontinental ballistic missiles and served as the cornerstone of mans' research into outer space.

Your V-2 model rocket is designed to be flown with a D12-3 solid-propellant engine. The model lifts-off slowly just like the real rocket and will reach altitudes up to 300 feet. For best flight performance, it is important to build the model as lightweight as possible. Avoid using unnecessary amounts of glue, body putty and paint. The lighter you build it, the higher it will fly. Due to the model's large size, it should be launched only from a sturdy launch pad. A 3/16" diameter launch rod is required for best lift-off results.

Estes Industries gratefully acknowledges the following for their technical assistance:

ALABAMA SPACE AND ROCKET CENTER

DIETER K. HUZEL

Mr. Huzel worked on the actual V-2 missile at the Peenemunde test site in Germany. At war's end, valuable rocket plans and blueprints were hidden under his direction to prevent them from being captured by the Russians. Following World War II, he continued rocket research with America's space boosters and is currently engaged in engine design for NASA's space shuttle.

NASA – GEORGE C. MARSHALL SPACE FLIGHT CENTER

US ARMY – WHITE SANDS MISSILE RANGE

PARTS LIST

KIT NO. 1267 GERMAN V-2
MODEL SCALE - 1" = 16.5"
RECOMMENDED ENGINE D12-3

(A)	4	Plastic fin sheets PF-67	32467
(B)	1	Wood Dowel WD-2B	85910
(C)	1	Spacing Guide EC-6	35012
(D)	1	Engine Block AR-2050	30164
(E)	1	Stuffer Tube BT-50KE (15")	30364
(F)	1	Engine Hook EH-2	35025 35021
(G)	1	Collar Tube BT-52AG	30378
(H)	1	Ring Set TA-67	30050
(I)	1	Nose Cone PNC-101F	71050
(J)	1	Shock Cord (18" Long) SC-2	85736
(K)	1	Shock Cord (30") SC-2MJ	85738
(L)	2	Parachutes PK-24A	85568
(M)	2	Shroud Line SLT-144	38241
(N)	2	Tape Disc Sheets TD-3F	38406
(O)	1	Tail Cone PTC-101Z	71060
(P)	1	Body Tube BT-101KJ (10.5")	30441
(Q)	1	Launch Lug LL-3B	38187
(R)	1	Decal KD-67	37067

In addition to the parts included in your kit you will also need the following tools and supplies:

White Glue
Plastic Cement (Both liquid and tube type)
Model knife or single edge razor blade
Pencil
Ruler
Sandpaper
Paint
Masking Tape
Plastic Body Putty

Estes "MAXI-ROD" recommended for all Maxi-Brute models. Two-piece, heavy duty launch rod, 3/16" dia. x 36" long, with screw-together fitting. Cat. No. 2239. Will fit Porta-Pad Tripod.

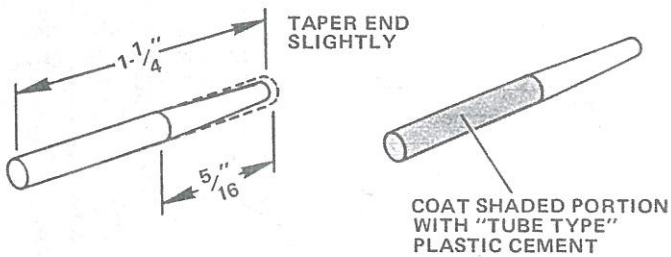
IMPORTANT: Three different modeling cements will be required during construction. Use the proper glue type exactly as recommended for best results.

ASSEMBLY INSTRUCTIONS

*Read all instructions carefully before beginning work on your German V-2. Then begin construction. Check off each step as you complete it.

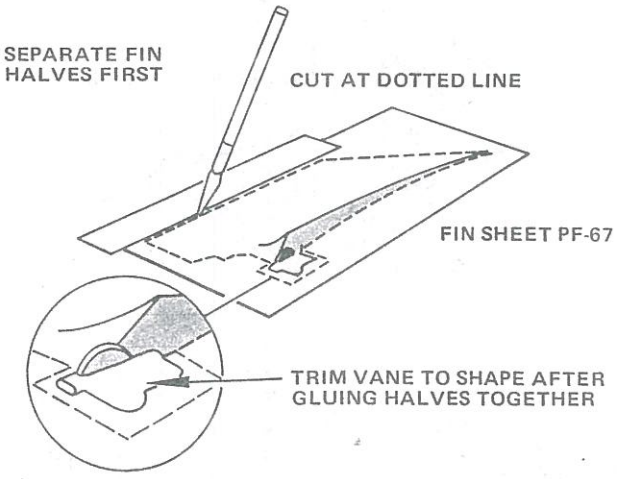
☐ **1** To insure good glue joints, wash all plastic parts thoroughly with soap and water. Rinse well, and dry completely.

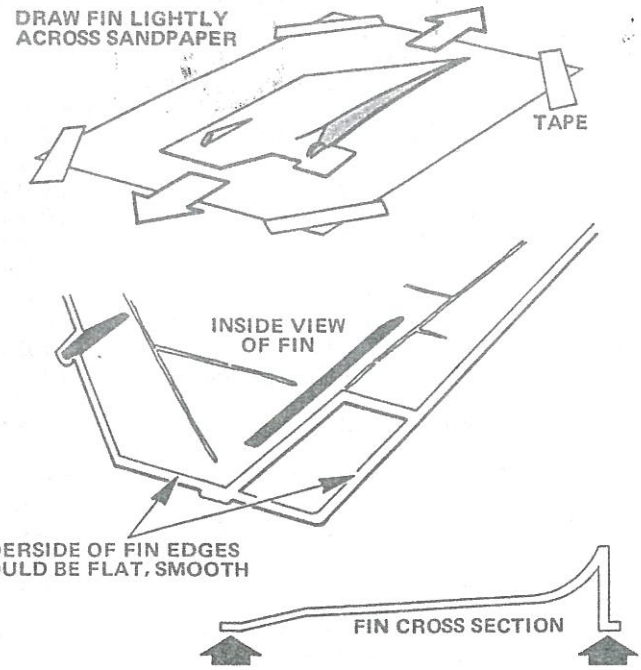
ANTENNA MOUNT DOWEL WD-2B



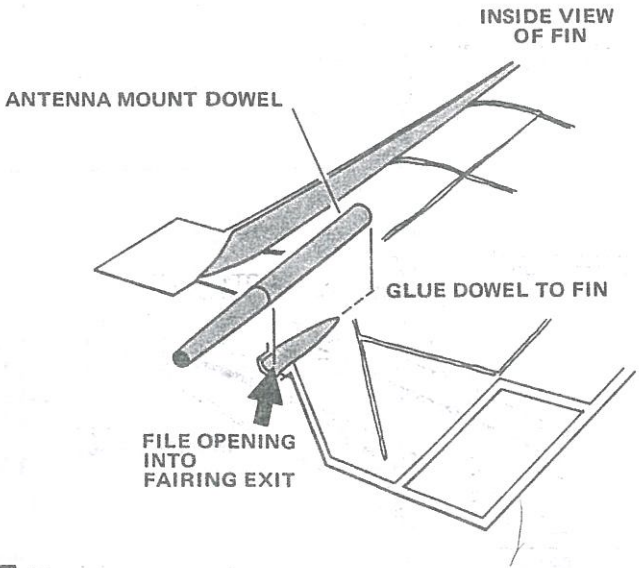
☐ **2** Cut the wooden antenna mount dowel into four 1-1/4" lengths. Sand smooth with fine sandpaper and taper one end of each as illustrated. Smear a coat of "tube type" plastic cement over shaded area of each dowel. Allow to dry.

☐ **3** Trim plastic fin halves using the "score and break" method. Use a metal straightedge to make straight score lines. First, draw a knife or single edge razor blade lightly along straightedge or fin contour. Then make a second pass along the same line, this time pressing down a bit harder. Repeat a third and fourth time until you have cut about half-way into the plastic sheet. IMPORTANT: DO NOT attempt to cut all the way through plastic. Work with one fin set at a time. Starting along any fin edge, bend excess plastic back and forth until it separates along score line. Work carefully around entire fin. If plastic does not break easily, score lightly and bend again. Should an accidental tear or break occur, simply apply liquid plastic cement to damaged area and allow to dry. Tape or mark each matched fin set to avoid mixing up fin sides.



