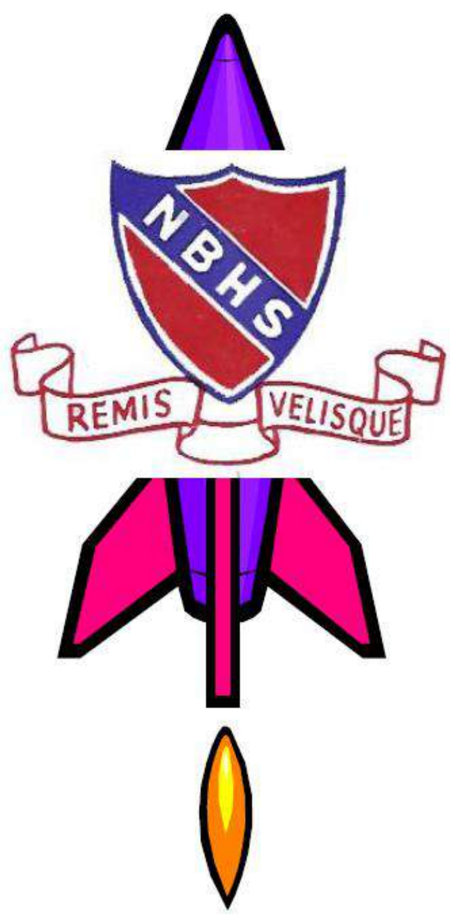
Schoolboy Rocketry

The Unofficial Rocketry Club at Newcastle Boys' High School 1964-1969

Trevor C. Sorensen



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Preface

In the last few years I have been amusing my children with stories and anecdotes from my life, especially my youth. They love these tales and have urged me to write my memoirs so that they are not lost when I pass on. I helped put together my father's memoirs after his death (published in 1998 in the book *In The Service Of My Lord* by Vivian C. Sorensen) and came to realize what a worthwhile project that was. As long as that book exists, the memory of him and his accomplishments will not be forgotten, even after those who knew him personally have gone to their reward. He led a fascinating life and the book makes wonderful reading, as has been expressed to me many times. I have led a very interesting and unique life and have had many incredible experiences, so I decided, at the age of 58, while in good health and still with most of my memories intact, it would be a good time to start these memoirs.

The first chapter I completed was on my experiences at Newcastle Boys High School 1964-1969 (which is the companion document to this one and should probably be read first). On 6th January 2012, I attended the informal annual 69er reunion held at the Bar Beach Bowls Club. It was suggested that I contribute my memoirs to the archives of the NBHS Old Boys Association. I thought this was a good idea, especially if I reworked the chapter to remove some extraneous personal events and information (which will appear in my full memoirs) and this could become the basis for a personal history of our form, if my old schoolmates would contribute to it with their own experiences (these could be added as sections in the appendix or as separate documents in the OBA archives). This would then provide future generations with a glimpse of what it was like to be a schoolboy at a public selective all-boys high school in the 1960s. I sent the first version of this out to the 69er distribution list in December 2012. I followed it in January 2013 with this companion volume, which describes the rocketry activities by myself and several schoolmates. Both chapters are living documents and will continue to be updated.

Please forgive any mistakes that I make in these memoirs. I am giving them my best effort. This is a personal recollection and not meant to be a definitive history.

One advantage of writing memoirs these days versus years ago is the power of laptop computers with word processors and the ability to easily add images, either from digital cameras or scanned from slides or photographs. I have loved photography since high school and have taken many thousands of photographs. Fortunately some of the incidents and periods described in these memoirs have photographic documentation available. I will insert the best ones to help illustrate the memoirs and to be a crux so that I don't have to depend on my descriptions alone to portray what happened or locations.

I especially want to thank my wonderful wife, Lori, for her love and support. I am so lucky to have her – I don't know what I would have done without her.

Trevor Charles Sorensen
NBHS Class of 1969

NOTE to the NBHS '69er Readers

Some background is needed to fully understand this document:

- My father was a missionary for the Reorganized Church of Jesus Christ of Latter Day Saints (now named The Community of Christ). Although we had the same origins as the Mormon Church, it is not the Mormon Church and there are major doctrinal differences between the two, such as the Mormon belief in polygamy.
- I have two older sisters – Beth, who is a retired nurse in Missouri (moved there from Australia in 1967), and Marvia, who is a retired lawyer in Newcastle (lives in Valentine, NSW).
- I was born in Brisbane in 1951, but when an infant, we moved to Tahiti and then the USA, finally moving to Newcastle in 1960. I attended Hamilton Primary School (1960-1963), where I was dux and School Captain.

I welcome comments on these memoirs. Although I have a good memory, it is not infallible and so I may have some things incorrect. I tend to find that I am less accurate in things I observed as compared to things in which I participated. Please send me any corrections or amusing stories that I missed. I especially welcome any remembrances you may have of me or these activities.

Editorial notes:

- I have tried to use Australian spelling and expressions where possible (as opposed to American), although I'm sure some Americanisms have slipped through since I have lived in the US since I left high school well over 40 years ago.
- I have formatted this document in US letter size instead of the more common A4 format used in Australia because I wanted hard copies of my memoirs and it is difficult to find A4 paper in America . I also did not want to have to reformat the document just for this NBHS version, because that is more work (time) than I can afford.

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PROLOGUE – IOWA, 1957

Although I am an Australian and was born in Brisbane, Australia in 1951, it was while we were living in the small town of Boone, Iowa (population 12,000) in October, 1957 that my interest in astronautics began. That is when the Soviets launched Sputnik I into orbit, becoming the first artificial satellite to orbit the Earth. I was six years old at the time and realized that something exciting had happened, that had everyone talking, out of both wonder and fear. They were all expecting the US to be the first into space, just like they were first in developing the atomic and hydrogen bombs. American technology was supposed to be superior to the Soviets in every regard – especially in rocketry and space. After all, the U.S. had obtained the cream of the crop of German rocketeers – the managers, scientists, engineers, and technicians that had successfully developed the V-2 rocket, which was years ahead of anything comparable in either the US or the Soviet Union at the time.

However, it was not the launch of Sputnik I, followed soon by Sputnik II, and Explorer I (the first US satellite) that really piqued the interest of this six-year old boy. It was my father who did that. Although he was a full-time missionary (that is the reason we were in Iowa and not back in Australia), he had previously been a mechanical engineer and expert machinist during World War II. The love of making things, both mechanical and electrical, never left him for the rest of his life. He made tape recorders, hi-fi radios and record players, amplifiers, pumps, transformers, slide projectors, and many other things, basically from scratch. During our four years in Iowa, my dad became interested in making telescopes. He first made a reflector telescope with a four and a half inch mirror which he ground himself. With the help of a young man attending the Iowa State College in nearby Ames, he ground a six-inch mirror which he put into a new and larger reflective telescope he made. This telescope was capable of viewing the celestial objects at up to 400x magnification, and on many dark Iowan nights I remember viewing in awe the craters and maria of the Moon, the rings of Saturn, the red spot and moons of Jupiter, and some hazy reddish patches and polar caps on Mars. My dad even made a motor that allowed the telescope to move, following the apparent rotation of the celestial objects due to the rotation of the Earth. That way we did not have to keep moving the telescope when the target object drifted out of the field of view. I was in awe of these majestic sights and longed to be able to visit them in person someday. Of course, fed by the science fiction of the time, I wondered at what great civilizations or creatures were there to be discovered.

My dad made several telescopes, including a refractive telescope that he gave to a friend, and also a small telescope we called the “Sputnik” telescope, because it was designed to view the passing of the satellites as they passed overhead during twilight when the satellites were still lit but we were in near darkness. I do not remember the details of how it worked, or even how well it worked, because seeing a white spot traveling across the sky was not nearly as interesting as looking at the other celestial bodies. I did not realize what a great technical achievement I was witnessing. That came later when I started to learn physics and to build rockets of my own, which had to wait until after we moved back to Australia in 1960.

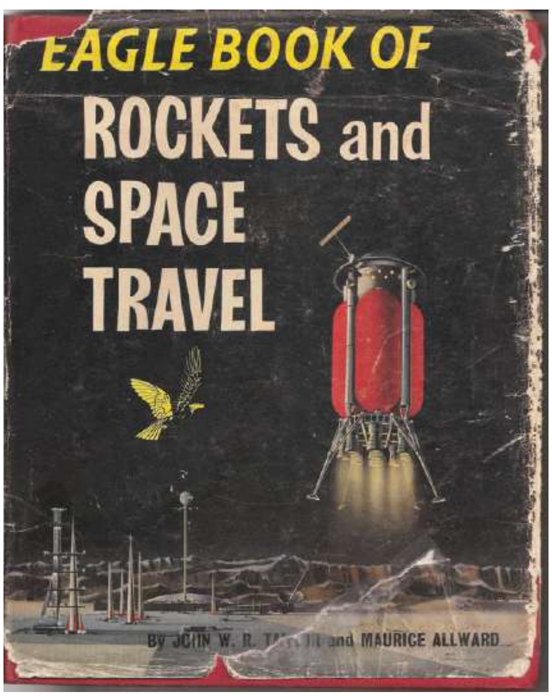
Trevor and Father Vivian Displaying Some of Vivian's Handiwork in their House in Boone, Iowa in 1959. From front to back are: camera to transfer print to 16mm slide film; 16mm slide projector (which Vivian invented); refractor telescope made for a friend; the "Sputnik" telescope; 6" reflector telescope with tracking motor. This photograph accompanied an article that appeared in an article about the Sorensens in the *Des Moines Register and Tribune* in 1959.

PART I - AUSTRALIA

Up until my first year of high school I wanted to be a medical doctor when I grew up (my mother and aunt were nurses). I remember the incident that changed my mind. My sister Beth also became a nurse and although she didn't live at home, she shared a bedroom with my other sister Marvia when she was home. Shortly after we moved to Lambton I remember going into their room started looking at the medical textbooks that Beth had in their bookshelves. It was when I looked at the textbook on skin diseases (with colour plates) that I decided I did not want to be a doctor after all.

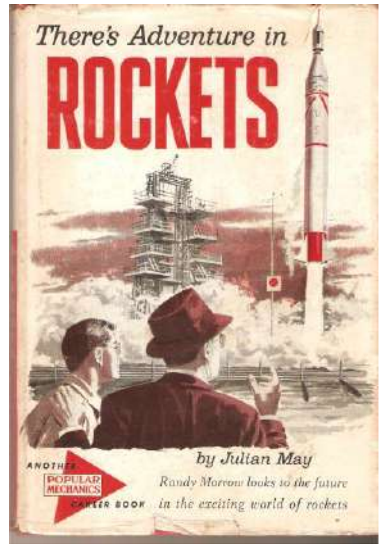
This was 1964 and the manned space programs of America and the Soviet Union were in their infancy. Every mission brought new firsts and it was very exciting. The Americans had started their Gemini program, which sent two astronauts into orbit with each mission. The Soviets were flying their Vostok and Soyuz spacecraft, each of which carried either two or three cosmonauts. I was fascinated with these missions and kept newspaper articles about them in a scrapbook (which I still have). When I discovered a book (I don't remember the name of it) on the theory of rocketry in the Newcastle Public Library, I was hooked. The mathematics was beyond me (I was only in 1st Form at NBHS), but I started designing liquid propellant rockets that I hoped to make. The first one was six inches in diameter and about six feet high with a parachute recovery system and a radio transmitter.

There was another book that I got from Ell's Bookstore about this time, called the *Eagle Book of Rockets and Space Travel*, published in the UK in 1961. This book described with many black & white photos the advances in rockets and satellites to that



time, a chapter of building and collecting models of rockets, and chapters looking to the future of space travel, including establishing bases on the Moon. This book was a great inspiration to me. There was an even greater inspiration contained in its pages. There was a full-page photo of an amateur rocketeer by the name of Marshall Kriesel with his 11-ft. three-stage liquid propellant rocket intended to reach over 50,000 feet in altitude, and the ground equipment, including computer, all of which he built himself.[1]

My close friend, John Farrell, also caught the rocketry bug with me. He introduced me to a book he found in the Scone Public Library. It was a 1958 book for youth called *There's Adventure in Rockets*[2] by Julian May. This was a fictional account of an American high school amateur rocketry club that designed, built, and flew solid propellant rockets. Besides telling the tale of these teenagers, it also presented the basic principles of rocketry. I found the book exciting and wanted to do something similar. It was with this book that I realized that it was possible to build small solid propellant rockets, and so I decided to shelve the plans for the liquid propellant rocket (which I never did build) and instead learn the basics of how to build, fly, and recover rockets using the much simpler solid propellants.

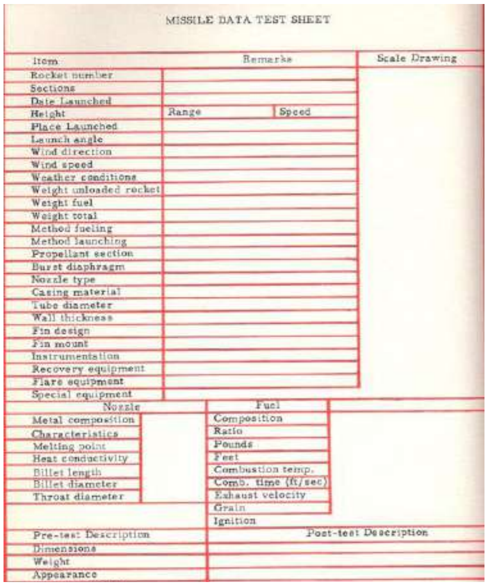


Because of the May book I planned to use a pendulum switch to fire the parachute ejection mechanism (although the book did not reveal its design). I also used the example Missile Data Sheet from the book for my later large rockets. Of course, I had to copy the book's example with a typewriter. I used carbon paper to make extra copies (this was before photocopy machines). Although the May book gave a lot of general information, it lacked specifics, like the ingredients of the propellant. I had to search other sources to find that answer. I found out from magazine articles that the propellant used for most amateur rockets was called "micrograin," made of zinc dust and sulphur. I decided that I should use the same. However, initially I could not find the mixture ratio and had to experiment to find what worked (more on this later).

My father was thrilled that I wanted to do rocketry as a hobby, because I would need to use his workshop. This would provide him an opportunity to teach me some of his mechanical skills, such as operating the metal lathe and welding. My mother was not exactly thrilled, but she was very supportive of me in this hobby, as long as I didn't injure anyone (I didn't) or damage our house or its contents (in this I was partly unsuccessful).

[1] While writing this, I was curious as to whatever happened to Marshall – did he launch his rocket? I did an online search and found his obituary. He died in St. Paul, Minnesota on January 26, 2014 at the age of 73. He was described as an entrepreneur, innovator, and inventor, having founded five companies and filed over 200 patents. He graduated from high school in Minnesota in 1958, and the information in the obituary states that his photo appeared in *Life* magazine with the rocket that he built and launched. I then did a search of *Life* magazine archives and found the article on him in the Sept. 15, 1961 issue. The Navy was so impressed with his missile, that they let him launch it at their China Lake range. The article says that although the missile functioned correctly, "aerodynamic instability limited flight to 500 yards." He did not quite meet his altitude goal, but it was still an impressive achievement. However, while I was in high school, all I knew about his rocket came from the book photo and caption.

[2] In Australia I checked this book out of the library several times, but never found it in a bookstore. However, I never forgot this book, and when I started bidding on eBay in the late 1990s, I was surprised to find this book available. Of course I bid on and won it. At last I had my own copy! In the following years I came across other copies on eBay and couldn't resist buying a couple of extra copies for $5 or less each.



