

# RRS NEWSLETTER



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For the Advancement of Rocketry and Astronautics

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## Silver Girl II Finally Becomes Airborn

By Mark Grant

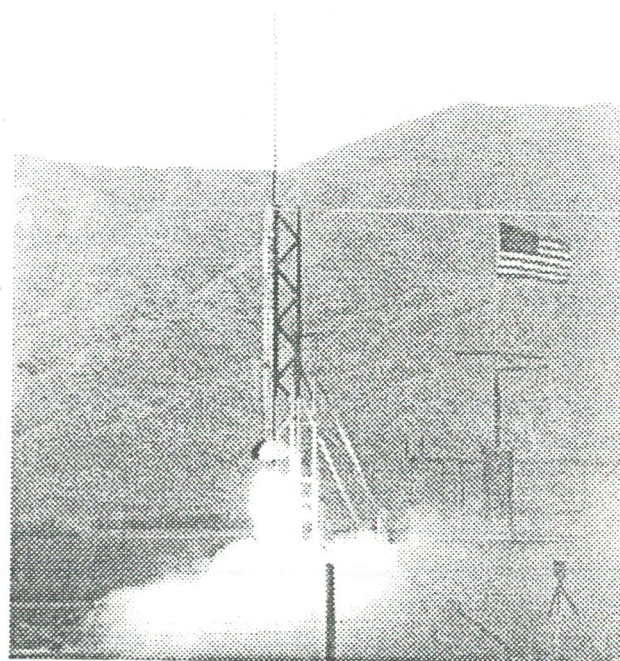
After two and a half years of on-again, off-again work, my rocket project finally came to life. On a windy October afternoon, the Silver Girl II, named after a line in the Simon & Garfunkel song "Bridge over Troubled Water", left ground zero, and delighted the crowd with a 35 second flight. Unfortunately, since the timer was set to deploy a parachute 37 seconds into the flight, the rocket never had a chance to survive, and will never fly again.

I have begun writing a full report on the project, but I wanted to take time now to briefly explain the launch and subsequent flight.

For those of you who were out there know that the flight occurred on the second launch attempt of the day. The first launch attempted failed due to burst disk problems, i.e. the LOX burst disk never burst. This burst disk was designed to rupture at 150 psi at LOX temperature, with the fuel disk going at 180 psi at ambient temperature. Hopefully these burst disks would provide a ox-lead at start. Well, needless to say they didn't. After power was killed to the flight Marrotta valve (opening the valve), the fuel and ox tanks pressurized but only the fuel disk ruptured. After dumping a couple seconds worth of fuel on the ground, the pressurization valve was quickly closed to prevent further pressure build up in the LOX tank and eventually LOX disk rupture, possibly leading to the formation of gel. GN2 dissolution and/or chilling in the LOX, i.e. the volume of the GN2 (pressurization gas) in the LOX tank was decreasing from the cold temperatures or going into solution with the LOX, probably caused a delay in pressure buildup leading to the fuel rich start.

This problem was resolved by replacing the LOX disk with a much thinner disk. So after the LOX tank was emptied, cameras reloaded, and nosecone pyrotechnic charge replaced, we were ready for a second attempt.

The second countdown went smoothly and at T minus 0 the engine ignited, the Silver Girl slowly cleared the tower, turned windward and thundered down range. After following a circular course, the rocket augured into the desert floor, leaving nothing to



*The Silver Girl II, a liquid oxygen & kerosene propelled rocket successfully leaves the launch tower.*

be salvaged. The rocket was found 4650 ft down range, according to G. Dosa's careful measurements, and probably only achieved about 5000 ft in attitude.

At first it was thought that the rocket turned into the wind from "weather cocking" alone. However inspection of the engine revealed that one of the fuel orifices was plugged, leaving a LOX stream heading straight toward the throat. The oxidizer stream notched the throat and created a thrust vector. This thrust vector, coupled with the strong wind, turned the bird down range. This changed the flight profile and greatly

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The Reaction Research Society, one of the two oldest Amateur Rocket Societies in the nation was organized in 1943 as a non profit civilian organization whose purpose is to aid in the development of reaction propulsion and its applications, and to promote interest in this science. The Society owns the Mojave Test Area, referred to as the MTA, a 40 acre site located two and one half hours north of Los Angeles. It is at this location were several hundred rockets, using both solid and liquid propellants, have been static tested and launched. Currently there are over 50 members.