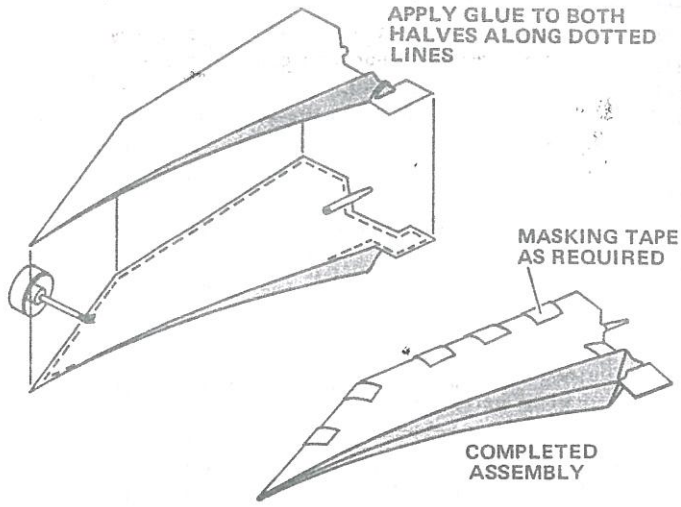


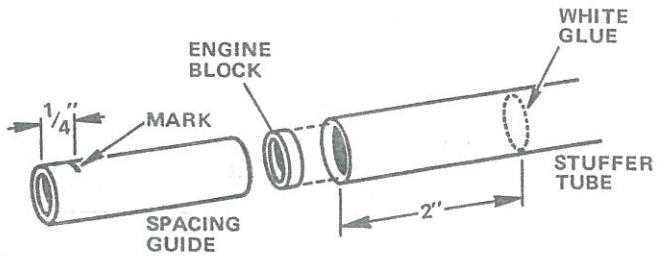
☐ **4** Tape a sheet of fine sandpaper to a table top or other flat surface. Draw each fin side lightly back and forth across the sheet several times to remove any burrs or rough edges. Sand only until you can see that you have an even, flat edge around entire fin. Final sanding of the outside edges will be done after gluing.



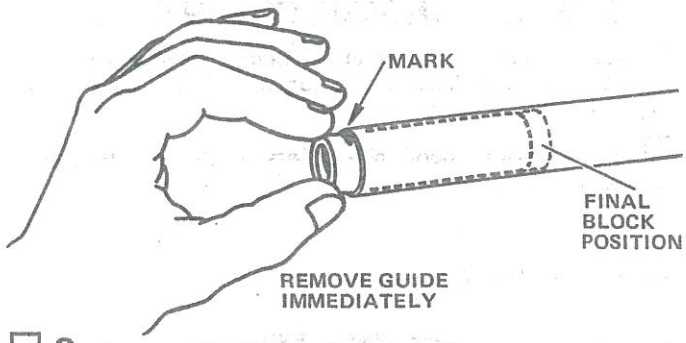
☐ **5** Carefully file or cut a half-round opening into the antenna exit at trailing edge of each fin side. Apply "tube type" plastic cement to one antenna mount dowel and place it into the antenna recess of one fin half as shown. It should project straight rearward for a distance of 5/16". Following the same procedure, glue a dowel into one half of each fin set. Allow glue to set several minutes.

☐ **6** Test fit fin halves together to be sure that you will get a proper matching fit and that you have trimmed enough plastic away to clear the antenna dowels. Working with one fin set at a time, apply liquid plastic cement to edges of both fin halves as illustrated and press together. Check alignment of fin halves by sighting down edges in at least two directions. Tape edges together at several locations and set the completed assembly aside to dry. Repeat gluing process with the remaining fins, one set at a time. When all fins are completed, allow them to dry at least overnight before final trimming.

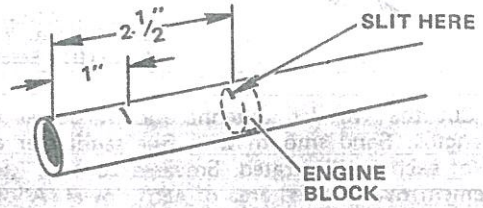




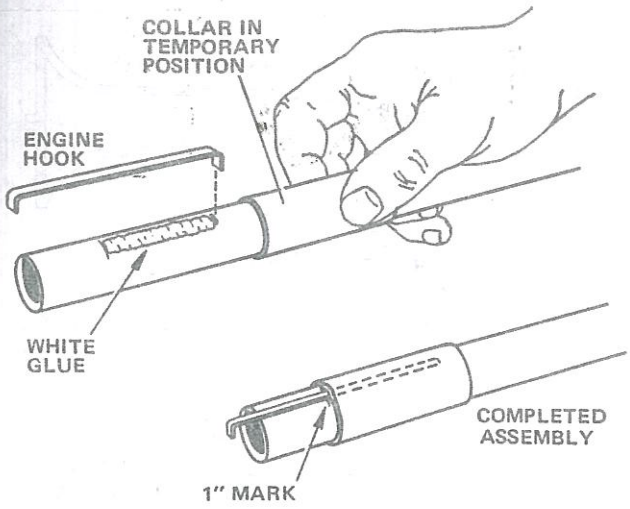
☐ **7** Mark the EC-6 spacing guide 1/4" from one end. Using your finger or a stick, smear a generous band of white glue around the inside of the BT-50KE stuffer tube 2" from one end.



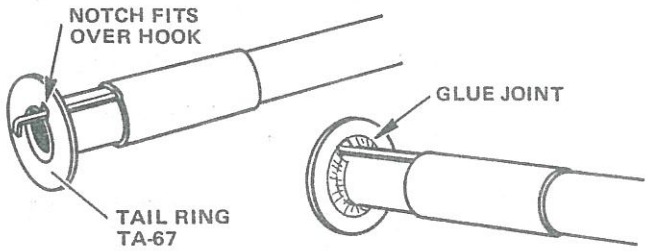
☐ **8** Insert AR-2050 engine block into same tube end. Using guide as shown, slide engine block into place in one smooth movement until guide mark and tube end are even. Remove casing immediately.



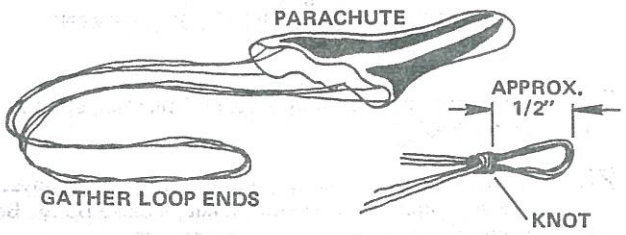
☐ **9** Mark the stuffer tube at 1" and 2-1/2" from the rear. Cut a 1/8" slit into the tube on the 2-1/2" mark. The slit is to be just behind the engine block.



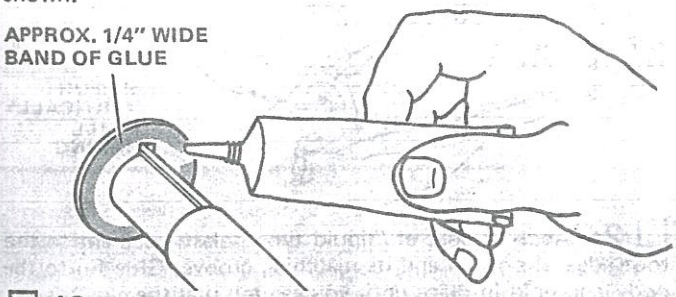
☐ **10** Insert an engine hook (EH-2) into the slit. Run a line of white glue 1-1/2" rearward from slit as shown. Press engine hook into the glue and align it straight along tube. Slip the BT-52AG collar onto front end of tube. Slide it over engine hook and up to 1" mark. Wipe away any excess glue.



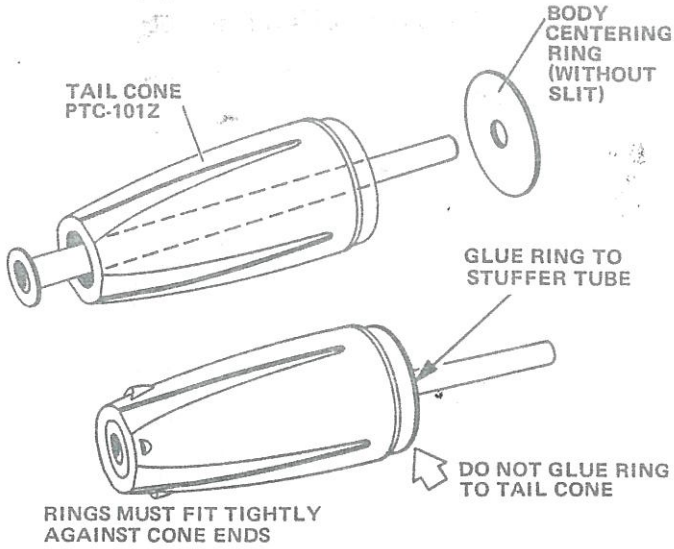
☐ **11** Slip the small, die-cut centering ring onto rear end of stuffer tube. Line up ring so it is even with rear of tube. Glue it in place by applying a line of white glue around the joint between tube and ring. Do not get glue on the engine hook. Set this assembly aside to dry thoroughly.