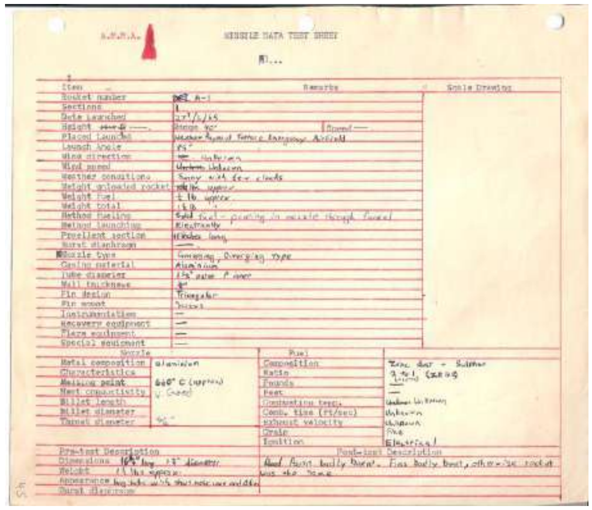
MISSILE DATA TEST SHEET

Item	Remarks		Scale Drawing
Rocket number			
Sections			
Date Launched			
Height	Range	Speed	
Place Launched			
Launch angle			
Wind direction			
Wind speed			
Weather conditions			
Weight unloaded rocket			
Weight fuel			
Weight total			
Method fueling			
Method launching			
Propellant section			
Burst diaphragm			
Nozzle type			
Casing material			
Tube diameter			
Wall thickness			
Fin design			
Fin mount			
Instrumentation			
Recovery equipment			
Flare equipment			
Special equipment			

Nozzle		Fuel	
Metal composition		Composition	
Characteristics		Ratio	
Melting point		Pounds	
Heat conductivity		Feet	
Billet length		Combustion temp.	
Billet diameter		Comb. time (ft/sec)	
Throat diameter		Exhaust velocity	
		Grain	
		Ignition	

Pre-test Description	Post-test Description
Dimensions	
Weight	
Appearance	

Missile Data Test Sheet Example from
There's Adventure in Rockets



MISSILE DATA TEST SHEET

Item	Remarks
Rocket number	A-1
Sections	1
Date Launched	27/5/65
Launch angle	45°
Weather conditions	Sunny with few clouds
Method launching	Electrically
Casing material	Aluminium
Fin design	Triangular

Fuel	
Composition	Zinc dust - Sulphur
Ignition	Electrical

AMRA Missile Data Test Sheet for A-1

The sulphur I bought from the Chemist (later Marvia's boyfriend/finance/husband, Terry Thompson, supplied me with the sulphur because he worked for the Wholesale Drug Company). The zinc dust was purchased from paint stores. Both powders were very cheap at that time.

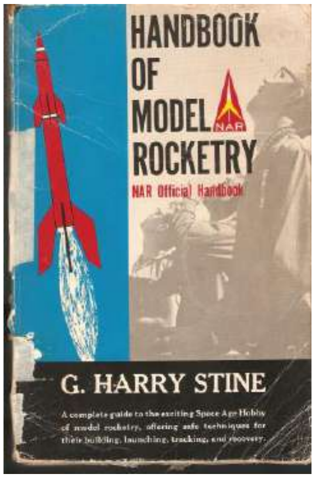
In 1965 Dad gave me a military 3-inch rocket body that someone had given him. The rocket was empty, although it had fins and a built-in nozzle (but no nose cone). It was made of steel and painted military olive drab. It was one of the small unguided rockets that aircraft would carry for bombarding the ground. I longed to build it into a flying rocket, but never did and had to leave it behind when we moved to America in 1969.

Model Rockets

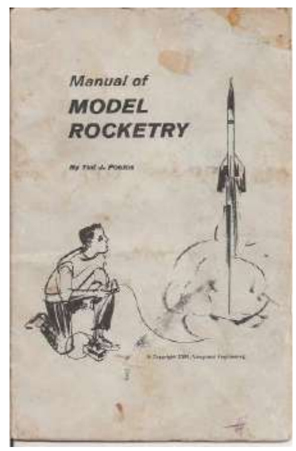
About this time I also discovered that you could buy model rockets commercially. There was a company, Model Rocket Industries, in Punchbowl (Sydney) that advertised in an Australian hobby magazine. I wrote to them and ordered one of their catalogues, and started buying some kits and rocketry supplies from them. I initially bought an Estes Astron Scout for 7/6 (seven shillings and sixpence or ~75c) and three rocket engines for 3/3 (33c) each. The Astron Scout was a small rocket with a short

First two model rockets bought from Model Rocket Industries in Sydney

pressed paper body, long balsa fins and nose cone, and no parachute – it was meant to tumble to a soft landing. We launched this in February, 1965 along with our A-1 rocket, but more about that later. At about the same time I also bought an Astron Mark, which with the substitution of a parachute for the its supplied streamer, became the basis of the model rockets that I would later teach at children and youth camps in both Australia and America.



I was thrilled when in 1965 I discovered a book in Ell's Bookstore in downtown Newcastle called *Handbook of Model Rocketry* by G. Harry Stine (who was the founder of the National Association of Rocketry). This contained a wealth of information about rockets in general and model rockets specifically. Although it was not as helpful for our larger metal amateur rockets, for which we made our own propellant and nozzles, it did provide a lot of additional information (launch systems, instrumentation, rocket stability and flight theory, altitude determination, etc.) that was very useful in our rocketry projects. It soon became well-worn and grubby, as it was used as a reference in our workshop. The book shown in the image at right is of my original book (with masking tape repairs to the spine, creased cover, and loose pages). The two areas the book did not help me with were the design of the rocket engine for our rockets, and the design of a suitable parachute recovery system. Model rockets use a blow-through system from the top of the commercial rocket engine for ejecting the parachute, and that method would not work for our micrograin rockets, which were far too powerful.



There was another booklet that I acquired called the *Manual of Model Rocketry* by Ted J. Poulos. It was a 16-page booklet that was a brief overview summary of what was in the Stine book. I used this also as a reference, especially at the church youth camps where I taught rocketry classes. That is why the cover is so dirty.

Rocket Car (~1965)

I don't remember exactly when this happened, but I wanted to build a model rocket car. I made a small car (wheeled vehicle) out of an Erector (Mechano) set and mounted one of the Estes model rocket engines onto it. Late one weekend afternoon when nobody was around, I put the car on Turner Street in front of our house. I ignited the engine with my electrical ignition system. Immediately after ignition the car shot forward a few feet, then went airborne and started doing some very entertaining somersaults and cartwheels with the engine burning. It was not the result I was looking for, but it was spectacular. I didn't find the time to troubleshoot and try this again.

Rocket Manufacturing (1964-1969)

My father had a workshop with a metal lathe, drill press, welding machine, and several tools (including soldering irons, etc.) that we used in manufacturing our rockets. For the test rockets we made the nozzles and nose cones out of wood, using the metal lathe (my dad didn't have a wood lathe in Australia). Once we started the "A" series of larger metal rockets, we made the nozzles and nose cones initially out of aluminium. The nozzle was turned out of a solid piece of aluminium. However, the nose cones were generally larger and the large blocks of solid aluminium were too dear, so my father and I built a small blast furnace[3] in our garage. We made a square out of bricks with a small opening on one side where we placed a pipe with an L-joint on its end and pointed up in the middle of the brick square. We covered the end of the L-tube with heavy wire grill. We then filled in the square with coke. The metal tube was attached to the blower end of a horizontal cylindrical vacuum cleaner via a hose.

After making the blast furnace, the first step in making the aluminium piece we wanted (usually the nose cone) was to make an exact model of it in wood on the lathe. We then filled a tin with wet Plaster of Paris. We coated the wooden nose cone with oil and placed it tip first into the wet Plaster of Paris all the way to its base. Next we tapped the mould[4] tin to dislodge any bubbles that might have formed during the insertion. After the Plaster of Paris was almost dry, we would remove the wooden nose cone by the screw eye that we had previously inserted into the end. This would then leave an impression of the nose cone. We let the mould dry for a couple days before using it.

We used paper and lighter fluid to light the coke blocks in the blast furnace and once it had taken hold, we turned on the blower (vacuum cleaner), which blew air out through the L-tube and into the fire, intensifying it. In the middle of this coke fire we had a small crucible, in which we put pieces of aluminium. After the aluminium melted, we added some powdered alum to bring the impurities to the surface where we would skim them off (we wore heavy gloves, aprons, and safety glasses while working on this). Once the aluminium was all melted and nearly all impurities gone, we would pick up the crucible with tongs and pour the molten aluminium into the plaster mould. Once the mould was filled, we would tap the tin with a hammer to dislodge bubbles. After the aluminium had solidified and cooled completely, we would either remove it by pulling it out or by breaking the Plaster of Paris mould. The resulting nose cone (or other piece) was the right size and shape, but fairly rough. We then mounted it on the metal lathe to finish it off using the lathe tool and fine emery paper for the final polishing. The resulting aluminium nose cone was not as smooth as ones made from aluminium block, but didn't look too bad once painted.

The rocket body was initially made of aluminium tube (which was donated by schoolmate Ray Armstrong's father, who ran Simsmetal), but after several explosive failures, we changed to steel. The aluminium (later steel) nozzle was secured in the body tube by screws, as were the fins made from sheet aluminium (later rockets had the fins brazed in place). At the top end of the combustion chamber was a bulkhead, which was also screwed into place using several metal screws (later rockets had this bulkhead welded into place). For the later rockets (A-4 on) we welded two metal loops onto the side of the rocket (one near the rear and one near the front) to act as launch lugs that fitted over a launch rod, which was between four and eight feet long.

For the B-series rockets we tested several different parachute ejection systems, including a couple that used model rocket engines as the means to open up the payload

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[3] It was actually a smelter, but we called it a "blast furnace" because it sounded more grandiose and it did have a blower to create a "blast."

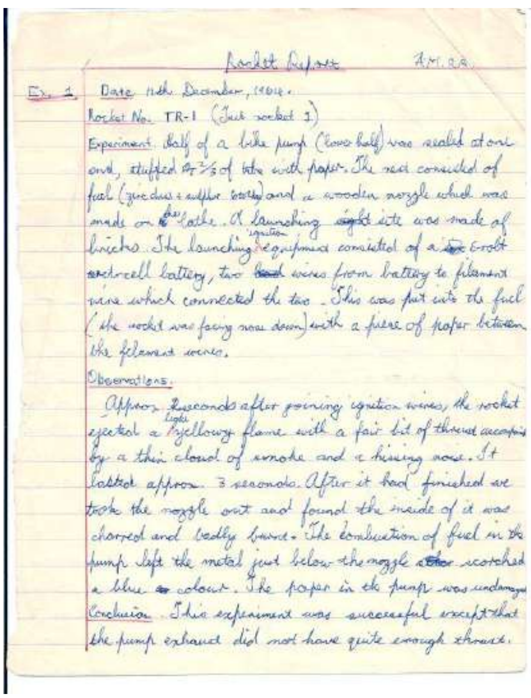
[4] "mold" in American English

section of the rocket and blast out the parachute (by pushing or pulling). The triggering mechanism for the parachute release was a pendulum switch. This was made on the lathe with parts made of brass. One of the model rocket engine methods used a wooden piston containing the model rocket engine. This wooden piston with hollowed section was also made on the metal lathe.

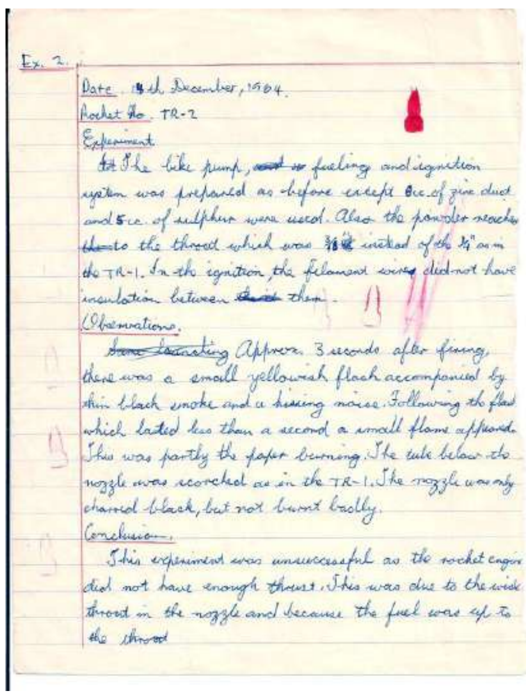
Basement Bomber (1964-1965)

Once I had determined which propellant we were going to use for the rocket, I needed to determine the correct proportions and test the burning characteristics. While in 1st Form, determining the correct ratio empirically was beyond my knowledge at the time, so I relied on trial and error. One afternoon I mixed up a small batch of zinc dust and sulphur (micrograin), and donning my army surplus gas mask (which I had bought for 1/6 or 15c), I tested it in my chemistry lab area under the house (which was also the laundry area). I used potassium permanganate and glycerine to ignite the powder, which I had placed on a tin lid on my mother's washing machine. When the potassium permanganate burst into flame a few seconds after the addition of the glycerine, it ignited the propellant. Micrograin made a most satisfying grey mushroom cloud when it burned in the open. A large mushroom cloud of poisonous zinc sulphide then billowed up to the low ceiling of the laundry, up through the floor boards, and into the kitchen. Unfortunately, my mother was there at the time, and to say I got in trouble was an understatement, especially when she saw the top of the washing machine with the paint burned off. From that time, I moved my propellant tests to outside and to when my mother was not home.

Bike Pump Fizzers (1964)


Rocket Report

Ex. 1. Date 11th December, 1964.
Rocket No. TR-1 (Test rocket 1)
Experiment. Half of a bike pump (lower half) was sealed at one end, stuffed 2/3 of the with paper. The rest consisted of fuel (zinc dust + sulphur [illegible]) and a wooden nozzle which was made on the lathe. A launching site was made of bricks. The launching ignition equipment consisted of a 6-volt [illegible] cell battery, two wires from battery to filament wire which connected the two. This was put into the fuel (the rocket was facing nose down) with a piece of paper between the filament wires.
Observations.
Approx. 2 seconds after joining ignition wires, the rocket ejected a light yellowy flame with a fair bit of thrust accompanied by a thin cloud of smoke and a hissing noise. It lasted approx. 3 seconds. After it had finished we took the nozzle out and found the inside of it was charred and badly burnt. The combustion of fuel in the pump left the metal just below the nozzle scorched a blue colour. The paper in the pump was undamaged.
Conclusion. This experiment was successful except that the pump exhaust did not have quite enough thrust.


Ex. 2. Date 14th December, 1964.
Rocket No. TR-2
Experiment
The bike pump, fueling and ignition system was prepared as before except 8cc. of zinc dust and 5cc. of sulphur were used. Also the powder reached to the throat which was 3/16" instead of the 1/4" as in the TR-1. In the ignition, the filament wires did not have insulation between them.
Observations.
Approx. 3 seconds after firing, there was a small yellowish flash accompanied by thin black smoke and a hissing noise. Following the flash which lasted less than a second a small flame appeared. This was partly the paper burning. The tube below the nozzle was scorched as in the TR-1. The nozzle was only charred black, but not burnt badly.
Conclusion.
This experiment was unsuccessful as the rocket engine did not have enough thrust. This was due to the wide throat in the nozzle and because the fuel was up to the throat

Original Reports of the Test Firings of the Bike Pump Rockets TR-1 and TR-2 in 1964

The next thing to do after testing the propellant was to get a rocket engine to work with it. My first experiments to attempt this involved taking a bike pump and cutting it in half, with each half making a strong tube for the rocket engine's combustion chamber. I still have the original reports written in 1964, which I am reproducing here. Although these tests weren't spectacular, at least the engines did not explode, so we thought it was time to attempt to launch a rocket with the same propellant. John Farrell helped me with these tests.

IYBM (1965)

After the almost successful bike pump static tests (at least they didn't explode!), it was time to try a rocket engine in flight. This resulted in the creation of my IYBM (Inter-Yard Ballistic Missile) in January, 1965. I took an aluminium tube about six inches long and glued some balsa wood fins to it. With my dad's help we made a small rounded wooden nose cone on his lathe (this was the beginning of my learning how to use the lathe). The nose cone was secured in the body tube by screws. We also made a small wooden nozzle, similar to the one used in the bike pumps. By this time I realized that I had the propellant mixture wrong and so this IYBM used one that was closer to our final mixture. I fuelled the rocket and added the ignition filament wire to it. I secured the wire in place, probably using a bit of tape (which also served to prevent the propellant from falling out).

Launch day arrived. Since this was a small rocket and I didn't really have transportation (my dad was away), I decided to launch it in my backyard. At this time I was not aware of the purpose of launch rods (i.e., to keep the rocket on track until it has built up enough speed for the fins to keep it stable), so I just sat the rocket on a board with the ignition wires attached to a six-volt motorcycle battery and switch. At ignition there was a whoosh and the rocket, trailing smoke, arched up and over the fence into a neighbour's backyard (behind and to the left of our house). The rocket attained a maximum altitude of about 20 feet and maximum range of probably 50 feet. I hurriedly scrambled over the fence and retrieved the still-smoking rocket. Fortunately, the neighbour never knew he had been attacked and so did not retaliate! However, I had successfully launched an IYBM – probably the first in Australia (at least the first to not use a commercial rocket engine).

RAB – Rocket Assisted Bicycle (~1965)

My house in Lambton was on top of a fairly high hill and there were a couple of other hills on my bike route to Boys' High. When I started to build rockets and saw how powerful they were, I got the crazy idea of using rocket boosters to help propel me up the hills (like the JATO[5]-assisted takeoffs used by military aircraft). I knew that a lot of heat was generated by the rockets and there was also the need to have protection in case of an explosion. My plan was to use two of the A-series rockets (without fins) mounted on either side of the rear axle. Between the rockets and my legs would be a half-inch wooden shield with aluminium lining. Ignition would be electrical, with a 6-volt motorcycle battery hooked to ignition wires through a switch on the handlebars.