This newsletter is a bimonthly publication by the RRS and is intended to provide communication between members, and other societies.

President	Frank Miuccio
Vice President	Robert Anderson
Secretary	Tom Mueller
Treasurer	Steve Majdali
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Information regarding the Society and Membership can be obtained by writing to:

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#### Silver Girl II (con't)

reduced the flight time. Instead of propelling the rocket straight upward, the rocket's impulse powered the rocket down range greatly increasing the distance but greatly reducing the attained altitude. The rocket also appeared to be under powered. A low  $c^*$  performer for an injector (the blocked fuel orifice didn't help) and/or insufficient pressurant gas flow is probably to blame. Too bad I didn't have any instrumentation to answer some of the unknowns.

After examining the wreckage, it appears that all the payload components worked. The camera took footage, the timer started, but the parachute never had a chance to prove itself. Too bad the film was shredded in the impact. Since the rocket didn't spin at liftoff, the camera probably took some great pictures.

So after lots of long hours of work, my project finally came to a close. All in all I am satisfied with the results; nobody got hurt, I learned a hell of a lot, and Silver Girl II thrilled us all for 35 seconds one fall afternoon. One thing I found was the tremendous support that I have from my friends. The project would of never got off the ground without the support of my close group of rocketeers, Dave Crisalli, Scott Claflin, Brian Wherley, Dave Matthews, and Steve

*Continued*

#### From the Editor

I would first like to thank you for electing me to be the RRS editor for 1992. I feel lucky to hold this position during such a dynamic time for the RRS. I would like to acknowledge Phillip Pesvento (RRS editor 1990) and Donald Trimborn (RRS editor 1991) for building the strong base for this newsletter, and also giving me a challenge to continue to "carry the torch", so to speak.

I have outlined several goals this year for the newsletter. The first is to bring the newsletter into the desk top publishing world, putting my Macintosh to good use. I would also like to see more educational articles in the newsletter. I feel that since one of the RRS main thrust is to educate those interested in the field of rocket propulsion, the newsletter should be used as a vehicle to achieve that goal. Additionally, I have talked to some of my liquid propulsion buddies, and we all plan to do a better job documenting the work we have accomplished, and to pass along the lessons learned. I also plan on writing a series of articles titled "So You Want to Build a Liquid Rocket?", containing all the good stuff one needs to know to build a liquid rocket successfully and safely. As far as the solid side of the group, I am asking for help. It would be great to have the same educational material given on solid propulsion. I know there is a lot of expertise on this subject in this group, so send me some articles guys.

Finally, I hope to use the newsletter to improve communication between members, and relive some of the work of others in the group. For example, I plan to include a order form of RRS items for sale. Hopefully, by centralizing activities, both the RRS can benefit from increased revenue, and the consumer can get what they want.

In closing, I am proposing the newsletter become a bimonthly publication. I feel this will allow enough time for a complete, informative, well written newsletter to be produced. I do plan on providing monthly communication to inform members of meetings and events by the means of post cards during the off newsletter months. I hope that I will accomplish these goals and provide an exciting and enjoyable newsletter. Please let me know your thoughts, concerns etc.

RRS Editor  
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Canoga Park, CA 91303

#### Silver Girl II (con't)

Palm, thanks guys. Also thanks goes out to Frank Miuccio, Steve Luhn, Niels Anderson, Steve Gates, and Bruce Markle for all their help. And finally thanks to my wife Lesa for all her help, patience, and understanding.



## January & February 1992 Meeting Highlights

The January meeting was attended by several members of the Independent Rocket Systems (IRS). This group, a spin-off of the PRS, is a highly active rocket group experimenting in both solid and liquid propulsion. Their current project, a 16' liquid propellant rocket using Nitric Acid and Furfuryl Alcohol, initiated the communication between the IRS and RRS. The IRS would like to launch some solid rocket and static fire their liquid propulsion system at the MTA prior to the rocket launch in Nevada this summer. For the past four years, the group has been using Lucerne dry lake bed for most of the testing. However, the lack of facilities and severe altitude restrictions (9000 ft) for launches at Lucerne have caused the IRS to look for other sites. During the meeting, Paul McLuown presented pictures and a video of the groups activities over the past several years.

I personally welcome the interaction between the two groups and hope than an agreement can be reached that would be a benefit to both groups.

Since the February meeting date fell on Valentines Day, the meeting was cancelled to allow members to be with their Valentines. Who said rocket scientists weren't romantics?