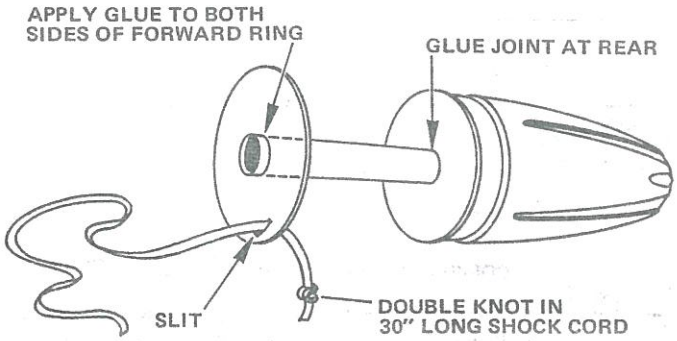
☐ **12** Cut out parachutes on their edge lines. For each parachute, cut three 48" long pieces of shroud line. Attach ends of shroud lines to corners of parachutes. Gather the centers of the shroud lines and tie them together to make a small loop as shown.



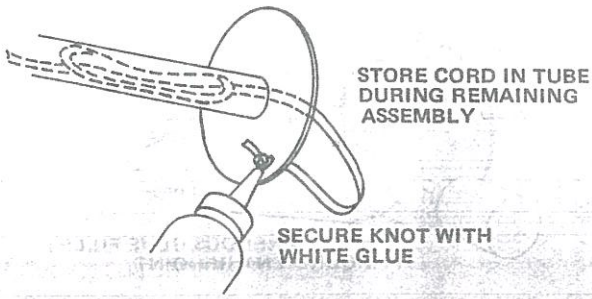
☐ **13** When the glue on the rear ring of the stuffer tube assembly is completely dry, coat the forward side of the ring with "tube type" plastic cement. Allow this cement to dry.



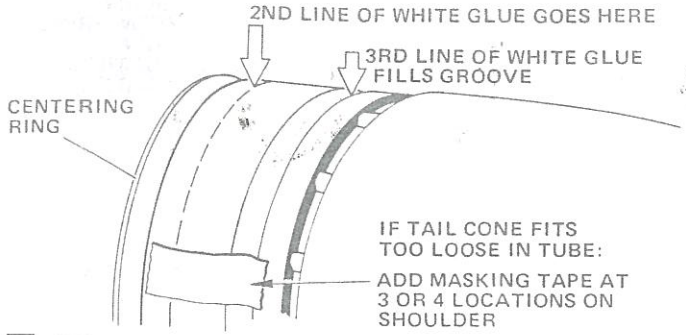
☐ **14** Apply a second coat of plastic cement to rear ring and slide stuffer assembly into the tail cone from the rear. With the ring centered and fitting up into its socket, slide the large ring, which does <u>not</u> have the slit in it, down along the stuffer tube until it fits tightly against the forward end of the tail cone. With rings at both ends of tail cone centered and held tightly against the cone, apply a line of white glue around the joint between stuffer tube and ring at front of cone. Let this assembly dry thoroughly before distrubing it.



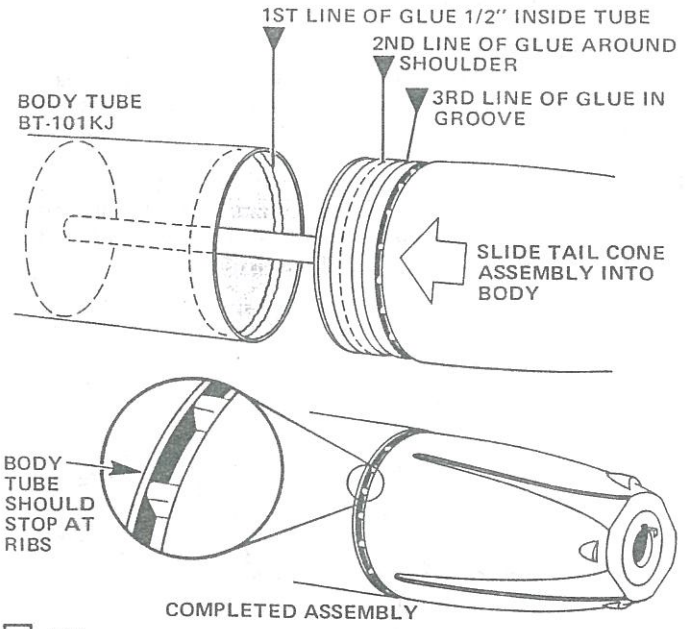
☐ **15** Slide remaining centering ring (the one <u>with</u> the slit) onto the front of the stuffer tube. Position it 1/8" from front end of tube. Glue it in place by running a line of white glue around the ring/tube joint on both sides. Set aside to dry.



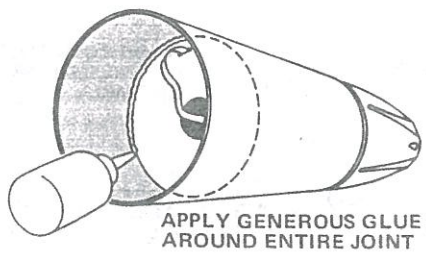
☐ **16** Tie a secure double knot at one end of the 30" long shock cord (SC-2MJ). Poke unknotted end through slit in forward centering ring (from the rear) and pull knot against ring. Apply a heavy coating of white glue over the knot to hold it in place. Poke shock cord down into stuffer tube to store it while continuing assembly.



☐ **17** Test fit stuffer tube assembly by sliding it into the body tube. Centering rings should slide easily inside tube. Forward end of tail cone should also fit easily into the tube end. If centering rings are too tight, sand edges evenly for proper slide fit. If tail cone is too loose, add masking tape as shown. Do not tape around entire shoulder.

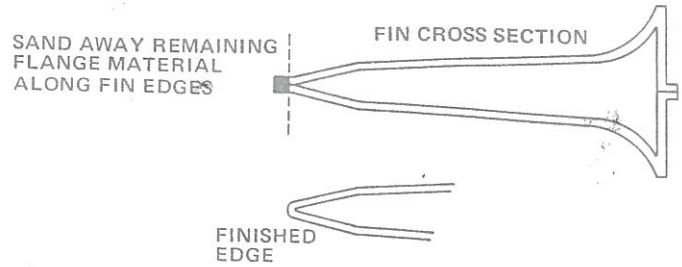


☐ **18** Slide stuffer tube assembly part way into body tube. Run a line of white glue around inside of tube 1/2" from the end. Run a second line of glue around forward end of tail cone shoulder as illustrated. Run a third line of glue around shoulder to fill groove. Work quickly so that you will have time to install tail cone before glue sets. Push tail cone smoothly into tube until the small raised shoulder ribs stop against tube end. Be sure that tail cone is in line and parallel with body tube. Support rocket vertically until dry.

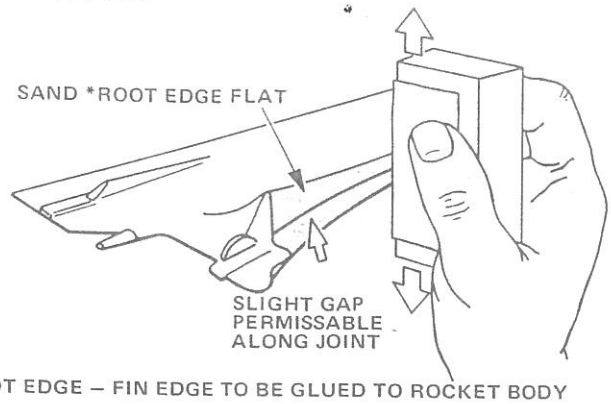


☐ **19** Apply a line of white glue around entire joint between tube and forward centering ring inside the body.