I was not stupid enough to build this and use it without testing. That's what saved me, because I could not come up with a good way to test the whole system in operation

[5] Jet-Assisted Take Off, also sometimes known as RATO – Rocket-Assisted Take Off

without having a human rider. As a result, this just remained as a plan and was never built. That is probably one reason that I am still alive and have all my limbs intact.

Formation of AMRA (1964)

I do not remember how it happened, but I got my closest friends interested in rocketry as well and they joined me in forming the Amateur and Model Rocketry Association (AMRA) in 1964. This club was not a high school organization (I was afraid they would not let us do everything we wanted to do). I was the leader of AMRA since I was the founder and the driving force behind it.

AMRA was founded in late 1964 and lasted all the way until the end of high school in 1969. The organization was based on that of the fictional rocketry club in the Julian May book (which was based on a real amateur rocketry club in Illinois in the late 1950s). The leader of that club was called the Director of Range Operations (DRO), so that was the title that I took. The founding members of AMRA in 1964 were:

Trevor Sorensen	**Director or Range Operations (DRO) and president**
John Farrell	**Director of Technical Engineering (DTE) and VP**
Ross Johnson	**Director of Tracking and Recovery (DTR)**
Phillip Archer	**Director of Timing and Firing (DTF)**
John Groom	**Chief of Airframe Development (CAD)**
Jeff Richards	**Director of Engineering (DE)**

By 6th Form (1969) there were 11 members of AMRA (with final position noted):

Trevor Sorensen	**Director of Range Operations (DRO)** President of AMRA; overall coordination and guidance
John Farrell	**Director of Technical Engineering (DTE)** VP of AMRA; design, development and testing of parachute recovery system; development and construction of BP cabin and support equipment; design and development of internal sensors and camera systems
Phillip Archer	**Range Safety Officer (RSO)** Checks and enforces safety practices at launching range; checks that area is clear of aircraft and unauthorized personnel; arming of firing panel
Jeff Richards	**Director of Aeronautical Engineering (DAE)** Design and construction of rocket body (nose cone, fins, lugs, etc.)
Colin Taylor	**Director of Tracking and Recovery (DTR)** Setup, calibration, and coordination of tracking stations; recovery of rocket after flight; assistance in design and construction of rocket internal recovery system
John Masters	**Director of Biological Payloads (DBP)** Research, selection, and preparation of biological payloads (BP); cabin design and biological sensors development

Leo Pinczewski	**Director of Engineering (DE)**	
		Treasurer of AMRA; overall engineering and coordination; launching pad design and construction; nozzle, heat shield, and bulkheads construction
Steven Dumpleton	**Director of Countdown Procedure & Launching (DCPL)**	
		Preparation of rocket and firing system for launching (or test firing); countdown procedure and firing
Phillip Graham	**Director of Electronics and Telemetry (DET)**	
		Design, construction, and testing of telemetry system; design & construction of firing panel and launching system
John Wurth	**Director of Design and Supply (DDS)**	
		Drawing of all rocket plans; ordering and obtaining supplies. John took Technical Drawing in school and drew a beautiful plan for the B-2 rocket.
David Cocking	**Director of Data Reduction and Computation (DDRC)**	
		Analytical predictions of rocket stability characteristics and trajectory; analysis of actual flight data; mathematical support for all departments
Unfilled	**Director of Propulsion Research (DPR)**	
		Propellant research and testing; nozzle design

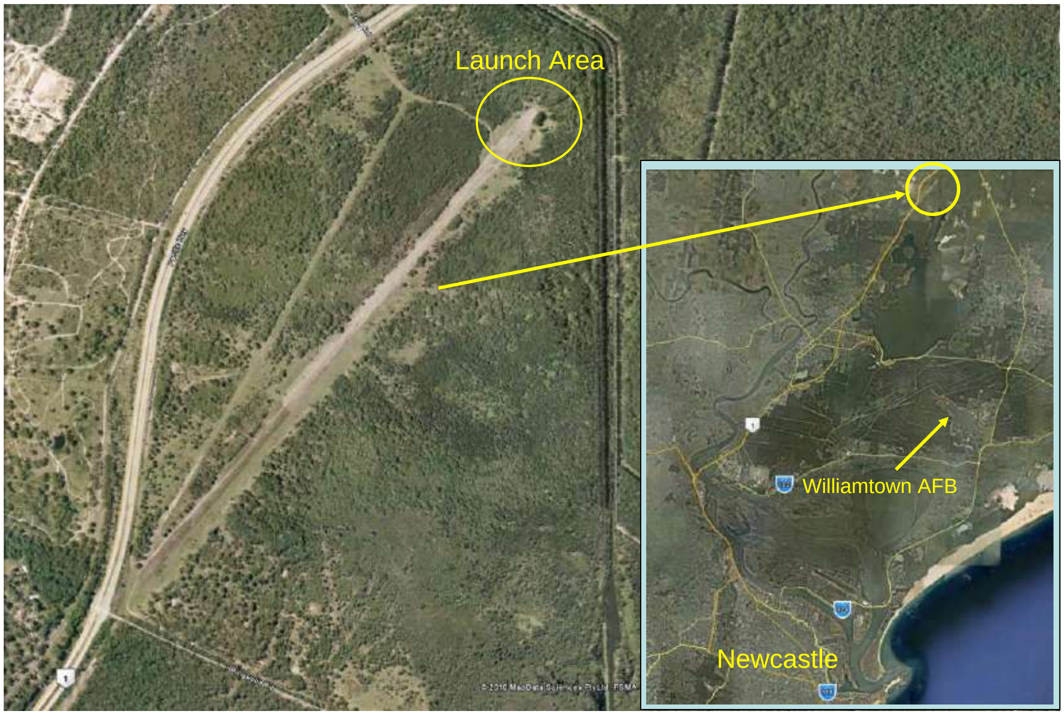
We met and did our planning at school during lunchtimes, although some of the boys (especially John Farrell) would come to my house to help work on the rockets. Leo did a good job as treasurer. Every week between October 1968 and May 1969 he collected the weekly dues from the members – 5c each. Some boys contributed more than others. I still have the financial records of AMRA, and here are the total contributions in descending order: Pinczewski - $1.60, Farrell - $1.35, Taylor $1.35, Masters - $1.35, Sorensen - $1.20, Graham - $1.20, Dumpleton - $1.15, Cocking - $0.80, Richards - $0.70, Wurth - $0.45, and the cheapskate of AMRA was….Phillip Archer - $0.05. The total income from fees was $11.20. This might not seem like much, but our rockets were remarkably cheap. Zinc dust was 40c a pound and we got sulphur for free. For instance, the expenses for the B-4 (we already had the steel body tube, which was muffler pipe and cost about $2) were: 40c for zinc dust, 51c for transfers (decals), 9c for shock cord rubber, 12c for shock cord line, and 40c for batteries. We reused the B-3 nylon parachute, the material for which had cost us $1.50.

For the launches we wore helmets, either army surplus World War II Australian steel helmets or construction helmets/hard hats. They were painted white (except for Steven's) and had the letters of our position in red decals on the front of the helmet. Mine had **DRO**.

AMRA Launch Facilities

The first metal rocket we launched (A-1) was at an old World War II emergency airstrip north of Raymond Terrace. We used my dad's car as shelter. The A-2 through A-4 were launched close to Wallsend High School and we sheltered either behind the car or behind an old abandoned refrigerator. The A-5 was launched on the beach at Tiona and we hid behind a sand dune. The A-6 through A-8 were launched in the shallow waters of Lake Wallis at Tiona and we used trees on the shore as cover. The B-1 was launched at

Ash Island across the river from the BHP steelworks (in Kooragang area) and we built a small bunker out of heaped sand, sheet metal, and stones. B-2 through B-4 were also launched at Ash Island and we used some large steel pipes with sandbags in front of the opening, facing the launch pad as bunkers (see photos).



AMRA Launch Facility #1 where A-1 was launched

Tiona – Sites for the launches of A-5 through A-8

Final AMRA launch site in Australia – on Ash Island near Newcastle (actual area difficult to identify because area has been extensively developed since 1969)

AMRA Launch Pads

The first launch pad we made for the A-Series was made of wood. Attached to a large wooden base was a pair of parallel wooden rails about four feet long and set at an elevation angle of ~85 degrees from the base. These two rails had a wooden support beam each going from near the top of the launch rail to the base. The rocket sat between the two rails with one of its fins passing through between the rails. The rocket was only resting on the rails by force of gravity, thus a non-axial thrust from the rocket engine could cause the rocket to leave the rail before it reached the end. This basic design was used for the first five rockets in the A Series, although the launch pad had to be rebuilt several times.

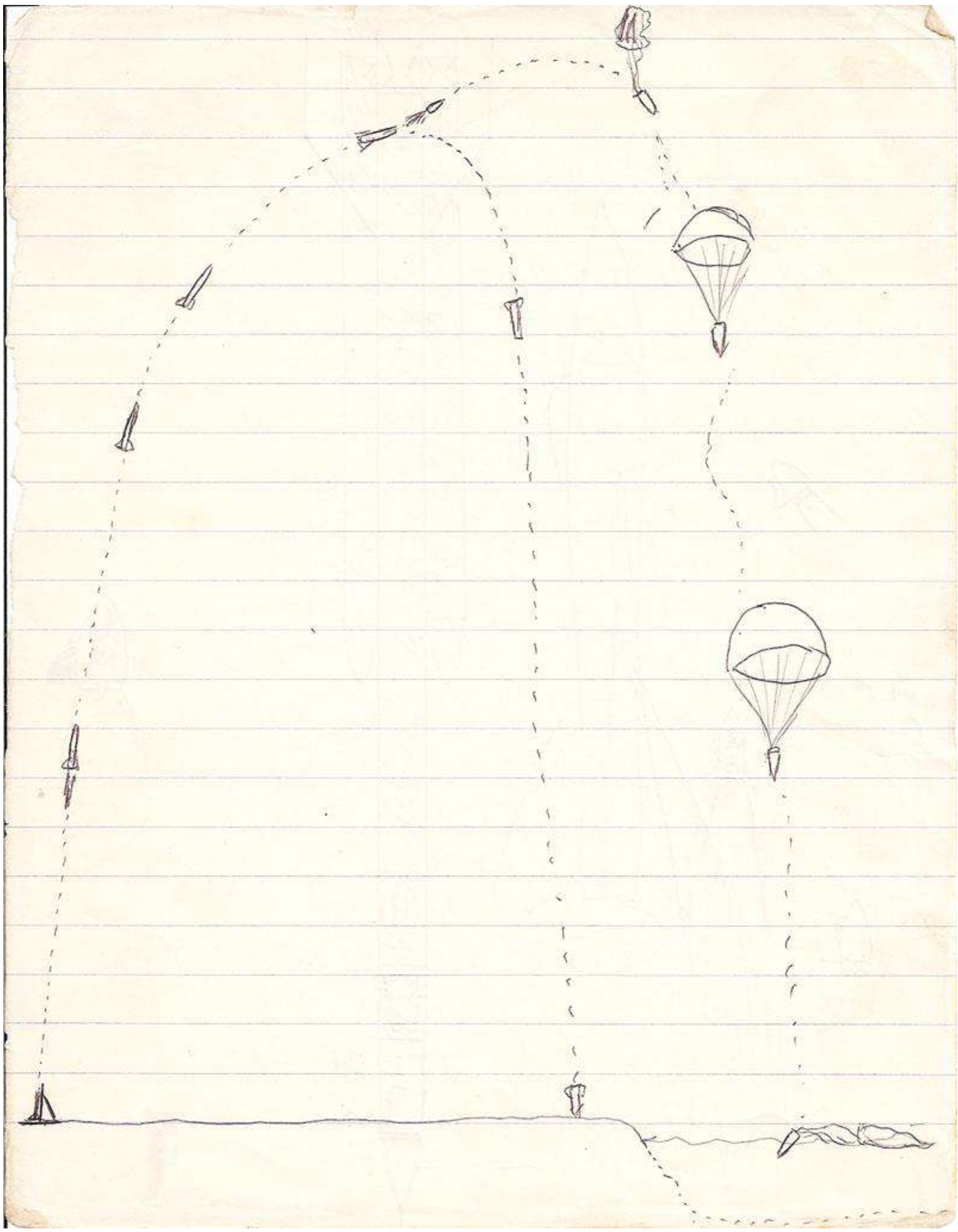
From the model rockets we bought and built, we learned about launch rods with launch lugs on the rocket body. This enabled a near-vertical launch if desired and ensured that the rocket did not leave the launch angle prematurely, since it kept the rocket on course until enough velocity had been obtained to keep the rocket on the desired flight path.

Starting with the A-4 and for all subsequent launches, we used a steel launch rod (from 3/8” to ½” in diameter) attached to a large flat steel plate base. The rod was four feet long for the A series and six to eight feet long for later series. The rod was bolted in place so that the launch pad was easily transported. Next to the rod at the bottom of the plate, a hole was cut in the plate to allow the passage of the ignition wires to the end of the rocket and to allow the rocket exhaust to go into the ground rather than just reflect off the base onto the rocket as it was rising. This type of launch pad worked well.

Dad (helmet on left), John Masters & Colin Taylor in bunkers at Ash Island Range

Phillip Archer and John Masters testing communications at Ash Island Range

Colin Taylor in bunker (above) and ready to recover rocket (r) at Ash Island Range (different launches)



Conceptual flight profile with detachable payload section and water landing - 1965

AMRA Rockets

Having shelved the plans for a liquid-propellant rocket, my friends and I concentrated on developing our skills with the solid propellant rockets. We decided to do a systematic approach of mastering the skills required by developing series of rockets, where each series was designed to master a required skill, and successfully launching three rockets in that series before progressing to the next series. Each subsequent series would be more sophisticated and challenging. Here are the series as we planned them[6]:

Series	Dimensions	Objectives/ Description	Results
A	1.125"* x 15.5" to 1.125" x 17.5"	Fundamental flight vehicle research (especially rocket engine & flight dynamics). No parachute (except A-7) or instrumentation. A-5, A-7 & A-8 carried dye for water landing.	Completed 8 launched 1965-1966
B	1.625" x 28" to 1.625" x 50"	Development of reliable parachute recovery system and continued flight research. Only instrumentation was for parachute system (B-2 also had auxiliary smoke generators)	Incomplete 5 launched 1966-1975
C	3.5" x 120" (revised)	Proposed 1964 – revised 1974. Same parachute system as Series B. Instrumentation includes cabins for biological payloads, cameras, sensors, and telemetry system. Replaced in series sequence by Series G (1974).	Planned
D	2.125" x 55" (1st stage) 1.625" x 30" (2nd stage)	Two stage rocket using originally proposed C-series booster and Series B upper stage. Proposed in 1966.	Planned
E	2.125" x 60"	Booster/glider using radio control for landing. Contains cabin and emergency parachute. Proposed 1966.	Planned
F	3.125" x 65"	Two-section rocket using retro-rocket to soft land payload section. Contains BP cabins, R/C, landing legs with suspension, telemetry & emergency parachute system. Booster recovered by parachute. Proposed 1966.	Planned
G	2" x 87.5" (low altitude) 2" x 112" (high altitude)	Two section rocket using Series B parachute system. Contains cameras, sensors, and telemetry system. No BP. Proposed in 1974 as intermediate series before Series C. GB-1 was high altitude version with vapour generator and no parachute or instrumentation to test the booster. G-1 was low altitude instrumented version with parachute.	Prototype (GB-1) launched in 1975 G-1 almost completed but not flown

* Note: Diameter is outside diameter

In Australia we successfully completed Series A and launched several rockets in Series B, although we never finished developing a reliable recovery system. At university in America I continued the experiments and launched another rocket in the B-series as well

[6] See some of the conceptual plans for these rockets in the Appendix

as a special rocket (GB-1). These latter activities will be described in the last section of this chapter.

A-1 (27th February, 1965)

The A-1 was made from aluminium tubing with an inside diameter of one inch and outside diameter of 1.125”. It was 15 ½” long with loaded weight of about 1.5 lb (1 lb rocket and 0.5 lb propellant). As stated previously it was designed to gather data on the rocket propellant, engine, and aerodynamic stability. The propellant consisted of zinc dust and sulphur in the ratio of 2:1 by volume. The nozzle and nose cone were made of aluminium and turned on our metal lathe. The four triangular fins were made of aluminium and screwed into the body tube. Four of these screws also held the nozzle in place. There were no launch lugs. The nose cone was attached by screws into the front end of the body tube. The rocket was painted the standard AMRA colours of white body with red fins and nose cone.