## Dave Crisalli gears up for Spring Launch

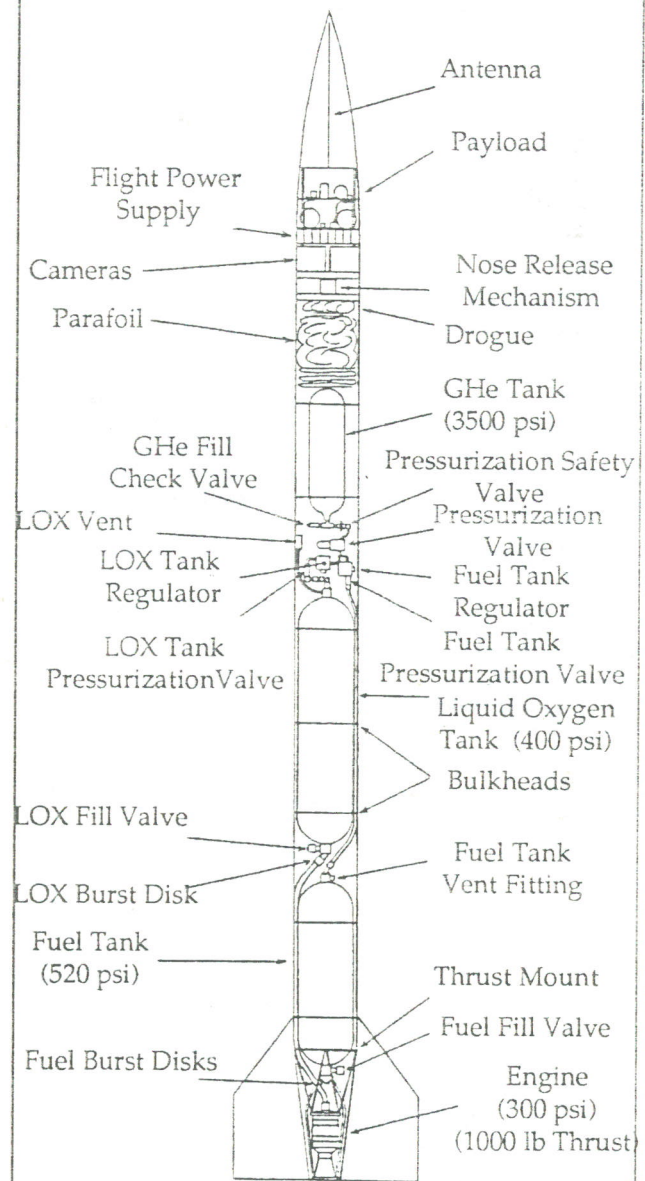
By D. Crisalli

*Editor's Note: Dave Crisalli is currently constructing a large liquid propelled sounding rocket. If all goes well, the rocket will achieve an unprecedented 200,000 feet in altitude. The rocket is scheduled for a spring launch at White Sands Missile Test Grounds.*

The following information is provided as a status report on the liquid propellant sounding rocket project. Included are drawings of the vehicle, static test stand, static test system schematic, test parameters and a sketch of the 50 foot portable launch tower now under construction.

New and stronger propellant tanks have been fabricated. Work is also starting on the components of the flight structure and payload (which may include a TV camera and transmitter, and a GPS receiver for accurate altitude determination).

To test several of the subsystems for this rocket, Brian Wherley and I are building a 600 pound thrust LOX/Alcohol rocket. It is similar in size to Mark Grant's at 6 inches in diameter and 12 feet long. We



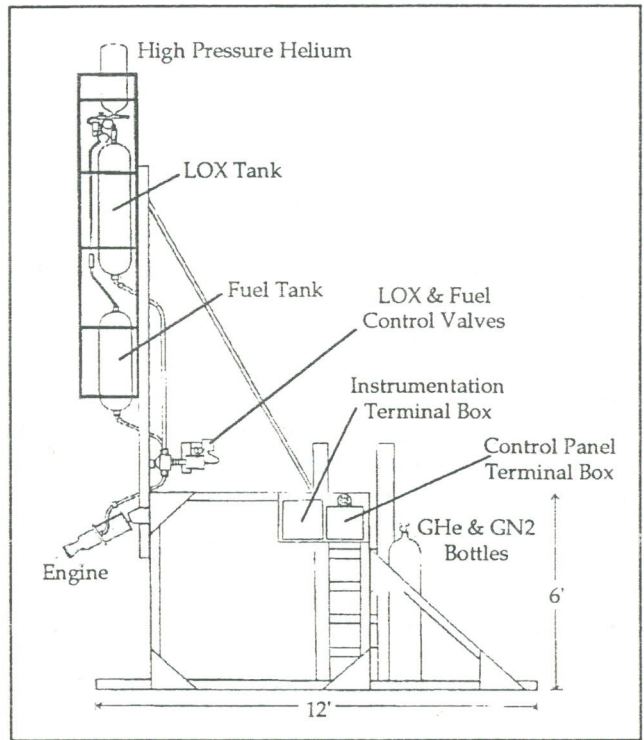
*Layout of D. Crisalli's LOX & Kerosene Propelled Rocket to be Launched at White Sands Test Range*