☐ **20** Use a modeling knife or single edge razor blade to trim away most of the excess flange material from each fin. Sand carefully with fine sandpaper to shape each fin to final



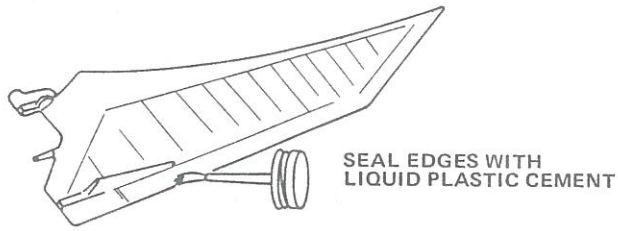
size. A sanding block should be used to square up long fin edges. Refer to V-2 Decal Placement drawing for proper fin outline as you sand.



*ROOT EDGE – FIN EDGE TO BE GLUED TO ROCKET BODY

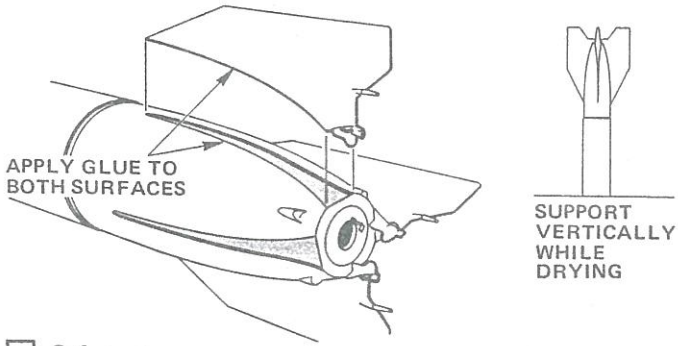
☐ **21** Cut or sand away the flange material along root edge of each fin. This edge must be flat so that it will fit properly against rocket body.

NOTE: It is not necessary that fin halves be glued together along root edge. A slight gap may occur as you sand. It will not interfere with attachment of fins to body.

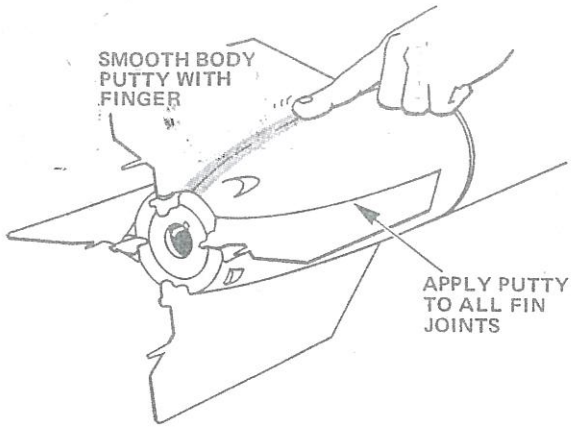


☐ **22** Brush a final coat of "liquid type" plastic cement around each fin to "seal" edges.

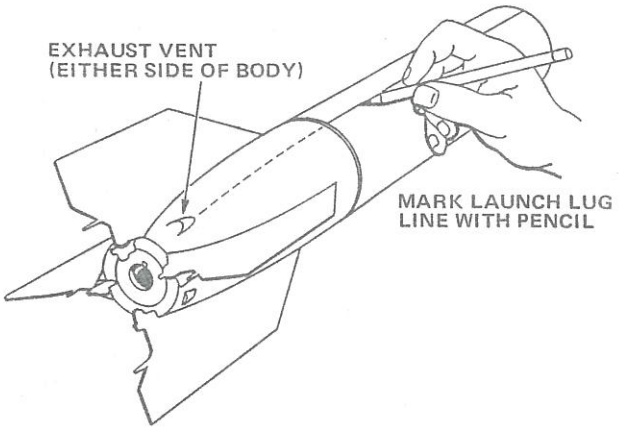
☐ **23** Test fit a fin into one of the tail cone fin grooves. The fin should seat squarely and snugly against the body. Be sure that it projects straight away from the rocket.



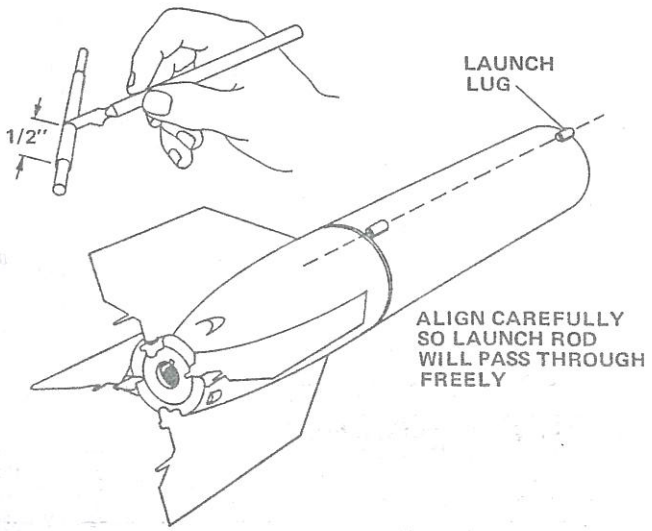
☐ **24** Apply a coat of "liquid type" plastic cement to the root edge of one fin and its matching groove. Glue fin to the body and hold in place until you can tell that the glue has set. Tape fin to body while it dries. Following the same procedure, test fit and glue remaining fins to body. Support rocket vertically as shown until assembly is completely dry.



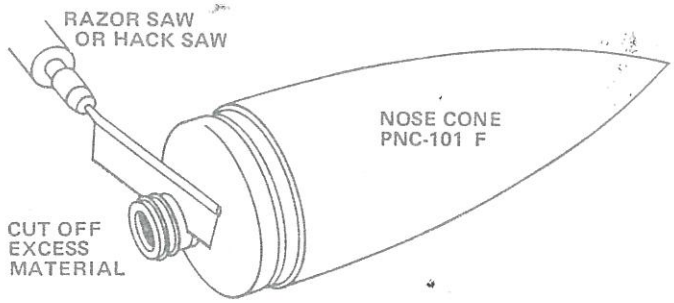
☐ **25** Apply a fillet of plastic modeling putty along each fin joint. Use only enough to fill in the joint. For best results, dip your fingertip into a small amount of ordinary rubbing alcohol and smooth out putty as you fill. The alcohol will prevent putty from drying quickly and give you more time to do a neat job. Be sure to work in a well-ventilated area. Immediately wipe any excess putty away from body or fin surfaces.



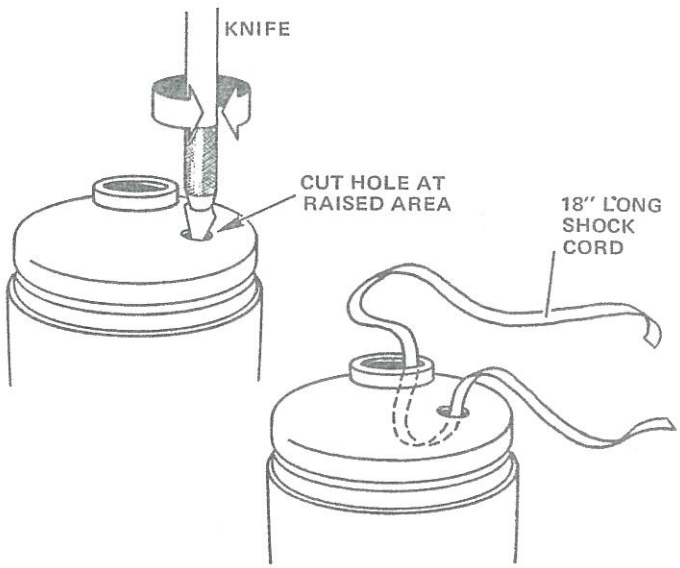
☐ **26** Locate one of the two tail cone exhaust vents. Using a drawer sill or door jamb as a straight edge, draw a launch lug alignment line along entire body tube midway between fins. Use a pencil for marking because ball-point pen ink will bleed through your paint finish.



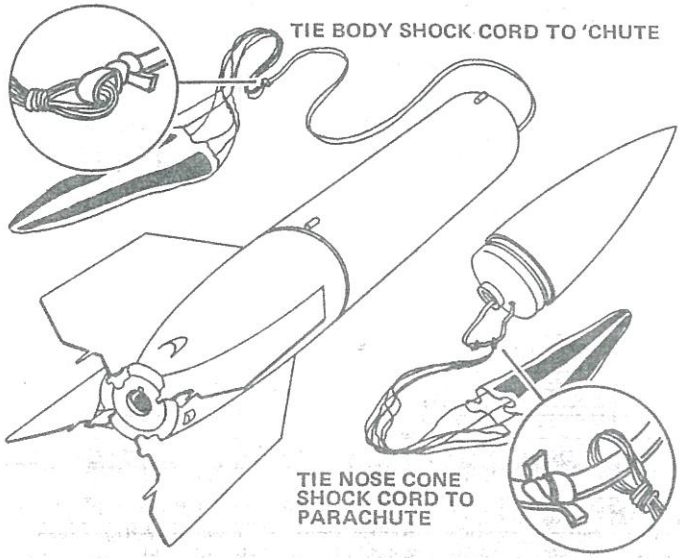
☐ **27** Cut two 1/2" lengths from LL-3B launch lug. Use a dowel or stick for internal support when cutting to prevent crushing the lug. Glue lugs to body on alignment line, even with tube ends as shown. Sight-align lugs carefully to be sure that the launch rod will slide freely through them.