A-1 prep: L-R: John Farrell, Trevor, Phil Archer

The Rocketeers
L-R: Trevor, John Farrell, Phil Archer, Jeff Richards

A-1 shooting along ground

John & Trevor stomping out fire (it grew much larger)

Images from 8mm movie film

We needed a clear area to launch this rocket. My dad thought that an abandoned World War II emergency airfield just off the Pacific Highway north of Raymond Terrace would be suitable. Three of my friends (Phillip Archer, John Farrell, and Jeff Richards) and I took the finished rocket (unfueled) and rode with my father in his car. It took us close to an hour to drive there. We turned off the road and drove the length of the runway to the far end. We decided to use the Astron Scout model rocket to test our launching procedures. At this time we did not know about launch rods and lugs, so we just placed the rocket onto a round tin. We had the igniter hooked up to the car’s battery through a firing switch. We were about to learn why model rockets use launch rods. We were standing about 20 or 30 feet away from the rocket when Phillip Archer (Director of Timing and Firing) pressed the firing button, the rocket ignited, lifted about 6 feet off the ground and then flew parallel to the ground right towards us! We ducked and scattered as the rocket zoomed past us for about 50 feet before hitting a tree, which was undamaged. The rocket was destroyed.

Now it was time for the big rocket, the A-1. We fuelled it near the car by pouring the propellant through the nozzle. Going through the nozzle into the propellant was a nichrome filament wire that was used as an igniter (I think we used masking tape to hold it in place and keep the propellant from falling out). We placed the rocket on the twin wooden rails of the launching pad that was described previously. We then ran a pair of wires from the rocket igniter to a firing box and the battery of my dad's car.

Phillip Archer again pressed the firing button after the ten-second countdown. Immediately there was smoke and flame that shot out the end of the rocket. It moved up and down a few inches on the launch pad for several seconds, and then while still burning, fell over to the right and shot along the ground for about 40 feet and set the grass on fire. My friends and I ran over there and started trying to stamp out the fire. Dad recorded all this on movie film, but then realized that we needed help and put down the camera. He grabbed some gunny sacks (sugar bags) that he had in the boot of his car and using those we finally put out the fire after it had burned an area the size of a large room.

We decided not to let a minor setback stop us since the rocket was still in pretty good condition other than badly burned paint. After the rocket had cooled down we cleaned the residue out, then poured in more propellant. Once the igniter had been put in place we put it back on the launching pad. We did the countdown and just as Phil pushed the firing button, two jet fighters (F-86 Sabres?) from the Royal Australian Air Force (RAAF) flew directly over us at about 100 ft. altitude. The reason they were so low is that we were right next to the strafing range for the Williamtown RAAF base and they were on a practice strafing run. Fortunately, the rocket did not launch. If it had been one of our later successful rockets, it quite easily could have brought down one of the jets, especially from that altitude. Phil quipped to my dad, "You know, Mr. Sorensen, if we had shot down one of those jets, I could just see the newspaper headlines: 'SCHOOLBOYS SHOOT DOWN A QUARTER OF AUSTRALIA'S AIR FORCE!'" That might have been a slight exaggeration, but nevertheless I'm glad we had a misfire. In fact, the rocket propellant ignited but burned only very slowly (I think we got the mixture wrong), generating a lot of heat, and causing the rocket to once more fall over, but it did not shoot along the ground. It did, however, burn the paint even more and badly bent the fins.

A-2 (6th May, 1965)

The A-2 was similar in size to the A-1, except the length was increased to 16-1/2 inches. It also was made of aluminium tubing with aluminium fins, nozzle, heat shield, and nose cone. The A-2 also had triangular fins like the A-1. In this rocket we used zinc dust and sulphur in the ration of 1:2 by volume.

This rocket was launched at what was designated as AMRA Launching Facility Range #2, which was an empty field about a quarter mile from Wallsend High School. We hid behind my father's car during the launch. During the construction of the A-2 we forgot to screw the nose cone to the body; therefore, at ignition the rocket blew the nose cone up a couple of hundred feet. The rocket was still on the launching pad basically undamaged, except for two fins which were bent when it fell over. The wooden launching pad was destroyed.

A-3 (19th June, 1965)

The A-3 was made from the A-2 with two new fins and a new heat shield. We again used the propellant in the ratio of 1:2 zinc dust to sulphur by volume.

A-3 on pad with refrigerator shelter in background

The A-3 was also launched at the Wallsend range. We hid behind an old refrigerator lying on its side that was about 50 feet from the launching pad. At ignition the rocket exploded, sending the nose section more than 100 feet in the air and blasting the rest of the rocket out in the area surrounding the launching pad. Hiding behind the refrigerator, we heard some loud thumping sounds at the time of the explosion. When we emerged from behind the refrigerator, we saw some pieces of rocket shrapnel embedded in the side of the refrigerator facing the pad.

The nozzle survived, but the rest of the rocket was completely destroyed, as was the launching pad. Most of the parts (pieces) of the rocket were found and the nozzle and nose cone were used in the next rocket (A-4).

A-4 (July, 1965)

The A-4 was the same size as the A-3 with some modifications. It was concluded (incorrectly) that the main reason the previous rockets did not work was that they did not have a burst diaphragm. The function of the burst diaphragm is to momentarily shut off the combustion chamber from the nozzle at ignition and thereby allowing the pressure in the combustion chamber to build up before the diaphragm ruptures. In the A-4 the burst diaphragm was made of 0.002 inch brass shim stock.[7] The nozzle throat diameter was made larger. A wooden heat shield was used, and the propellant was zinc dust and sulphur in the ratio of 3:1 by weight (which was more accurate and consistent than measuring by volume). To avoid having to make a new wooden launching pad every time due to their continued destruction during each launch, we built a new launching pad

[7] In July 1965, in a back issue of *Scientific American* in the Amateur Scientist section I found an article about the activities of a real high school amateur rocketry club that built a series of rockets that they flew at night with a strobe light in a transparent nose cone to help them track the trajectory (on film). They described the burst diaphragm they successfully used, which we adopted as well. This article also gave details concerning the use of a pendulum switch, which we used to trigger the parachute ejection in the B-series rockets.

consisting of a vertical steel rod welded to an iron plate. We screwed round lugs (clips) to the side of the rocket body. The rod slid through these launch lugs.

The A-4 was also launched at Wallsend. At ignition there was a small explosion which destroyed the bottom half of the rocket (except the nozzle) and sent the top half up into the air (again). After this failure it was concluded (correctly) that aluminium was not a suitable material for the rocket body. It was thus decided to use steel tubing in the next rocket.

A-5 (September, 1965)

The A-5[8] was similar in size and outward design to the A-4. The main difference was that we used a steel body tube instead of an aluminium body tube as in the previous rockets. However, there was still a concern about the weight of the rocket, so the steel tube with 1/16 inch thickness walls initially was thinned on my dad's metal lathe.

We screwed in a wooden heat shield that was ½ inch thick. There was a small space between the heat shield and the nose cone. Since we intended to launch the A-5 in the shallow Lake Wallis at Tiona, we drilled several ¼ inch holes in the chamber between the heat shield and the nose cone. In this compartment we packed some potassium permanganate crystals, which we hoped would act like a dye when the rocket hit the water, thus enabling its recovery. As it turns out, we decided to launch the A-5 on Tiona Beach instead of the lake. The propellant used was zinc dust and sulphur in the ratio of 3:1 by weight.

This launching was done as part of a Children's Camp being held at Tiona that week. John Farrell helped me with this launch and also with the model rocketry class I taught at the Children's Camp. The A-5 launch was during the normal recreation period on Friday afternoon when we launched all the rockets that the boys[9] had made. The rockets that the campers built were similar to the Estes Astron Mark, and some flew successfully. We also launched a slightly larger model rocket that had a clear plastic payload section. We thought it would be good to add a payload, and the only thing we could find that would fit in it were some jumper ants (which can give you a nasty bite). This flight was also successful and the ants (which we named "Astroants") survived, but when we opened up the payload section, they were hopping mad and we left them alone while they escaped.

We finally launched the A-5. At ignition there was an explosion, which sent the top section of the rocket approximately 300 ft. into the air. It landed in shore break of the ocean, and we were able to retrieve it. The bottom section of the rocket was destroyed (except the nozzle which was only slightly burnt). The heat shield had blown out, but the nose cone was still attached to the top section of the rocket.

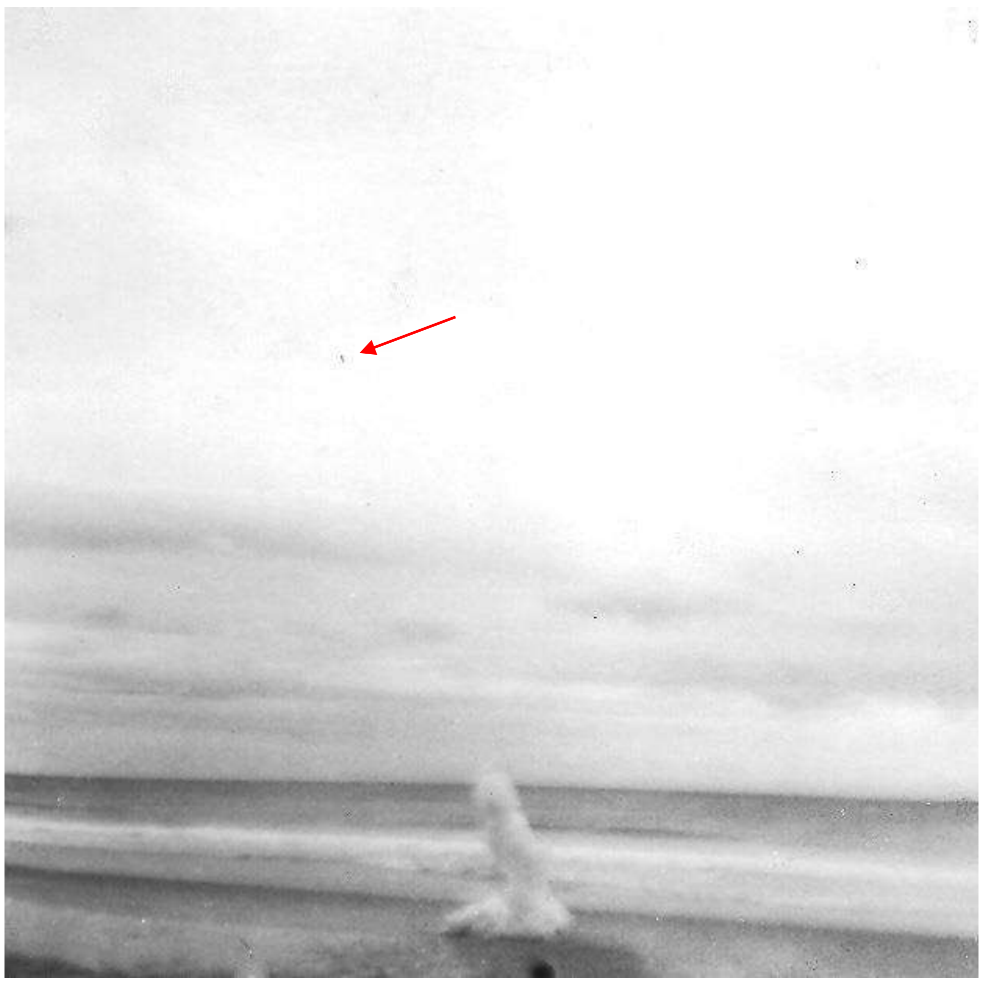
The cause of the explosion was determined to be due to the metal lathe cutting unevenly when we attempted to thin the body wall thickness, thus creating a weak section in the middle of the rocket.

[8] Prior to the A-5 the rockets were designated as "X-", so we had X-1, X-2, X-3, X-4. After the X-4 we split the types of rockets into separate series instead of a single series. These first rockets were part of the A Series, so this rocket was the first designated in the new nomenclature: A-5. Retroactively we renamed the earlier rockets.

[9] There were no girls in that particular class, although at other camps we had girls make rockets.

John Farrell preparing a camp rocket for launch on Tiona Beach prior to A-5 launch

A-5 ready for launch on Tiona Beach, 1965



A-5 “launch” (note nose section)

A-6 (November, 1965)

In the A-6 we made a number of improvements. Firstly, the steel body tube retained its original thickness. Next, the aluminium heat shield was secured in the body tube by several long metal screws. A new nozzle and nose cone were also made. The nozzle was made of steel with a slightly larger throat diameter (0.5") than the A-5 and was secured by longer metal screws. The nose cone was made of aluminium with a thicker flange and secured by four long screws. The rocket still had aluminium fins that were attached to the body by screws, but this was the first rocket to have larger four-sided fins rather than the previous triangular fins. To make the rocket stable, a lead weight was placed in the nose cone. The overall length of the rocket was 17 ½ inches with a 1 inch inside diameter and 1.125 inches outside diameter. The propellant consisted of zinc dust and sulphur in the ratio of 1:1.5 by volume (mixing it in the field we did not have a means to weigh the ingredients, so did not mix by weight). The rocket had been painted the standard white and red, but the white paint was not fully dry and some was lost during handling giving, the rocket a mottled appearance.


A-6 on launching pad on Lake Wallis, Tiona in Nov. 1965

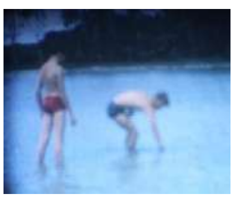
The steel launching pad (same as for the A-5) was placed on timbers sitting in the shallow water of Lake Wallis (this became AMRA Launching Facility Number 3) with ignition wires leading from the rocket to the firing box and battery on the shore, where we watched the launch from the cover of tree trunks. This was our first successful launching and flight. At ignition there was a whooshing sound and a cloud of smoke over the water surrounding the pad with a smoke trail going straight up to about 50 feet where it stopped. The rocket went far too quickly for any of us to see (much faster than the model rockets we had launched) and none of us saw where it landed. It was estimated that it had gone about 2000 feet in altitude at about 600 mph. We were ecstatic; at last our hard work and perseverance had paid off! I had a feeling of exhilaration that was unfortunately rare in my rocketry career/

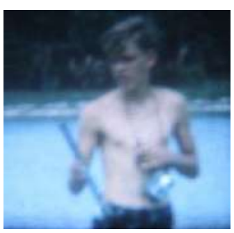
We spent about 90 minutes searching the lake for it, but without success. The A-6 did not have any dye in it to help mark its location. Despite not finding the rocket, AT LAST A SUCCESS!!! We broke out the soft drinks to celebrate our first successful flight.

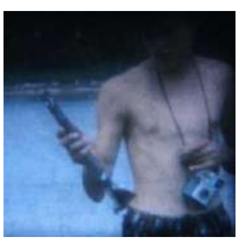
A-7 (December, 1965)

Building on the success of the A-6, we constructed another rocket in the series, but with some modifications. The A-7 was also made of steel tubing with a steel nozzle, aluminium nose cone and fins, and a ½ inch thick aluminium heat shield. It had the same dimensions as the A-6, but the main difference was that a small parachute was put in this rocket. It also included a small compartment with holes in the side that contained a dye to colour the water when it landed. There was no ejection system for the parachute. Instead, the nose cone was made to fit loosely in the body tube so that when the rocket reached apogee and tipped over, the nose cone would fall out, pulling the parachute with it (at least that was the theory). Because of time constraints, we did not paint this rocket. Propellant was zinc dust to sulphur 1:1.5 (volume).

The A-7 was launched at the same site as the A-6. Ross Johnson assisted me for this launch. This time we put the launching pad on a box. The launch and flight were successful, although the nose cone was dislodged during ascent and when it separated, took the parachute with it. The nose cone with parachute floated down to the ground, but we failed to find it. We later found the rocket buried almost to its fins in the sandy bottom of the shallow lake in the vicinity of the launching pad. The nozzle was missing (and never found) and the dye had failed to work, but otherwise the A-7 was in good condition.







Above:
Ross Johnson & Trevor prepping A-7 at Tiona

Above Right:
A-7 on launch pad

Left:
A-7 retrieval images from 8 mm movie film (Ross in red swimmers and Trevor with camera)

Right:
A-7 body in sandy lake bed minus nozzle

A-8 (January, 1966)

We used the A-7 body for the A-8. A new steel nozzle and aluminium nose cone were made since they had been lost. Otherwise, the rocket structure was the same except that the parachute was replaced by dye in the compartment between the heat shield and the nose cone. Holes were drilled in the compartment for the dye to work. The propellant mixture was also changed, with a ratio of zinc dust to sulphur of 1:1 by volume. We had time to paint this rocket in our standard AMRA colours of white body with red fins and nose cone.

A-8 launch

The A-8 was also launched on Lake Wallis at Tiona. The launching and flight were successful and although we saw the impact splash, the dye again failed to work and we never found the rocket. Based on what we have learned subsequently, I believe that the rocket completely buried itself in the sand on the lake bottom and we would have needed a metal detector to find it. We estimated that the rocket went over 2000 feet altitude at more than 600 mph.