hope to fly it at the MTA to check out the TV system, the roll stabilization system, and the parachute deployment device that will all be used on the larger rocket.

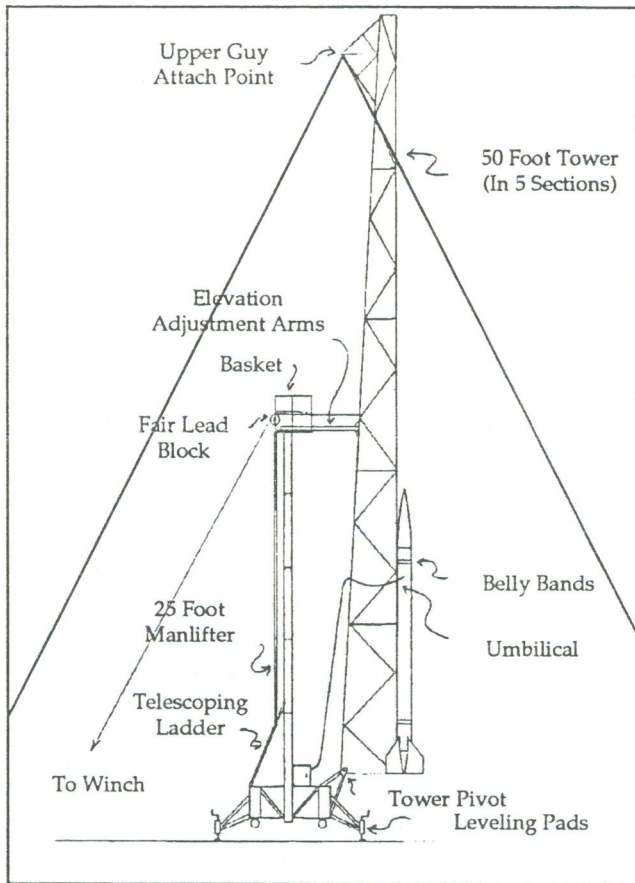
A complete set of drawings, design calculations, and data analysis are in work for both projects and will be available at the completion of each project. As an interim measure, I have given George Dosa a copy of a 5 minute video report and a compilation of drawings, procedures, project outlines, and pictures for the RRS files.