☐ **28** If desired, use a fine-tooth hobby razor saw or hack saw to cut away excess neck material from bottom of nose cone. Sand cut edge smooth.



☐ **29** Cut or file away the small raised circle on rear of nose cone to form a hole of approximately 1/4" diameter. Poke one end of the 18" long shock cord (SC-2) through the hole and pull it on out through the large center hole.



☐ **30** Tie one parachute to each shock cord.

☐ **31** Sand the body putty fin fillets until smooth. Use fine sandpaper first, then finish with extra-fine sandpaper.

PAINTING AND DETAILING

☐ **32** A single color, green paint scheme is the simplest for the V-2 rocket. Pactra Flat Forest Green or Flat Olive Drab Spray Enamel is recommended. If you prefer a camouflage paint scheme, follow steps 34 through 38. Use as little paint as possible to finish your model. This will prevent adding unnecessary weight. Try applying two very light coats instead of one heavy coat. Sand lightly with extra-fine sandpaper between coats. Too much paint will also cover up much of the plastic surface detailing. Allow the paint to dry completely.

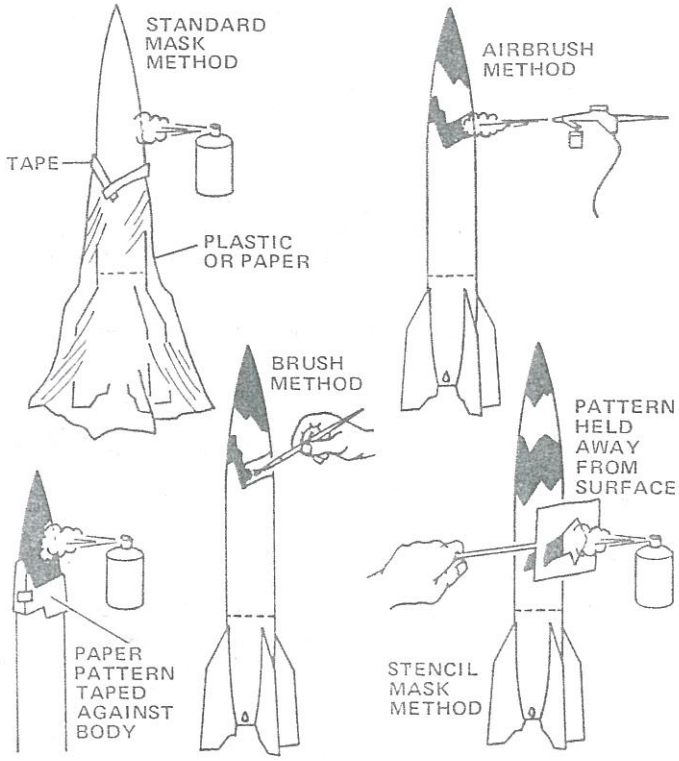
☐ **33** Apply the decals as shown in the Decal Placement drawing.

CAMOUFLAGE PAINTING

The V-2's camouflage paint scheme worked well to disguise its shape and helped conceal it against its local or seasonal environment. Remember that military war-time rockets were never painted just to look pretty. Occasionally, a rocket was hurriedly painted in the field using floor brooms for paint brushes. So be neat as you paint, but ragged or fuzzy paint lines will actually be scale-like. The following Pactra Flat Enamel spray colors are recommended for the camouflage paint scheme:

Base color	-	Camouflage Gray
2nd color	-	Light Earth
3rd color	-	Forest Green
4th color	-	Dark Earth

☐ **34** Apply two light coats of Camouflage Gray spray paint to the rocket body and nose cone where indicated in the camouflage pattern drawing.



DO NOT USE BUTYRATE DOPE ON PLASTIC SURFACES

☐ **35** Mask the body and tail section where the Light Earth color will go as shown in the paint scheme drawing. Masking tape and plastic bag material from dry cleaners, etc. work best. Apply a spray coat (one coat here should be sufficient) of Light Earth. Carefully remove the masking tape and plastic either immediately after spraying, or leave in place until paint has dried completely.

☐ **36** Mask and paint the rocket as required for the Forest Green.

☐ **37** Mask the rocket as required for the Dark Earth. Apply one or two light spray coats and allow to dry overnight befor applying the decals.

☐ **38** Apply the decals as shown in the Decal Placement drawing.

OPTIONAL PAINT SCHEMES

There are many interesting flight test and post-war US White Sands paint schemes possible for the V-2. If you choose to duplicate any of these paint patterns, use only the access panel and small rectangular decals. The following books will be helpful for general V-2 information and alternate paint schemes:

BALLISTICS OF THE FUTURE by Kooy and Uytenbogaart
THE BIRTH OF THE MISSILE by Ernst Klee and Otto Merk
GERMAN SECRET WEAPONS by Brian Ford
PEENEMUNDE TO CANAVERAL by Dieter K. Huzel
V-2 by Walter Dornberger

COUNTDOWN CHECKLIST

☐ **14** Temporarily install parachutes, recovery wadding and a D12-3 engine to check the balance point (center of gravity) of your model. Refer to Decal Placement drawing for proper balance location.

☐ **13** Pack 12 to 14 squares of loosely crumpled Estes RP-1A recovery wadding into main body tube. The wadding should fill the bottom of the parachute compartment for at least two inches.

☐ **12** Loosely fold the main parachute and lay it on top the wadding with its shroud lines and shock cord on top of Fold and pack the parachute for the nose cone on top of t main 'chute. Slide the nose cone into place.

NOTE: DO NOT pack parachutes until you are actually ready to launch. For maximum parachute reliability, lightly dust the parachutes with ordinary talcum powder before each flight, especially in colder weather.

☐ **11** Install an igniter in a D12-3 engine as directed in the engine instructions. Insert the engine into the engine mount. Make sure the engine hook latches securely over the engine.

☐ **10** Disarm the launch panel.

☐ **9** Lower the rocket into position on the launch rod. (A 3/16" diameter launch rod is recommended.) Clean the micro-clips and attach one to each lead of the igniter. The clips must not touch each other, and the igniter leads must not cross.

☐ **8** Clear the launch area, alert recovery crew and trackers.

☐ **7** Check for low flying aircraft and unauthorized persons in recovery area.

☐ **6** Arm the launch panel.

5-4-3-2-1- LAUNCH

MISFIRE PROCEDURE

Occasionally the igniter will heat and burn in t without igniting the engine. This is almost always caused by a failure to install it correctly. Disarm the launch panel, remove the model, clean the igniter residue from the nozzle, and install a new igniter. Follow the launching procedure again.

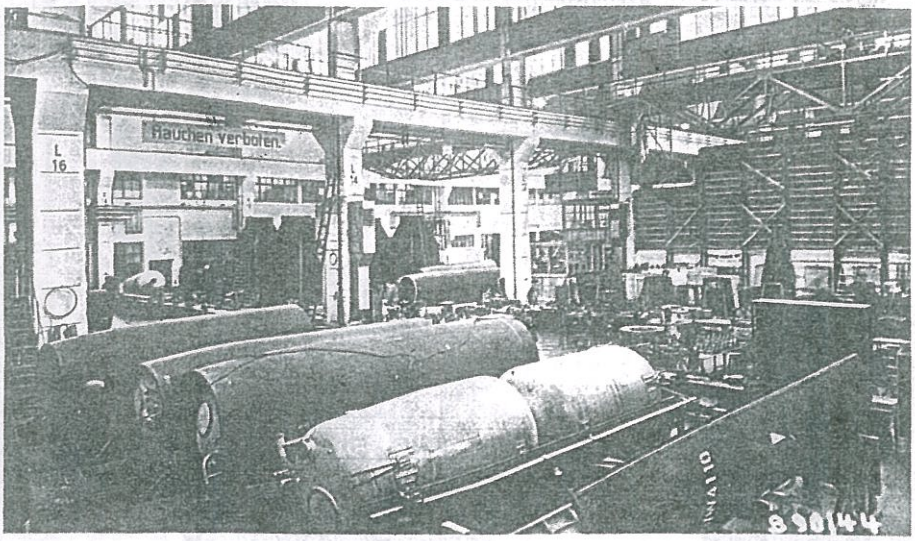


PHOTO COURTESY DIETER K. HUZEL

V-2 mid-sections under construction. Alcohol and liquid oxygen tanks are clearly visible. Sign reads: "Smoking Forbidden."