Since the purpose of the A Series was to develop a reliable rocket that flew well, with three successes in a row, we decided it was time to move on to the B Series.

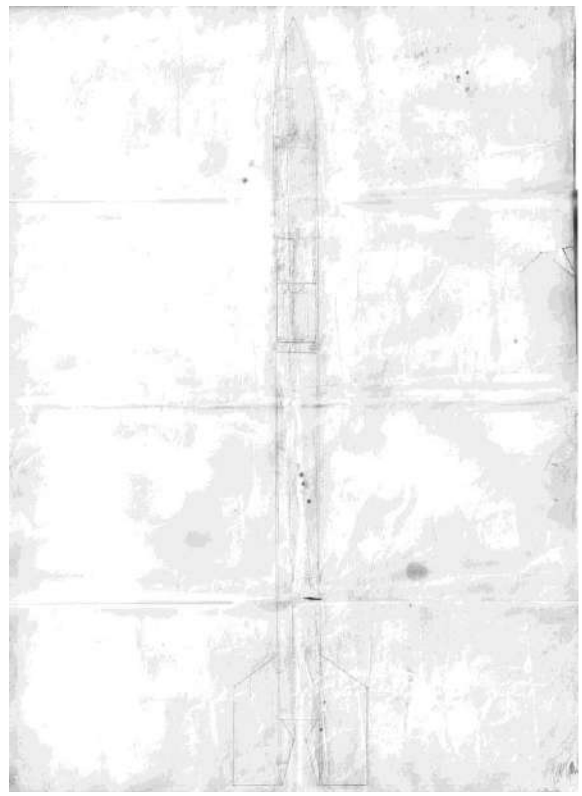
B-1 (August, 1966)

In early 1966 I came across another book which was to prove very influential in the development of the rockets of the B Series. This book was *Projects: Space* by Judith Viorst and published in 1962 by Washington Square Press. It had several chapters that were of interest. One chapter entitled "Rocket Propulsion System" by John S. Arrington, gave theoretical characteristics of micrograin propellant for the theoretically best mixture ratio of 2.04:1 (zinc dust to sulphur by weight). The rocket he built had 1-7/8" inside diameter (combustion chamber) and carried a total 11.58 lb. of micrograin propellant. He calculated a theoretical thrust of 1000 lb., but when he tested the engine, it only produced 40 lb. thrust for 3 seconds burning time. In this same book was another chapter entitled "Ignition of Multi-stage Rockets" by Thomas A. Rickard of the Pacific Rocket Society. He used micrograin very successfully with the mixture ratio of 78% zinc dust to 22% sulphur by weight. Since this latter mixture ratio seemed to produce much better results than the theoretically best ratio, we decided to use it in our B-series rockets.

The B-1 was the first rocket of the B Series, the purpose of which was to develop a reliable parachute recovery system. These rockets were larger and more sophisticated than the A Series.

Technical Description

The B-1 was 28 inches long (compared to 17-½ inches for the A-8) and 1-½ inches inside diameter (compared to 1 inch for the A-8). It weighed two pounds empty and carried three pounds of propellant for a total weight of five pounds (½ pound empty, 1 pound propellant, 1-½ pounds total for the A-8). The casing material was steel, had a wall thickness of 0.0625" and was 24.5 inches long. The nose cone was made of cast aluminium and excluding the flange was 3-½ inches long. A cylindrical cavity was machined from its centre to accommodate a small model rocket motor to pull out the parachute at the apex of the rocket's flight. The parachute was made of black plastic and was three feet in diameter. The shroud lines were made of cotton thread, ten being attached. To ignite the rocket motor just past the apex of the trajectory, we had a pendulum switch and four penlight batteries attached to a nichrome wire igniter in the rocket motor. The parachute and instrumentation section took about eight inches of the rocket length.



B-1 Construction Plans drawn by Colin Taylor (dirty from using in the workshop)

The heat shield was made of aluminium and was 0.375 inches thick. The nozzle was made of steel and was 3" long with a throat diameter of 0.5" and had a convergent angle of 24° and divergent angle of 12°. There were four aluminium fins which measured on the sides 5" x 1.75" x 3.75" x 2.1875" and each was mounted to the body by three metal screws, two of which also secured the nozzle. Two aluminium launch lugs were screwed to the outside of the body. Propellant was again micrograin with the ratio of zinc dust to sulphur 78% to 22% by weight. The propellant section was 12 inches long. The burst diaphragm was 0.002 inch brass shim stock. A nichrome filament wire igniter was used. The shock cord connecting the nose cone to the rocket body was made of tough rubber 36" long by 0.25" wide by 0.0625" thick.

Launch Activities

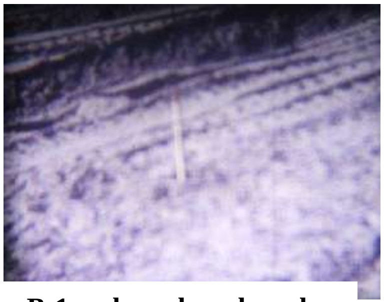
The B-1 was launched from our new launching range (AMRA Launching Facility Range Number 4) at Ash Island, just across the river from the B.H.P. steelworks. The steel launching rod was 0.5" in diameter and 8 ft. long, and was bolted to a steel base plate. For the Director of Timing and Firing (now Steven Dumpleton), we constructed a small bunker mad of heaped sand with some corrugated iron and some stones.

Before we launched the B-1, we decided to launch another model rocket with a biological payload. The rocket was an Estes Astron Space Plane kit that we had bought from Model Rocket Industries in Sydney. The Space Plane was a rocket glider and we were hoping for a good launch, then a gliding flight back to the ground and soft landing. We had a metal rod and stuck it into the ground as a launching pad. Prior to coming to the launch we had problems finding a suitable biological subject small enough to fit into the payload section of the Space Plane. John Masters was our Director of Biological Payloads (DBP) and had the responsibility of finding the subject. In the short time available, the only one he could catch was a snail we subsequently named Hermann the Astrosnail. John placed Hermann in the payload section and then we pushed the rocket down onto the launching rod, which was a bit of a snug fit.

At ignition the Space Plane took off, but took the launching rod with it. It only went about 20 feet into the air, then hit the ground hard with the rocket engine still burning. We raced over and after burnout we opened up the payload section. Inside was a green slime that used to be Hermann the Astrosnail. Since John was the DBP, it was his duty to scrape poor old Hermann out of the rocket. We then buried him nearby with full AMRA military honours. He had given his simple life for the advancement of science (or our craving for excitement??). This was the last biological payload we ever flew.

B-1: L-R: John Masters, Colin Taylor, Trevor, Leo Pinczewski, Steven Dumpleton, John Farrell

At ignition of the B-1 there was a mild explosion and swhooshing sound as the rocket soared up. The smoke trail was plainly visible for several hundred feet where it ended. Up to that point the smoke trail was straight and right on course. A few seconds elapsed and when no parachute appeared we were about to start looking for the rocket when a loud whistling was heard for a few seconds (causing us to duck for cover), then ended abruptly. Although we searched the area thoroughly, we could only find the aluminium nose cone, which had lost its ejection engine. We believed that the pendulum switch worked, but the lines to the parachute broke when the nose cone was blown off by its rocket engine. We estimated that the B-1 went several thousand feet into the air at probably 700 mph. Based on later experiences, I believe this rocket body completely buried itself into the ground, which is why we could not find it (either that or it went into orbit).



B-1 on launch pad ready for ignition

Trevor's hand and B-1 nose cone as found on ground

Images from 8mm movie film

B-2 (7th December, 1968)

The B-2 was of similar design to that of the B-1. However, we had to completely construct a new rocket since only the nose cone of the B-1 was recovered, although the nose cone was undamaged and we were able to use it again for the B-2.

Technical Description

An investigation into the failure of the B-1 recovery system revealed several design flaws in the parachute system and its construction materials, although it was assumed that the pendulum switch and ejection rocket functioned correctly. The main reason for the failure was found to be that when the nose cone was blown from the rocket by means of the ejection engine, the cotton thread shroud lines connecting the parachute to the nose cone broke, leaving the parachute in the rocket body. After burnout, the small ejection engine in the nose cone successfully blew itself free of the nose cone as planned by means of a small charge built into the engine. This decreased the weight of the nose cone allowing for a slower descent and landing. Both the nose cone and rocket completed their separate ballistic trajectories, unhindered by the recovery system, and impacted somewhere in the firing range. Only the nose cone was found.

It was also found that the parachute material (plastic) was too weak for the weights and forces involved; the means of connecting the shroud lines to the parachute were inadequate; the shroud lines themselves were far too weak; and an ineffective shock cord system was used. Also, a better protective method should have been used to protect the parachute from the hot exhaust of the ejection rocket.

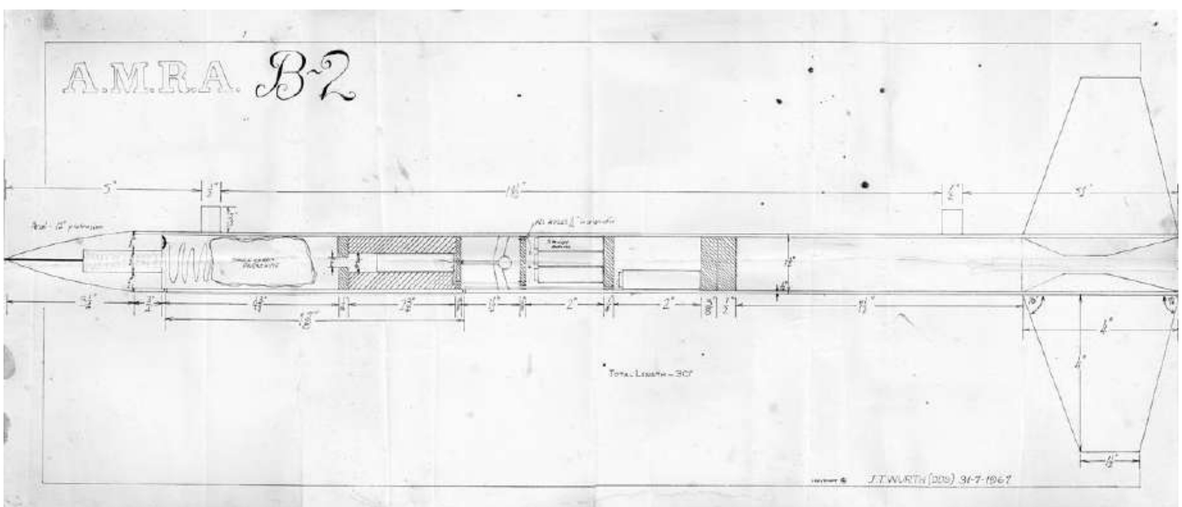
These findings were taken into account during the design of the B-2, and as a result, a completely new recovery system was designed, which we considered to be more effective. The pendulum switch seemed to work, so we again incorporated it in the B-2, with four penlight batteries used to fire the separation system. In the B-2, instead of using a pulling ejection system like in the B-1, we used a pushing ejection system instead. This protected the parachute from the ejection engine exhaust gases. In this system, the ejection engine, instead of being in the nose cone and pulling the parachute out, was placed in a wooden piston below the parachute, and at the apex of the trajectory, was to push the nose cone off and parachute out. The parachute shroud lines were connected to the nose cone, which was connected by a strong nylon cord to the piston, which was in turn connected by means of a rubber shock cord to a half-inch thick wooden bulkhead secured in the rocket body by screws.

The pendulum switch was of a similar design to that of the B-1, with only a few constructional differences. The pendulum switch and batteries were constructed in the new module form, allowing ease of construction and mounting. This method was so successful that it was incorporated in all future rockets. The module consisted of three aluminium disks joined by three 0.125” diameter steel rods and spaced about two inches apart, the pendulum switch being in the top compartment and the batteries in the lower compartment. The upper section was enclosed by a sheet of aluminium, which acted as the ring material of the pendulum switch (brass or copper was used in later rockets because they are better conductors). Instead of using a stiff rod for the pendulum as in the B-1, a flexible ball-chain with a heavy brass ball at the end was used. This proved to be more versatile than the older pendulum. When the rocket was ready for assembly, the completed module was then just slipped down the body tube and the arming wires were fed out through a small hole in the rocket body. It was intended to use a small arming staple switch, but the technical difficulties involved were too great to be solved within the time available. The ignition wires from the pendulum switch were fed through the retaining bulkhead to the ejection rocket engine in the piston. Attached to the ends of the ignition wires was a small nichrome ignition filament which was sealed in the end of the ejection rocket engine by melted pitch.

A bungee shock cord system connected the piston to the retaining shield, and the nylon shock cord itself was about two feet long when fully extended. A foot length of nylon shock cord then connected the piston to the nose cone. The strong shroud line threads were also connected to the nose cone. The parachute itself was made of bright red nylon material and was three feet in diameter. The ten shroud lines were sewn to the parachute instead of the tape disks used in the B-1.

The steel nozzle was of the same size and design as that of the B-1 and had an identical burst diaphragm. However, the B-2 propellant section (combustion chamber) was only 8.25 inches long compared to the twelve inch section of the B-1. This was to lower the maximum altitude and thus improve the chances of recovery. The same propellant composition was used except that the proportions of the constituent chemicals (zinc dust and sulphur) were measured much more accurately and the resultant propellant was made much finer, giving a more efficient propellant mixture which left practically no residue when burned.

At the top end of the combustion chamber was a half inch thick aluminium heat shield secured to the body tube by four long 0.125” self-tapping screws. Above this was a half inch layer of Plaster of Paris, which acted as a sealant and an insulating layer between the heat shield and the batteries in the automated ejection module.



B-2 Construction Plans drawn by John Wurth (DDS) – some details are incorrect, such as the aerial in the nose cone and the length of the nozzle throat caused by incorrectly making the nozzle the length of the fins (it was shorter). Strap-on smoke rockets were added later.

A new fin design was used for the B-2 (and for subsequent rockets in the B Series). Four aluminium trapezoidal fins were made out of aluminium, each measuring 4” x 4.25” x 1.5” x 4” and attached to the rocket body by two self-tapping metal screws, which also served to hold the nozzle in place. The lower launching lug was the same as those on the B-1, but the upper lug was made of sheet steel and welded onto the body because protruding screws would have hindered the ejection piston, possibly snagging the parachute.

A completely new feature incorporated into the design of the B-2 was the use of two cylindrical tubes of smoke powder to aid in the tracking and recovery of the rocket. Each one looked like a typical booster rocket because of the wooden nose cone and was placed against the rocket body at the bottom between the fins. Each was attached with an aluminium clip to the rocket body. The overall length of each of these smoke rockets was 8.5 inches, with the nose cone being three inches long. The inner diameter was 5/8" and at the bottom end was a 0.25" thick wooden plug with a 0.25" hole in the centre. The means of ignition was the same as used for the main rocket, i.e., a nichrome ignition filament placed in the powder and connected to a 12-volt car battery. However, in the smoke rockets the ignition wire was held in place by melted pitch instead of the burst diaphragm as in the main rocket. The smoke powder used was one developed by our own research and consisted of zinc dust, sulphur, charcoal, aluminium dust, potassium nitrate, and fine sawdust. It was intended for these smoke rockets to burn for longer than the duration of the flight. The overall length of the B-2 was 30 inches and the weight was approximately five pounds, of which three pounds was propellant. The B-2 was painted the standard white and red, as were the smoke rockets.

Launch Activities

The B-2 was launched at a new location on Ash Island about a half mile from where the B-1 was launched. We took cover in some large steel drain pipes, except for the Director of Tracking and Recovery (Colin Taylor), who was about 200 yards away in a makeshift shelter to better enable him to follow the flight of the rocket. We also used a set of transceivers (walkie-talkies[10]) to communicate between the firing area and the DTR. They were tested successfully, but a malfunction occurred in one of them, preventing their use during the actual firing of the rocket. For the first time we also used a set of military surplus field telephones. However, they weren't needed since all the AMRA personnel were in the same general area (except for the DTR), but they were tested under actual launching conditions and functioned perfectly, proving their suitability for future launches when they might be useful.

Just before ignition of the main rocket, the two smoke rockets were ignited and went off with a thud and a fairly large cloud of smoke, which unfortunately did not last as long as we expected. This was followed by the firing of the main rocket engine, which resulted in a large explosion and billowing of smoke. We were not sure what had happened at first, but it definitely did not sound like a successful launching. Our fears were confirmed when the smoke cleared and revealed the rocket body still on the launching pad (minus the nose cone) and badly burnt in some areas. We noticed a parachute floating down by itself and quickly retrieved it after it landed. A closer inspection of the rocket showed that the heat shield and everything above it had been blown out (like a mortar), leaving the nozzle as the only component still in the tube. The rocket itself had actually gone about six inches backwards through the 1/16th inch steel plate of the launching pad and into the ground. The fins were badly mangled and sheared off the tube, as were the two smoke rockets, which were relatively undamaged except for their paint. The nozzle was undamaged. I believe we probably set at least an Australian record for the minimum maximum altitude achieved by a rocket (-0.5 ft.)!

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[10] These walkie-talkies were a present for my 17th birthday sent to me by Beth in the United States.

After extensive searching of the area, all the internal components of the rocket were found. The first object found was the aluminium heat shield, which was the cause of the failure as the screws holding it had been sheared off. The heat shield had then acted as a piston and ejected all the other components to a considerable altitude. The force of the propellant going up through the tube was sufficient for the rocket body to punch a hole through the steel plate despite the thrust coming out through the nozzle and the resistance of the fins and smoke rockets.

B-2 on launching pad – note smoke rockets

B-2 explosion – smoke to the right is from smoke rockets

B-2 after explosion – note recovered parachute in background

B-2 punched through steel pad – note hole in ground to right

Next to be found was the recovery system ejection module. The batteries were undamaged, but the section containing the pendulum switch had been squashed flat. The three steel rods from the module supports had smashed through the half-inch wooden retaining shield and hit the piston, which was relatively undamaged. The rubber part of the bungee cord connecting the piston to the retaining shield was burned through and the nylon cord was singed in places, but was still strong. The parachute shroud lines had all broken about six inches from the nose cone as they had been subjected to large forces during ejection, much greater than predicted to be encountered during a nominal flight. Only one section of the parachute was burned and it was easily repaired. The nose cone itself was undamaged.

B-3 (30th January, 1969)

The B-3 was of similar design to that of the B-2. However, again we had to completely construct a new rocket except for the nozzle and nose cone, which were recovered in relatively good shape from the B-2 wreckage. We used the same basic piston ejection system (which was not tested in the B-2), but allowed a couple more inches of the body tube for containing the ejection module and parachute. The total length of the B-3 was 32 inches compared to 30 inches for the B-2. The length of the combustion chamber was kept at 8.5 inches. The propellant mixture was also unchanged (78% zinc dust to 22% sulphur by weight). We decided that the attached smoke rockets of the B-2 had not performed satisfactorily, so until that problem could be solved, we would not use them again. Thus the B-3 did not have these "boosters".

We launched the B-3 at the same location on Ash Island as we had the B-2, again using the large pipes with sandbags piled in front as bunkers. This time the transceivers worked correctly. We slid the rocket down the 8-ft long launch rod and John Farrell, as the Director of Technical Engineering (DTE), who was responsible for the recovery system, armed the rocket's recovery system prior to the connecting of the ignition wires. At ignition there was the satisfying sound of a successful launch, but because we had shortened the combustion chamber, the smoke trail only went about 50 feet into the air. From about 100 feet altitude we noticed the red parachute, nose cone, and ejection piston coming down, which we quickly retrieved. The DTR observed the descent of the rocket and got a general bearing, which enabled us to find the rocket fairly quickly. When we located the B-3 it was buried in the ground to its fins, and this was despite having a hollow tube several inches in length hitting the ground instead of a nose cone. We had a shovel and I dug most of it out, but Leo Pinczewski finished and pulled the rocket out of the ground. The recovery module containing the pendulum switch was again squashed, as it had taken the full force of the ground impact.

We almost had a successful mission. In fact, this was the most successful flight of the entire B Series (there were to be two more launches after this one). Our investigation revealed that almost everything had worked as planned. The pendulum switch closed the circuit when the pendulum touched the ring, igniting the ejection rocket engine that then propelled the wooden piston up, pushing off the nose cone and ejecting the parachute. The problem is that this happened early during the ascent when the velocity was near maximum instead of after the apex of the trajectory. It was determined that the pendulum switch was more sensitive than expected and the lateral motion of the rocket during powered flight cause the pendulum to hit the side and the ejection to take place prematurely. The aerodynamic forces were much too strong for the parachute and shock cords, which snapped immediately upon exposure to the airstream. This didn't seem to slow down the rocket much and it still had enough velocity and momentum when it hit the ground to bury itself over two feet. It seemed that all that was needed to correct the recovery system failure was to add a resistor of some sort (e.g., filament wire) to the pendulum switch circuit to prevent transitory contacts from firing the ejection system. It would thus take a second or two of sustained contact to pass enough current to ignite the ejection rocket in the piston.

Phil Archer holding the B-3

B-3 on launching pad

John Farrell arming B-3 parachute recovery system

B-3 on launching pad

Successful launch!

B-3 buried to fins

Leo Pinczewski and Trevor

B-4 (11th April, 1969)

Technical Description

Since the B-3 basic structure was relatively undamaged, we reused it for the B-4. This meant that we had to remove the fins, and remove the nozzle with gentle tapping on the body tube to help dislodge it. Using a wire brush we scrubbed out the combustion chamber and removed the residue from the nozzle. We remounted the nozzle on the metal lathe to polish it using ultrafine Emery Paper so that it looked as good as new, except for some shallow scarring near the throat, which we were able to mostly polish out. The fins were cleaned up, and the paint was stripped from the rocket body and fins. We repainted with the AMRA colours, with the addition of two ½ inch red bands around the body, one of which was at the location of the heat shield, and the other at the forward bulkhead. When the paint had dried, the rocket was reassembled (except for the nozzle, which had to be inserted and secured after fueling). A new brass burst diaphragm was soldered to the top of the nozzle and the two small wires leading to the nichrome filament wire igniter were poked through the nozzle so that several inches protruded from the rear, ready to be connected to the leads from the firing box.

The pendulum switch was damaged, but we were able to salvage most of the parts to make a new one. In an attempt to prevent the premature triggering of the recovery system, we added about a one-inch length of nichrome resistance wire to the pendulum switch wiring. It now required about a half second of continuous contact to trigger the ejection system, which should eliminate the chance of "rattling" during ascent to trigger the firing. The piston was undamaged except for some scorching from the ejection engine. The nose cone and parachute were undamaged. Once the pendulum switch had been repaired, new batteries were installed in the instrumentation module and the ignition wires from the pendulum switch were passed through two small holes in the retaining bulkhead into the nozzle of the ejection engine, which had been inserted in the wooden piston. The ignition wires were fastened to the model rocket igniter that had been held in place with some melted pitch. The whole assembly was then inserted into the body tube. The arming wires were fed out of a small hole in the side of the rocket and the retaining bulkhead was screwed into the body with several self-tapping metal screws. Before inserting the retaining bulkhead, the rubber shock cord (wrapped in aluminium foil to protect it from the ejection rocket exhaust) had been tied between the retaining bulkhead and the piston. On top of the piston in the end of the body tube, we placed the red nylon parachute that was wrapped in its nylon shroud lines. The shroud lines were connected to a screw eye on the top end of the piston, while another nylon cord attached the piston to the nose cone.

We decided it was safer to fuel the rocket in our workshop rather than out in the range, so once the rest of it had been assembled, we carefully put the rocket in the bench vise (with padding to protect the paint), and then poured the micrograin propellant into the combustion chamber through a plastic funnel, while using a wooden rod to tap the side of the rocket to settle the powder and make it as compact as possible (we also used the rod for tamping the propellant down). Once we had reached the appropriate level, we carefully inserted the nozzle. To avoid a possible spark that could be caused by scraping a steel nozzle into a steel tube (with disastrous results) we first covered both surfaces with petroleum jelly, which also lubricated the nozzle insertion. Once in place and aligned, we screwed the nozzle and fins in place using metal screws.

Launch Activities

We transported the loaded B-4 out to the Ash Island Launching Range with the engine loaded. After preparing the bunkers (the large industrial steel pipes with sandbags in front of the ends), we set up and tested the equipment (field telephones, transceivers, etc.). We assembled the launching pad was and Phillip Archer slid the rocket onto the launching rod. We then set it to the correct launch angle and secured the launching pad base plate with large rocks. John Farrell then armed the ejection system, and I connected the firing wires. Once everyone had taken shelter and everything checked out, we launched the B-4.

Once again there was the whooshing sound and smoke trail of a successful launch. However, this time we did not see a parachute and other objects coming down. We did hear and see the rocket itself rapidly descending on the other side of a large rock pile and heard a crunching sound upon impact. The bad news was that the parachute system didn't work, but the good news was that we quickly found the rocket. It was resting nose first in a large pile of rocks, and apparently had split a rock on impact. The solid aluminium nose cone was mangled, as was the front section of the steel rocket body, which looked like the end of an exploded cigar. Upon examination, we determined that one of the wires in the ejection system had broken, and this was the cause of the rocket's failure to fire the ejection rocket.

Phil Archer sliding B-4 onto launch rod – Dad is holding it for him

This was the last launch of AMRA in Australia. Because this was our last year of high school and we were all working hard preparing for our Higher School Certificate, along with our other activities (e.g., rock band, surfing, wargaming, etc.), we never found time to start work on the B-5. Since I could not bring a whole rocket with me to America because of the weight, I cut off the rear section of the rocket body containing the nozzle, and brought that along with the mangled nose cone, and the wooden ejection piston with me to America (of course I still have these items).

However, the work of AMRA was not finished. I re-established it in America, and in 1975 we made three more rockets (the B-5, C-1, and GB-1) and launched two of them (we never finished the C-1), but that will be described in the last part of this chapter. The launch of the B-4 was also not the last rocket I made or launched in Australia. However, the other rockets were model rockets that we made at a youth camp in September, 1969.

B-4 post-mortem.
L-R: Leo, Trevor, Phil, Steven,Colin

B-4 in rock pile

Leo showing damage to B-4

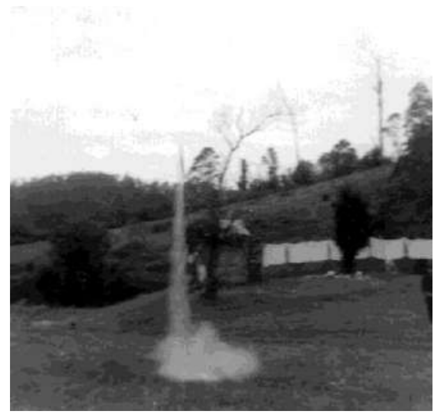
Camp Rockets (1965-1969)

When we in AMRA started making and launching rockets, there were two basic types: *amateur rockets* and *model rockets*. The amateur rockets, the A- and B-Series, which I just described, were made mostly of metal and used a rocket motor that we built ourselves from scratch. Model rockets were made mostly of cardboard and balsa wood and used commercial rocket engines. We used the latter type to learn the basics of rocketry, practice our launching range and launch procedures, and to have fun. They were also cheaper, and much easier and faster to make than our big amateur rockets. After making and launching several of these model rockets, my father realized that making them would be an ideal crafts activity for children and youth at our Church camps, where I was starting to assist my father instead of being just a camper.

Starting in September 1965 I would go to Church Children's Camps which were run by my father and assist him as a member of the staff or as a camper (for the older youth camps). I started by helping to organize recreation. My father was the one who actually suggested that I could teach a rocketry class at these camps, and I agreed to try. The advantages of model rockets as a craft for these week-long camps was that they were very cheap (cost about $2 each), relatively easy and fun to make, very safe, an excellent way to express creativity and artistic expression (in the design of nose cones, fins, and paint jobs), and fit well within a week from start to finish.

Typical camp rocket ready for launch

We decided to let the kids really make them from scratch and the only model rocketry components we bought were the rocket engines and igniters. We used construction paper and white glue for making the body tubes, using different diameter wooden dowels as wrapping aids. We had sheet balsa wood for making fins, blocks of balsa wood for making bulkheads and nose cones, cardboard rings for engine rings, metal screw eyes for mounting the parachute shroud lines to the nose cone, rubber bungee cords for the shock cords, sewing thread for the shroud lines, straws for the launch lugs, and cut-up plastic bags for the parachutes. We used facial tissues for the parachute wadding.



Launch at Willow Bend, 1969

On Monday I would give the class a brief introduction to the theory of rockets, describing how they were built and worked. Monday through Thursday the children made the rockets and finally painted them on Thursday. There were some very creative designs. On Friday, instead of doing recreation in the afternoon, we launched the rockets. Improperly-made rockets provided some spectacular failures and flights, but most worked very well. Everyone in the camp (including staff) turned out to watch the launches. The kids had a lot of fun chasing the rockets down and usually recovering them. Although we started doing this at Tiona, we also made them at the camps held at Willow Bend near Bowraville on the North Coast.

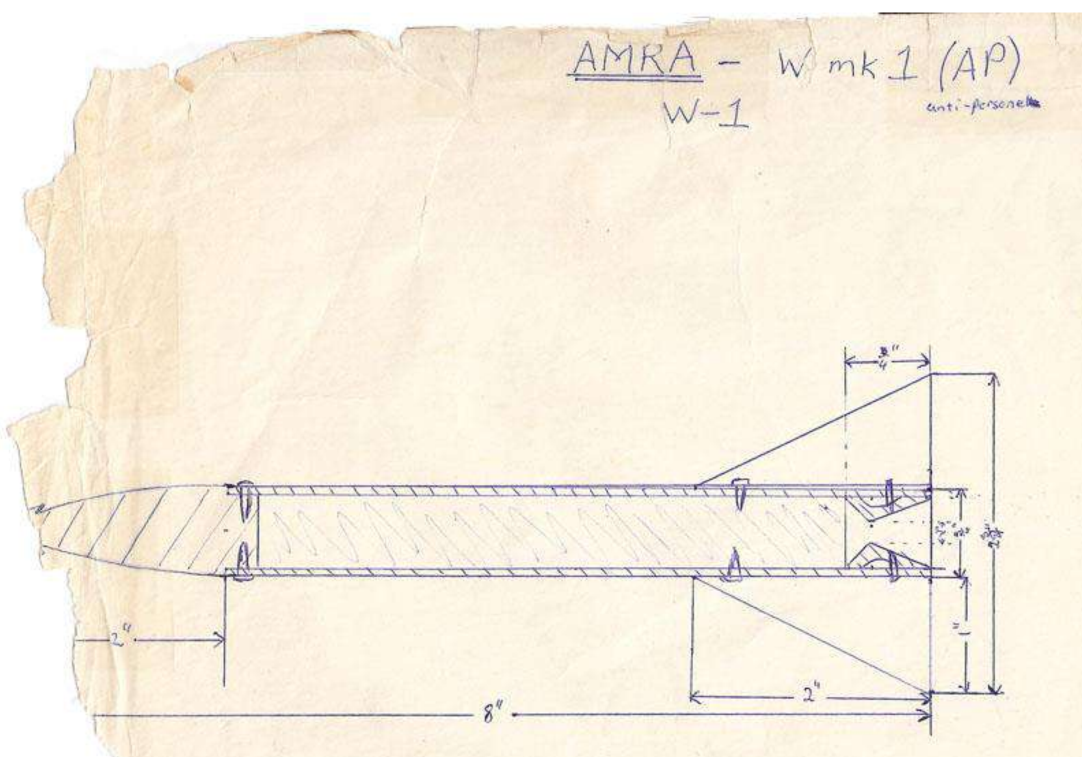
Kids chasing model rocket descending on parachute (arrow), Willow Bend 1969

Arming for Armageddon (June, 1967)

In June, 1967 a major war broke out in the Middle East between Israel and a coalition of Arab countries including Egypt, Syria, Jordan, Lebanon, and Iraq. The Israelis had the backing of the United States, while the Arabs had the backing of the Soviet Union. This war was viewed with great alarm in Australia and the rest of the world, because if it looked like the Israelis were on the verge of defeat (and they were greatly outnumbered), then it was likely that the United States would intervene to prevent that from happening. If the United States entered the war on the side of the Israelis, there was a good chance that the Soviet Union would enter on the side of the Arabs. This could then escalate into a world war with nuclear exchanges – in other words, Armageddon as prophesized in the Book of Revelation in the New Testament. Australia would enter the war on the side of the United States. If that happened, then there was a good chance that Australia, with its small military, could be invaded, probably by the Muslim country of Indonesia or even Communist China.

I decided that I would do what I could to help prepare for the possible coming conflict, and designed a small anti-personnel rocket designated the AMRA W-1 (Weapon 1). It was small and very easy to build, and was based on our standard multigrain propellant. I still have the plan I drew for this rocket, although it is somewhat damaged (see figure).

Fortunately, I never had to build or test the W-1. The magnificent Israeli armed forces (mostly army and air force) soundly defeated the Arabs in less than a week, in what came to be called "The Six Days War." The Soviet Union was not willing to risk a conflict with the United States (which had officially stayed out of the war) in support of its Arab clients, so the war ended with the defeat of the Arabs and the capture of some important territory by the Israelis (Golan Heights, West Bank of the River Jordan, the remainder of Jerusalem, and the Sinai Peninsular).