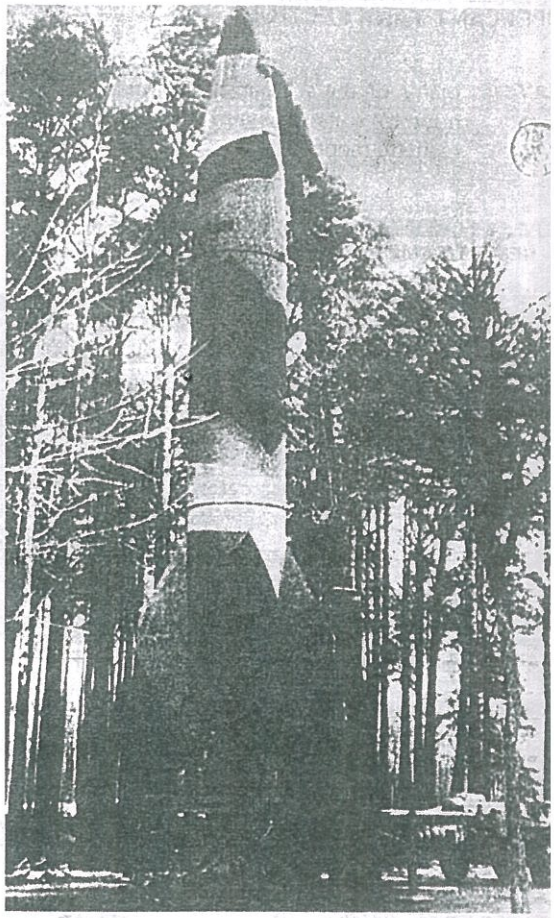
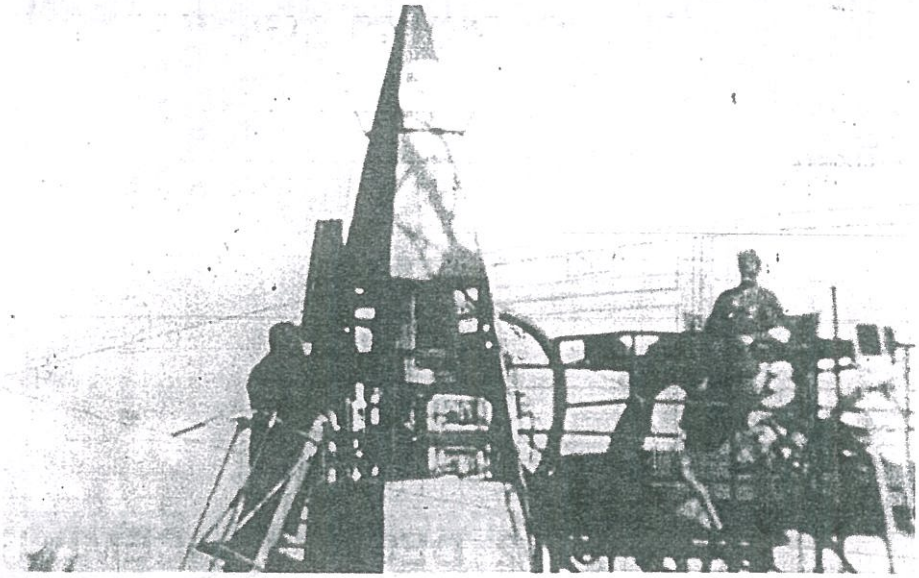


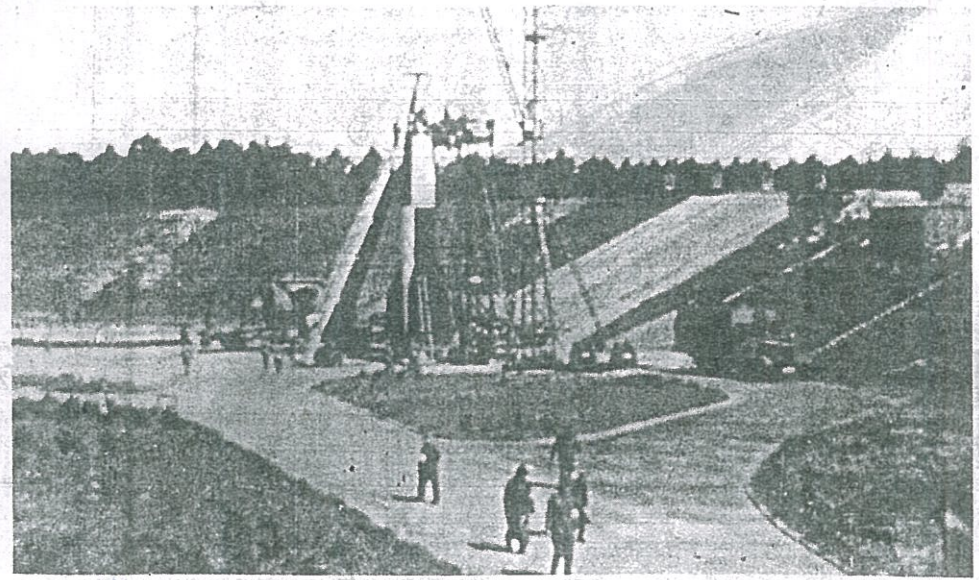
PHOTO COURTESY DIETER K. HUZEL

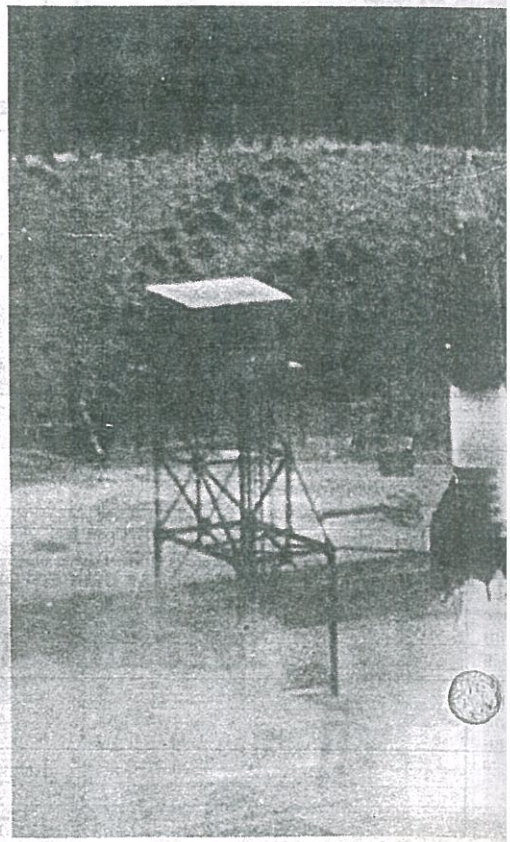
Operational V-2 missile on mobile launch form prior to firing by tactical unit. Note effective camouflage paint scheme against tree background. Missile transporter is visible at right.



Above: Pre-launch adjustments to guidance section. Below, an A-4 rocket undergoes preparation at Peenemunde P-7 launch complex. Early servicing was accomplished from ladders.

PHOTOS COURTESY DIETER K. HUZEL





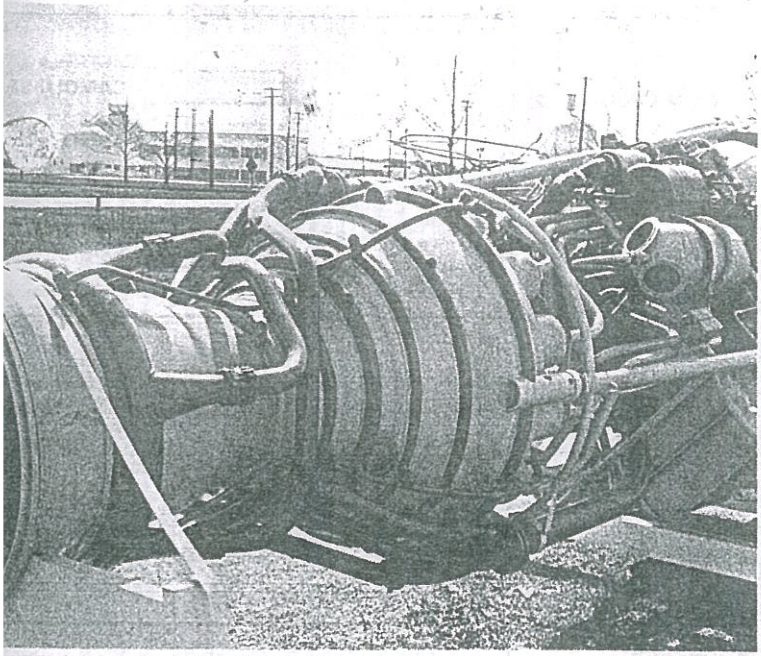


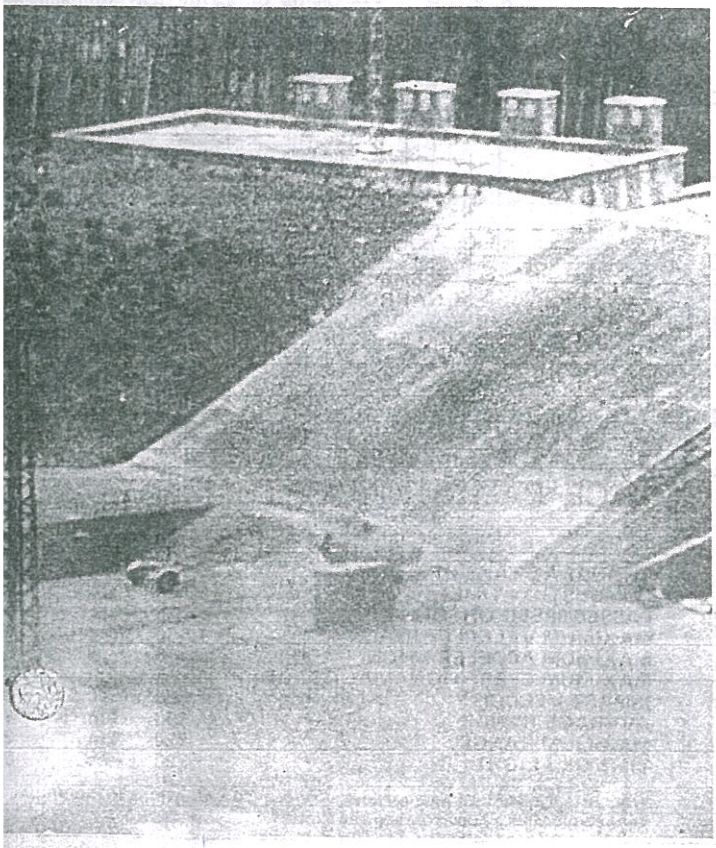
PHOTO BY GREG GEIS

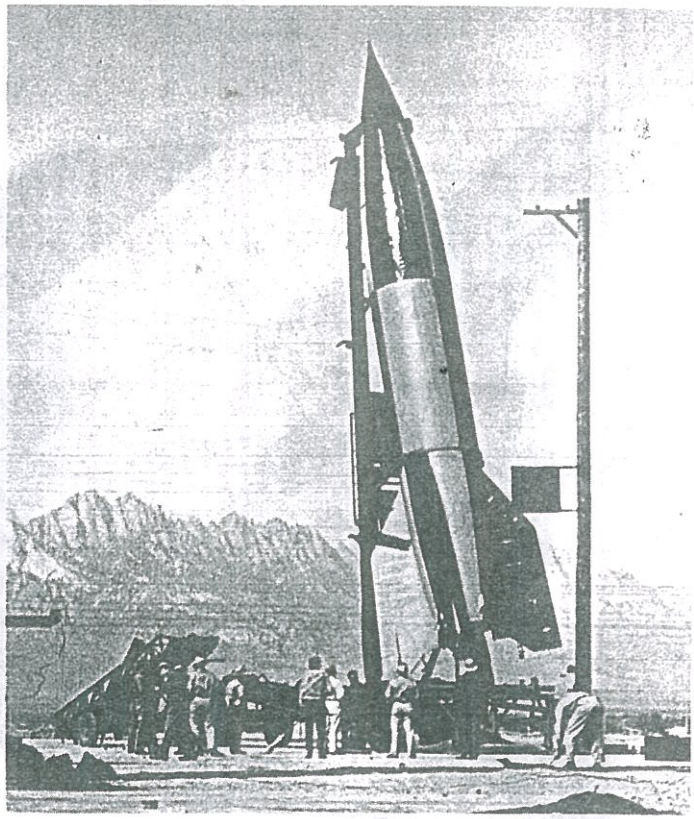
Complex V-2 liquid-propellant rocket engine. Alcohol is pumped around the engine through the piping shown before it enters the combustion chamber. Simultaneously, the engine walls are cooled and the alcohol is pre-heated which improves combustion efficiency.

V-2 PHOTO HISTORY

Below; A-4 missile shortly after lift-off. Note frosted LOX tank section. Static firing flame pit is visible behind rocket. Structure at left is pressure transducer cubicle which lines up with moveable test tower. Behind earth wall is roof of pump house and power transformer station.