EPILOGUE

Now that you have hopefully finished reading this description of my rocketry activities during high school, it is appropriate to make a few observations. One is that what we did may have been illegal at that time and definitely would be illegal now. That was one reason that this club remained unofficial. I did not want it to come to the notice of the general public and hence the authorities, as it undoubtedly would have if we had been an official NBHS club with the resulting publicity (each club was featured in the annual Novocastrian school magazine).

Another observation is that although we took some precautions, we were very, very lucky that no one associated with this club or its activities was injured (or possibly killed). A much safer alternative available to the youth today is model rocketry, best known for the rocketry kits built by Estes and others. Clubs featuring model rockets are very common now in the USA (and presumably Australia), even down to grade (primary) school level. Some very sophisticated and challenging model rockets can be designed, built, and safely flown. I would strongly recommend that youth through the end of high school stick to model rockets. At university level and above, what we called “high power rockets” are popular. These are much larger and more dangerous than model rockets, but with no substantial metal parts, are still much safer than the rockets made by us in AMRA.

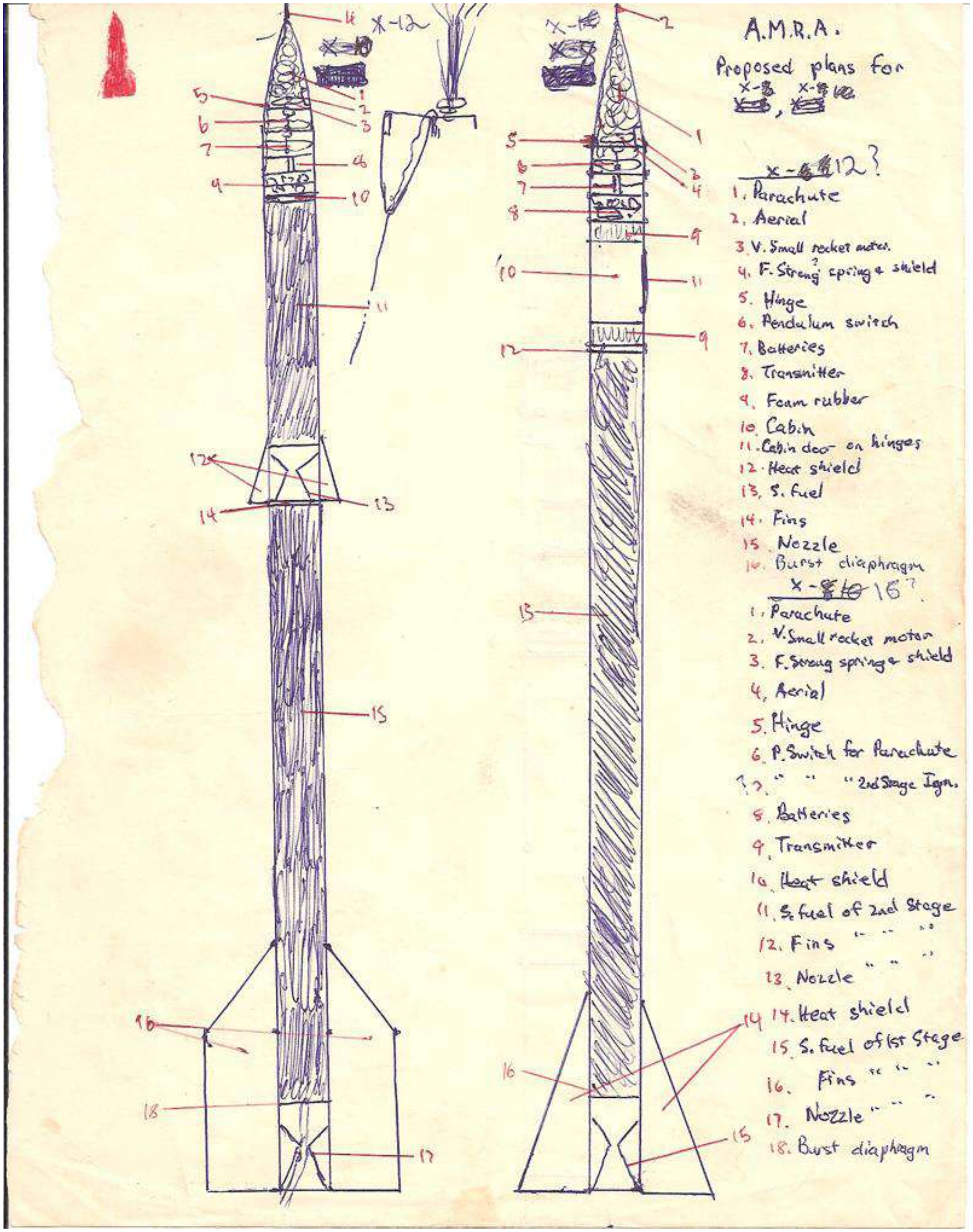
I loved making and launching rockets, which led to my taking Aerospace Engineering in university and a very rewarding career in the space field in America. That is the only reason that I stayed in America instead of returning to Australia after obtaining an education – Australia did not have a space program, at least nothing on the scale of the US. I enjoyed a fantastic career in the field of astronautics, which is briefly outlined in my biography in Appendix B. I trained on the Space Shuttle simulators, worked in Mission Control in Houston during several Shuttle missions, met and became good friends with many astronauts including from the Apollo program. I even got to meet Neil Armstrong and Buzz Aldrin, the latter on several occasions. I commanded a spacecraft that produced the first global digital map of the Moon and first discovered water in the lunar polar region, and many other exciting things. Of course, you can read all about this someday in my full memoirs (which I am in the process of writing). All this, and some of the leadership skills I have developed, had their start in that small rocketry club in high school.

Ad astra!

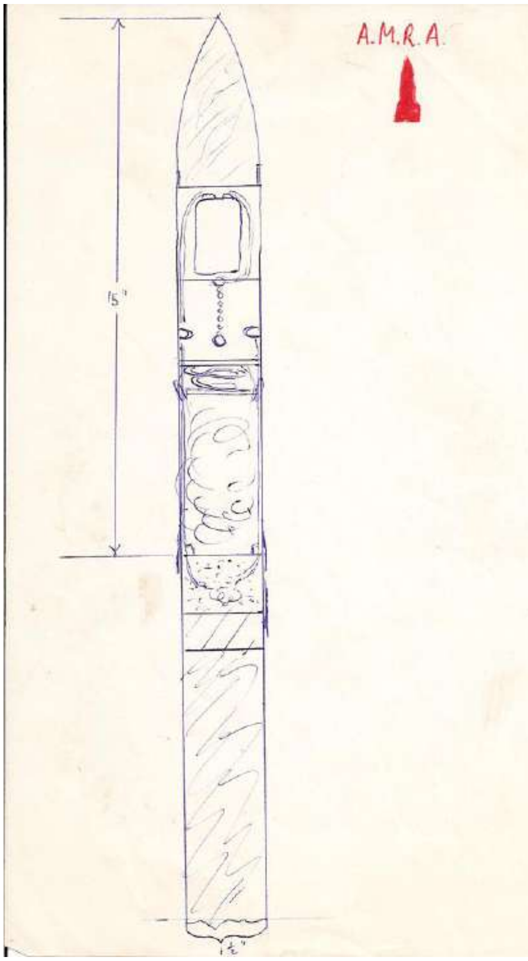
PART II – COLLEGE ERA (USA)

This section will describe my continued rocketry activities while at university in the United States (1970-76). It will appear in my full memoirs.

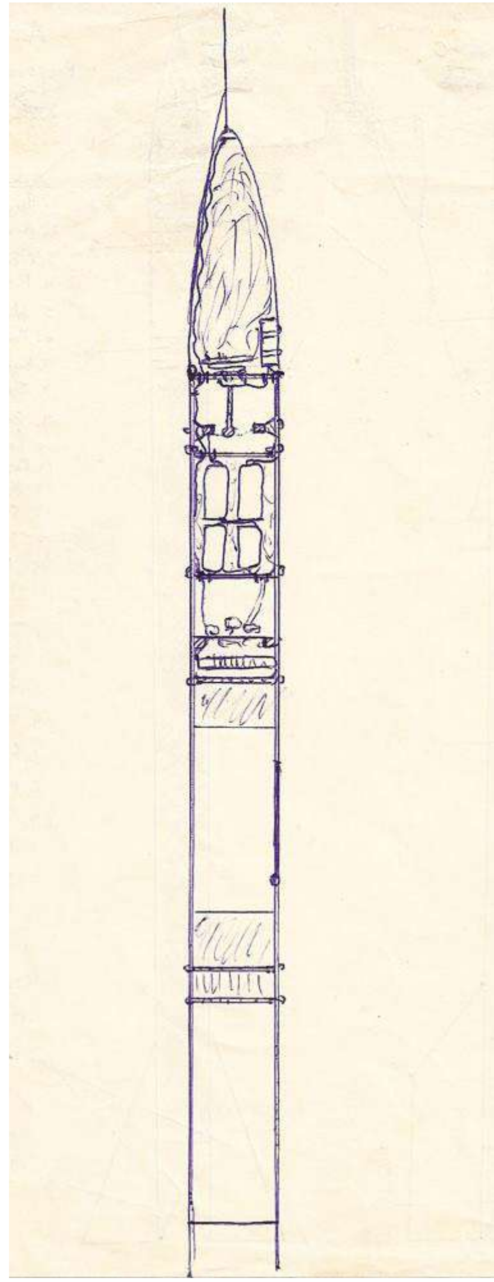
Appendix A - AMRA Rocket Plans



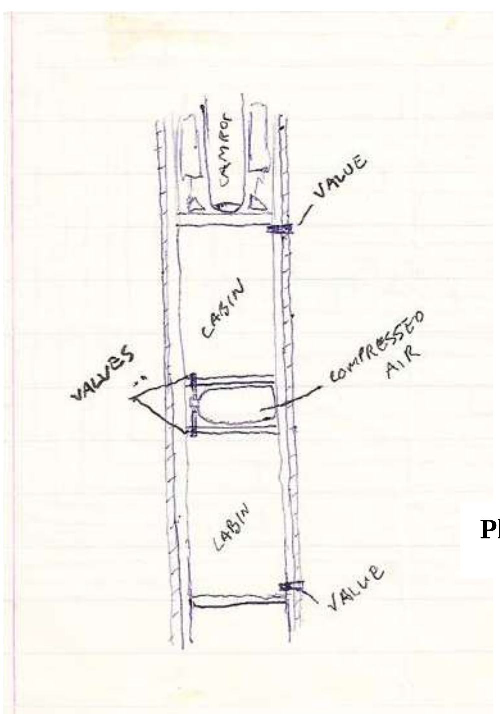
Plans for X-12 & X-15 (originally X-8 & X-9) - 1965