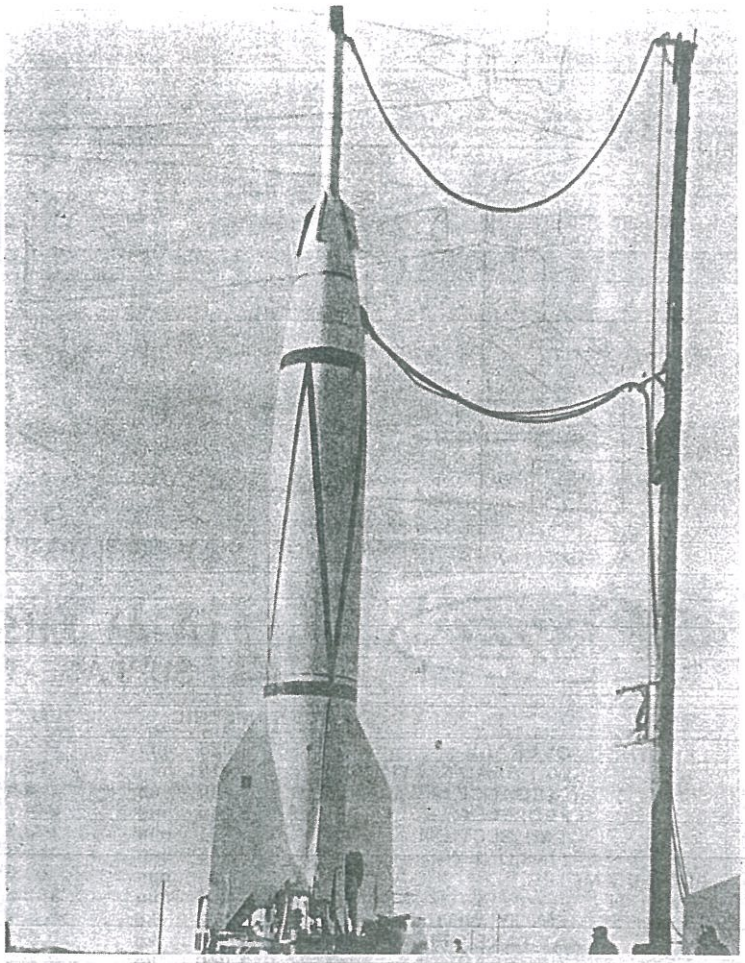
PHOTO COURTESY DIETER K. HUZEL





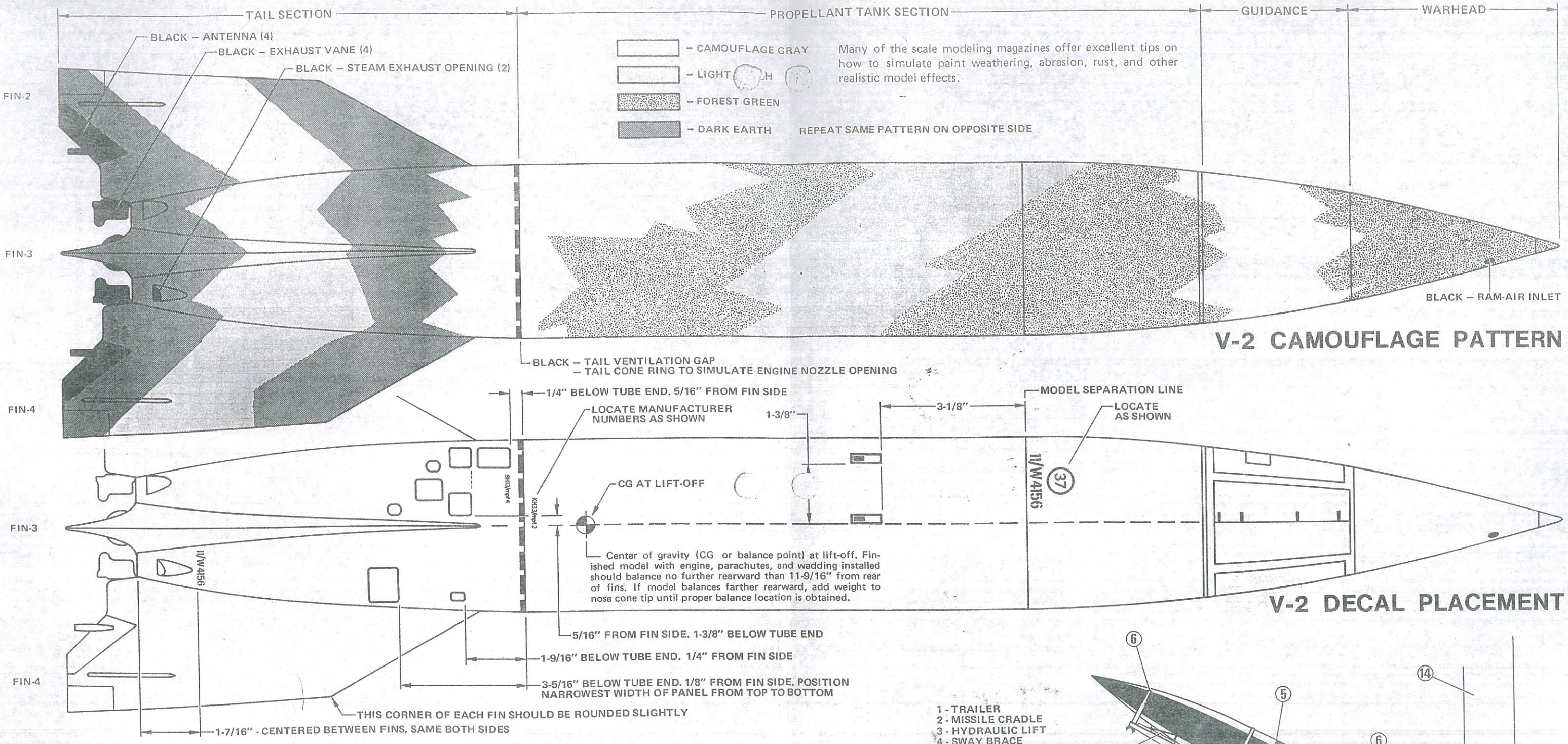
COURTESY US ARMY – WHITE SANDS MISSILE RANGE

White Sands V-2 being placed in position for launching.



COURTESY US ARMY – WHITE SANDS MISSILE RANGE

Combination V-2 and WAC Corporal two-stage research rocket.



Many of the scale modeling magazines offer excellent tips on how to simulate paint weathering, abrasion, rust, and other realistic model effects.

V-2 CAMOUFLAGE PATTERN

V-2 DECAL PLACEMENT

ESTES
A SUBSIDIARY OF DAMON

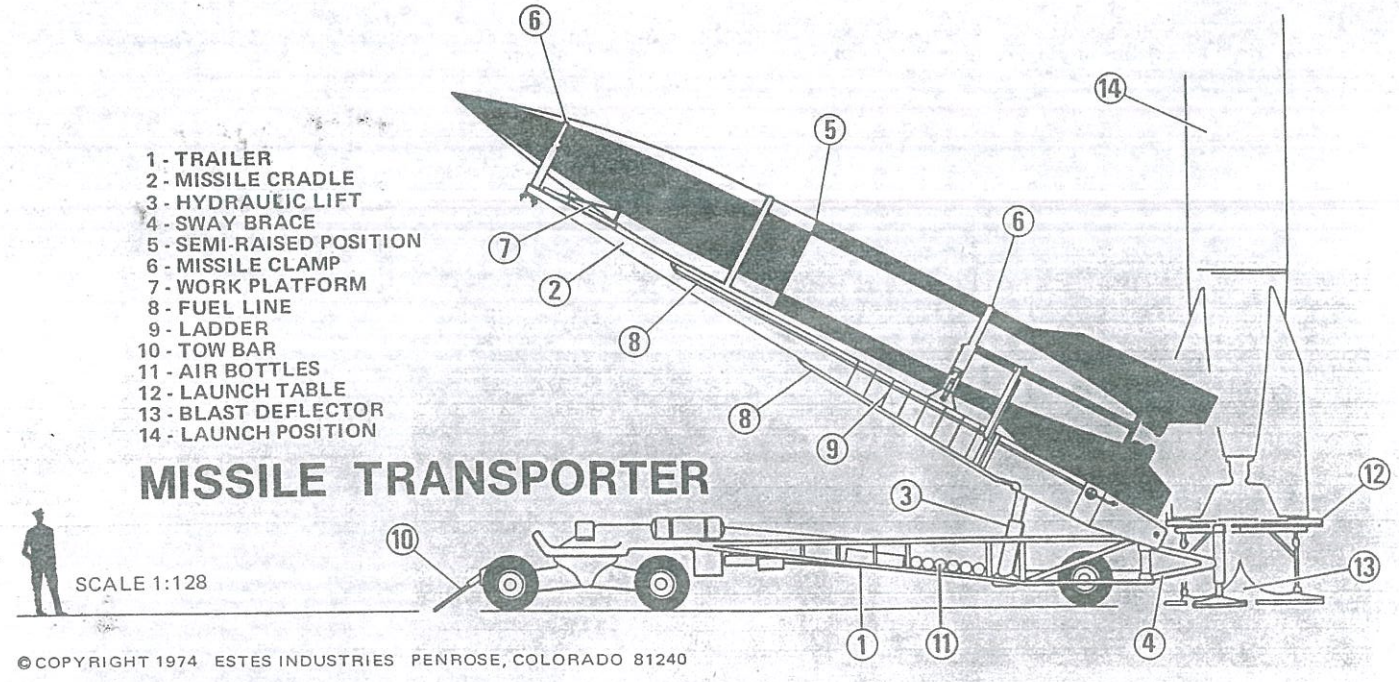
GERMAN V-2 (A-4) MISSILE SPECIFICATIONS

SURFACE-TO-SURFACE BALLISTIC MISSILE

		METRIC		U.S.	
LENGTH:	- OVERALL	14,036	mm	552.6	in
	- WARHEAD SECTION	2,010	mm	79.1	in
	- GUIDANCE SECTION	1,410	mm	55.5	in
	- PROPELLANT SECTION	6,215	mm	244.7	in
	- TAIL SECTION	4,401	mm	173.3	in
	- FINS ONLY	3,945	mm	155.3	in
BODY DIAMETER		1,651	mm	65.0	in
FIN SPAN		3,564	mm	140.3	in
WEIGHT:	- EMPTY, WITH WARHEAD	4,000	kg	8,820	lbs
	- AT TAKE-OFF, MAXIMUM	12,900	kg	28,440	lbs
	- WARHEAD	1,000	kg	2,200	lbs
	- FUEL, ALCOHOL	3,800	kg	8,380	lbs
	- LIQUID OXYGEN	4,900	kg	10,800	lbs

	METRIC		U.S.	
THRUST AT TAKE-OFF	25,700	kg	56,600	lbs
COMBUSTION TIME	60-63	sec	60-63	sec
PASSES SPEED OF SOUND (MACH-1)	25	sec	25	sec
MAXIMUM VELOCITY (MACH-4.5)	1,500	m/sec	3,360	mph
MAXIMUM ACCELERATION	6	g	6	g
MAXIMUM OPERATIONAL ALTITUDE	80-95	km	50-60	mi
IMPACT VELOCITY	800	m/sec	1790	mph
AVERAGE RANGE	300	km	185	mi
MAXIMUM RANGE	320	km	200	mi
TIME OF FLIGHT	320	sec	320	sec

PERFORMANCE FIGURES ARE APPROXIMATE DUE TO VARIATIONS IN INDIVIDUAL MISSILES, TARGET DISTANCES AND REQUIRED TRAJECTORY.



MISSILE TRANSPORTER

SCALE 1:128