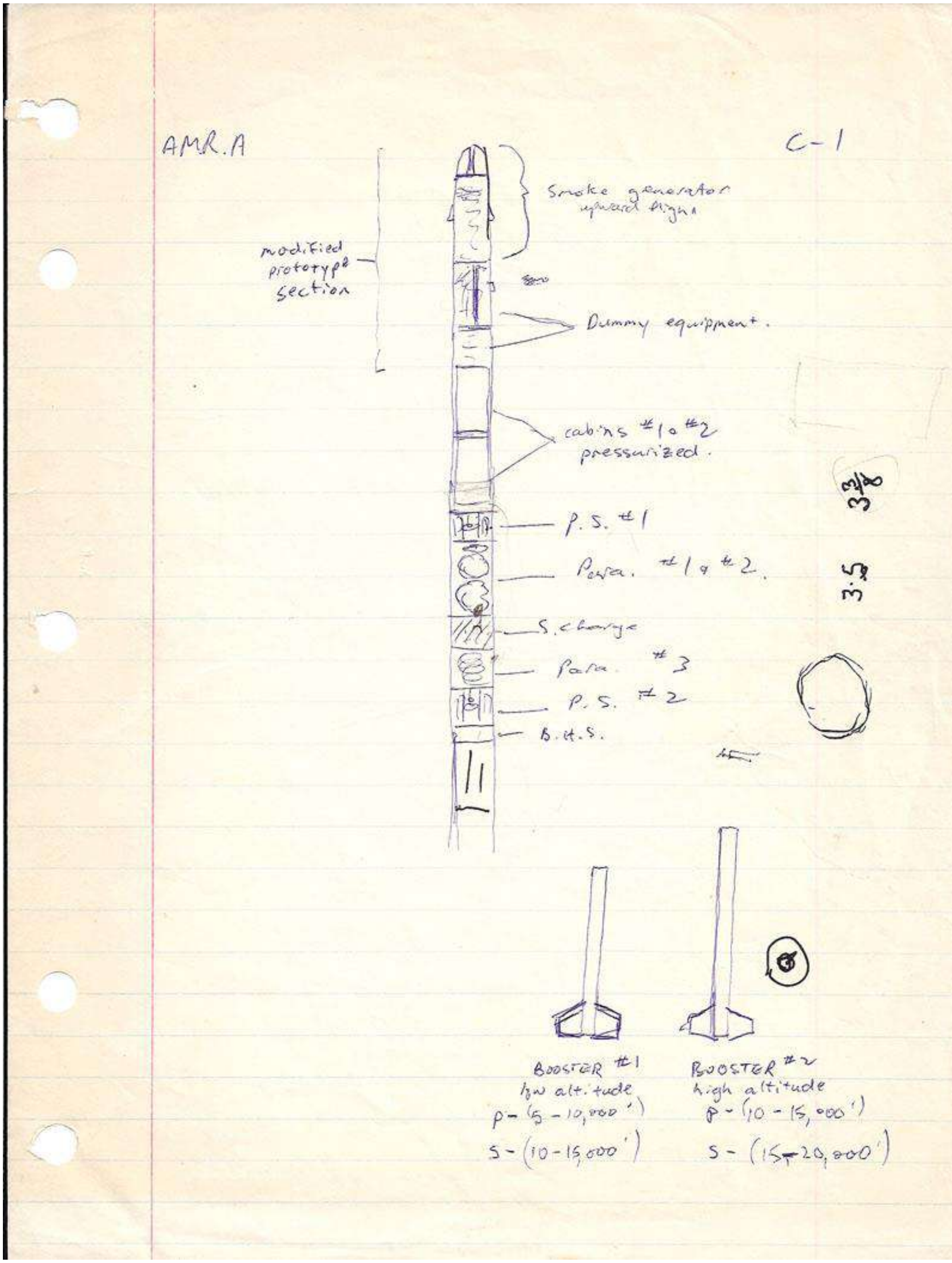
Candidate B-series Recovery System



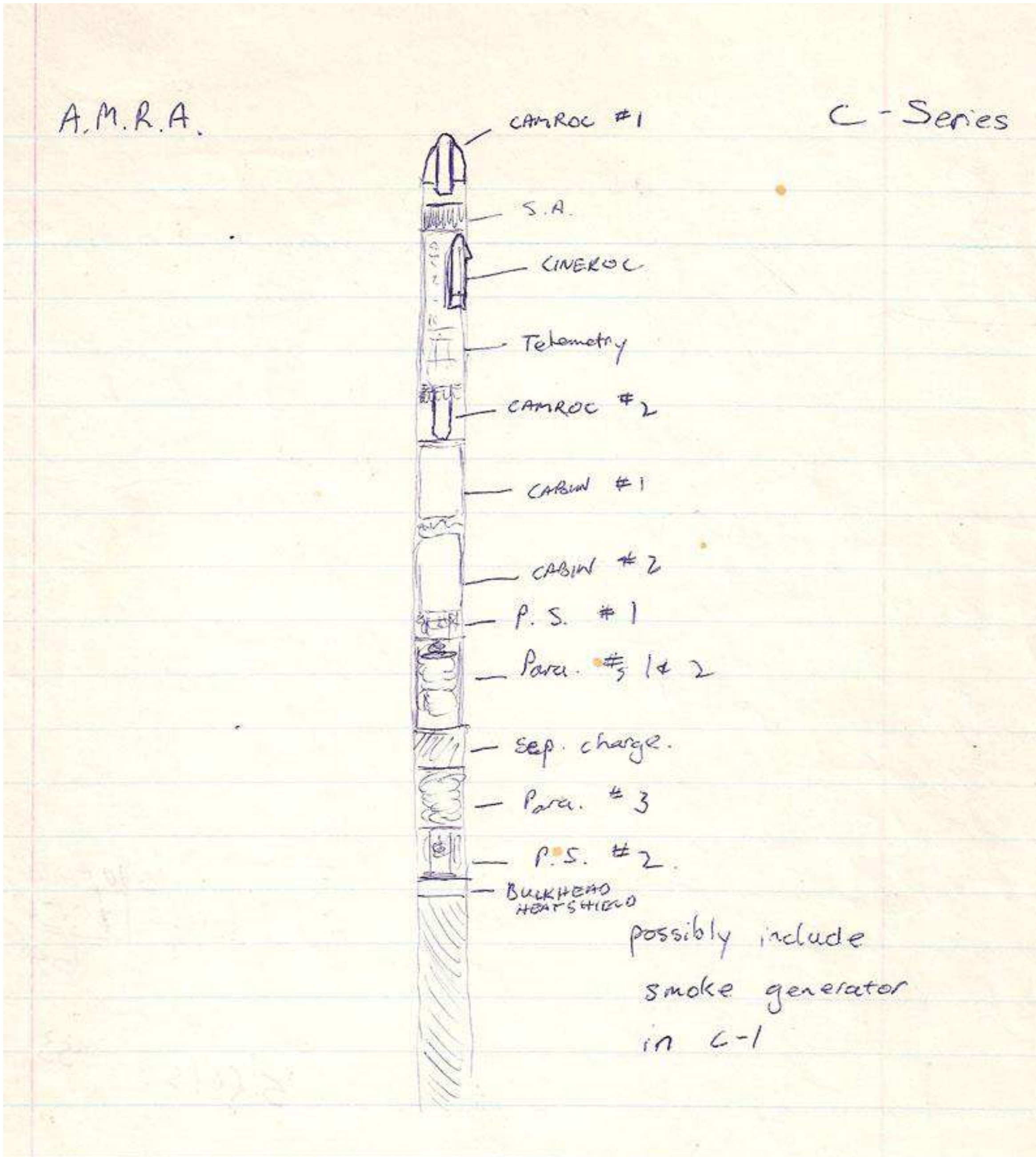
Hinged Nose Cone Recovery System



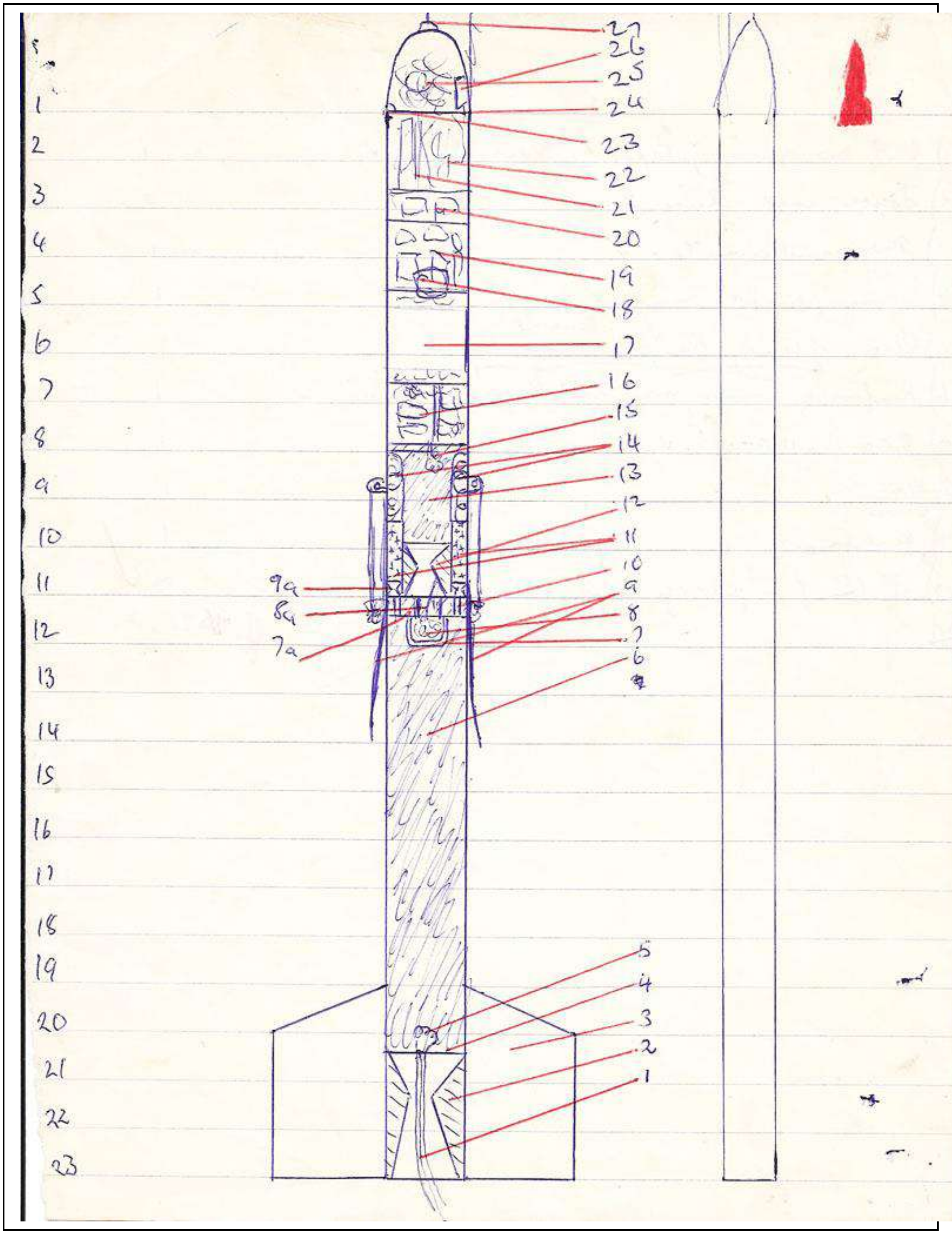
Plans for dual Biological Payloads



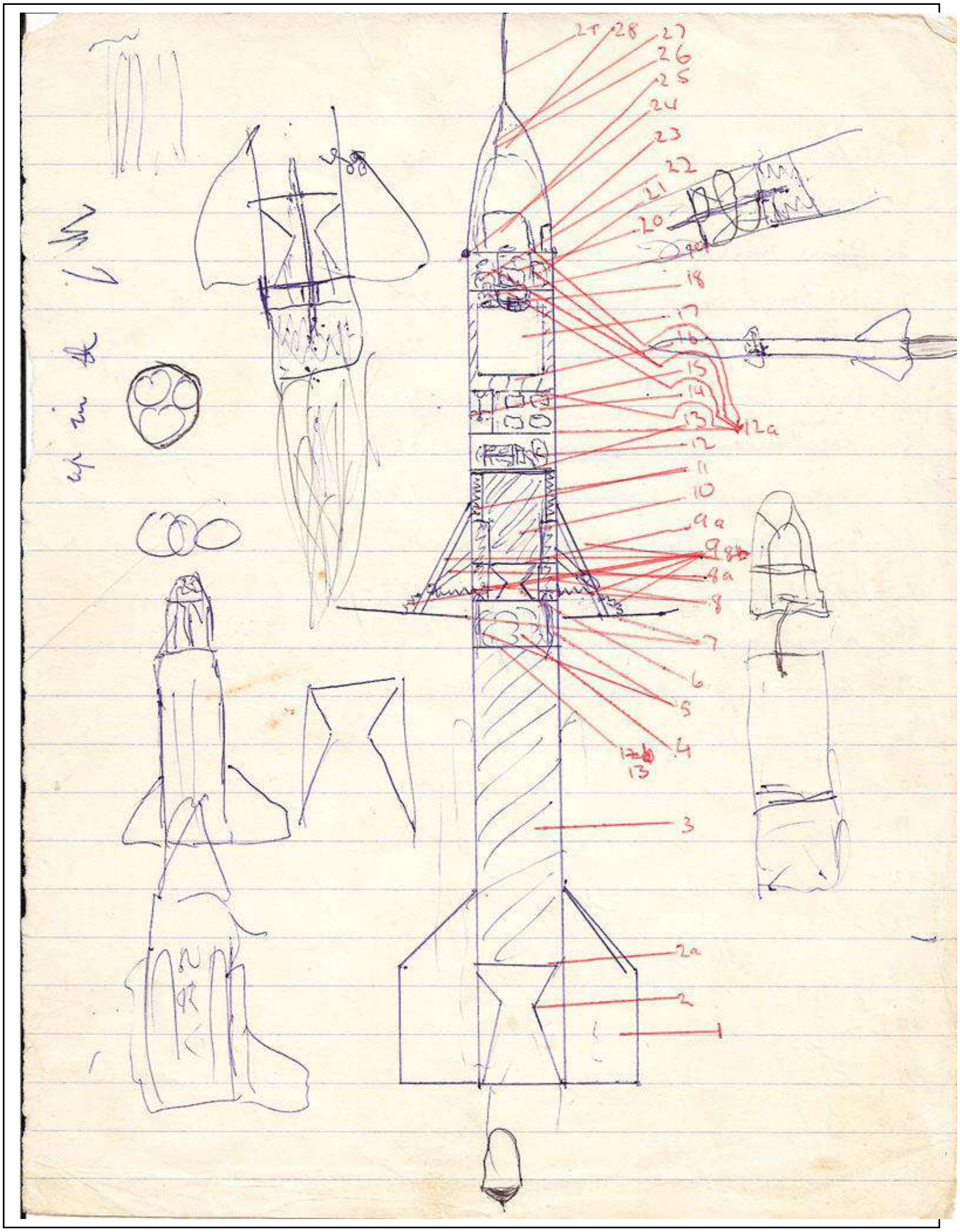
C-1 Plans – circa 1966



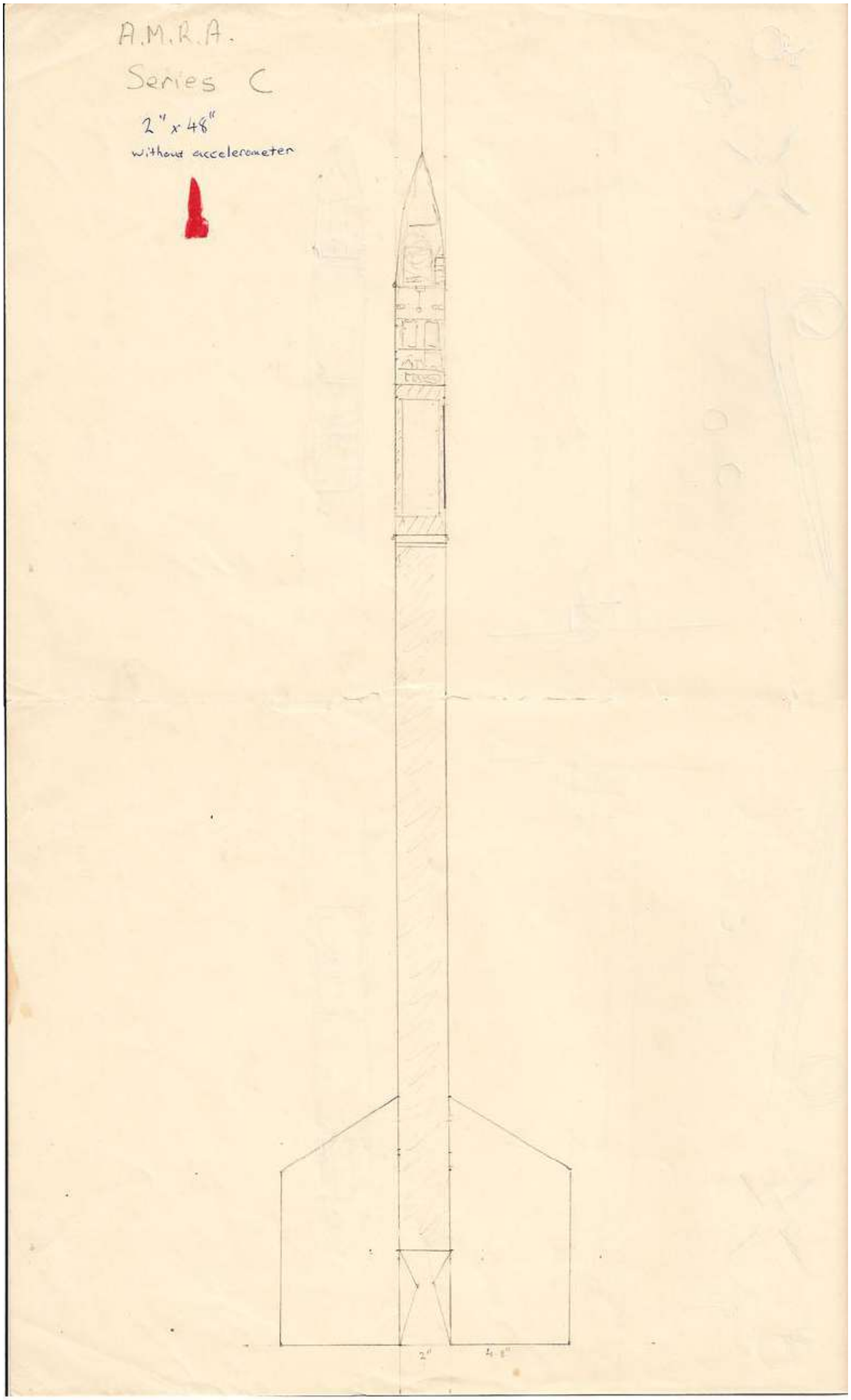
Series C Plans– circa 1968



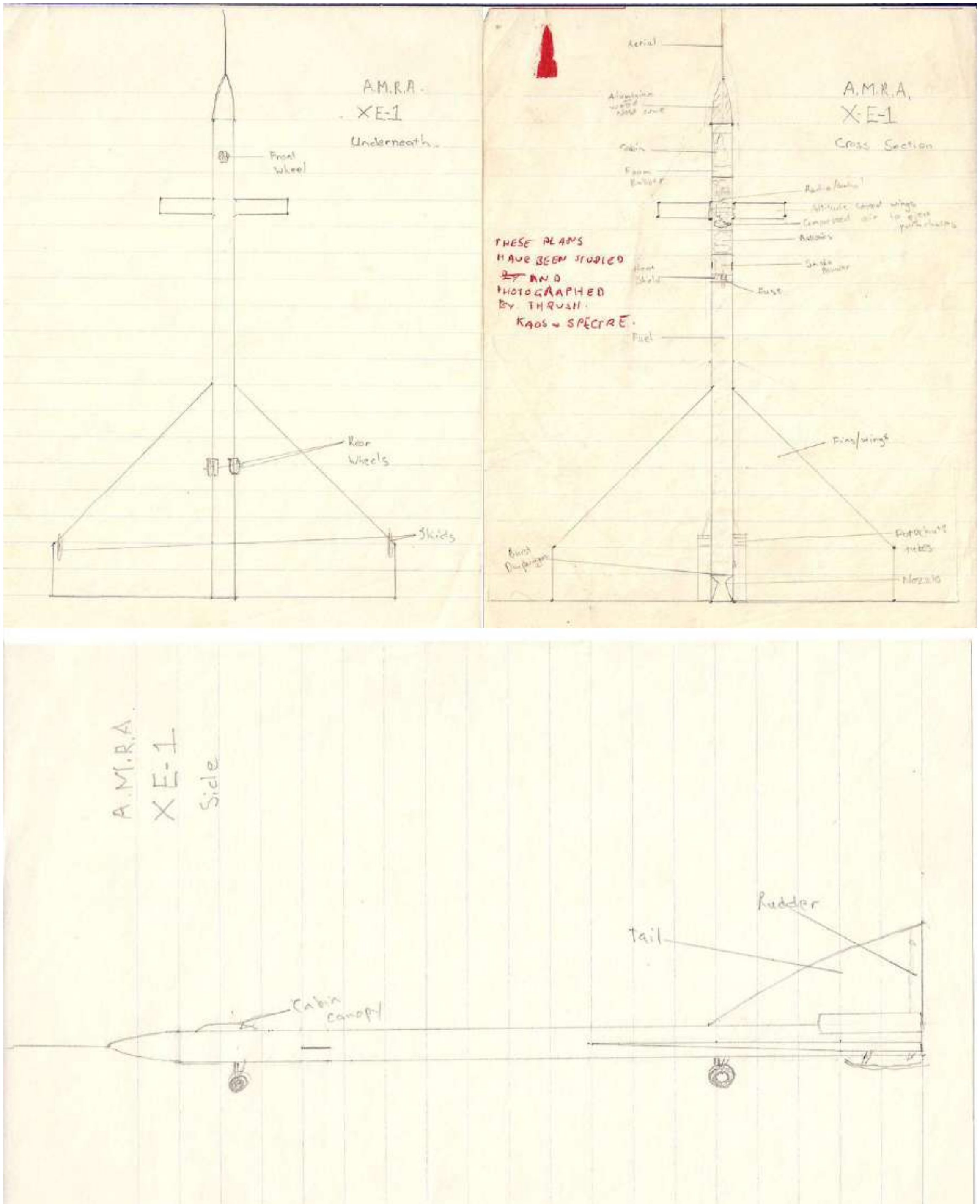
F-Series conceptual plan 1 - 1966



F-Series conceptual plan 2 (with doodles)- 1966



Another C-Series plan – circa 1965



Conceptual plan of XE-1 rocket glider - 1965