## Static Test Parameters

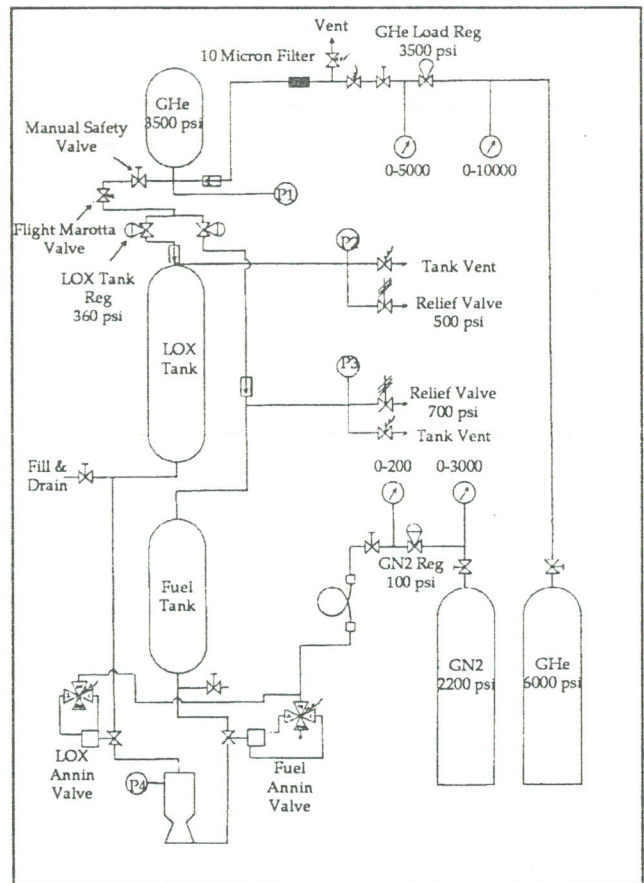
<b>Engine</b>	
Thrust	1000 pounds
Chamber Pressure	300 psi
Fuel Flow Rate	1.34 #/sec
Oxidizer Flow Rate	3.2 #/sec
Expected Isp	220 seconds
Mixture Ratio	2.4
Throat Area	2.159 sqin
Throat Diameter	1.658 in
Expansion Ratio	4
Thrust Coefficient	1.4
Cylindrical Chamber Length	6.0 in
L*	36 in
<b>Injector</b>	
Pattern	24 F-O-F Triplets & BLC
Boundary Layer Coolant (BLC)	32 at Injector Face
	24 at Nozzle Inlet
Oxidizer Orifices	24 Holes - 0.067 in dia
Fuel Orifices	48 Holes - 0.034 in dia
Oxidizer Side Delta P	67 psi
Fuel Side Delta P	215 psi (80 psi injector + 135 psi cooling jacket)
<b>System</b>	
Fuel Tank Volume	2300 cuin
Oxidizer Tank Volume	3200 cuin
Total Fuel Weight	53 lbs
Total Oxidizer Weight	131.4 lbs
Burn Duration	Approximately 60 secs



*Static Test Stand*



*Launch Tower Assembly*



*Static Test Schematic*



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## So You Want To Build a Liquid Rocket?

By Mark Grant

At the request of some RRS members, I have started a series of articles discussing the design and fabrication of a liquid propellant rocket. I hope these articles will provide enough information so that anyone interested could start a liquid rocket project of their own. These articles will be written from an amateur rocket standpoint, namely how to design a sounding rocket. I don't want to write a boring tutorial on the physics of liquid propulsion, and you probably don't want to read one. There are already plenty of good books on that subject, namely "The Design of Liquid Propellant Rocket Engines" (NASA SP-125) by Huzel and Haung, or "Propulsion Elements" by Sutton and Ross. I do want to convey that any rocket project deals with very exciting but possibly dangerous technologies. Safety has to be the number one priority. So please make use of the Society's resources/experience to ensure a safe and successful project.

Since writing from the perspective of first hand experience may prove the most useful, I plan to use my project and others as examples. If you have any questions regarding different types of systems that I don't cover, please send them in and I will respond to the best of my ability.

This first article deals with 3 questions one must answer before beginning such a project. Throughout the project, there are many questions to be addressed, but the answers to three basic questions really anchor the design. These are (1) propellant choice, (2) selection of chamber pressure, and (3) selection thrust level and corresponding burn duration.

### Propellant Choice

For the amateur rocketeer on a tight budget, the propellant should be cheap, available, easy to handle, and provide reasonable performance. This narrows a vast number of combinations to a few. These are LOX/RP-1 (or Kerosene), LOX/Alcohol, and Nitric Acid/Furfuryl Alcohol for possible bipropellant combinations. Hydrogen Peroxide is about the only choice for a monopropellant. There are a few other propellant combinations to choose from, but the combinations listed have all been successfully used in amateur rockets in the past.

There is a certain romance with the choice of LOX/Kerosene as propellants. To use the same propellants that the mighty F-1 rocket engines used to take man to the moon strikes a cord. Additionally, this propellant combination is the cheapest, most readily available, and gives reasonable performance. A LOX dewar holding roughly 300 pounds of LOX can be obtained easily through a welding supply distributor for about \$70. Although there are some difficulties

with handling a cryogenic liquid, especially a strong oxidizer, but the price, performance, availability and cost usually outweigh the disadvantages.

Kerosene can be obtained at any hardware store for under \$2.00 a gallon, or diesel fuel can be substituted for about \$1.25 a gallon. As far as performance goes, this combination has a theoretical specific impulse equal to 249 seconds at sea-level (mixture ratio of 2.28, a chamber pressure of 300 psi). With a reasonable injector design, you can expect to obtain an ISP around 200 seconds at sea-level. Design improvements can increase this specific impulse number, but they are usually too costly for the amateur rocketeer. Both Dave Crisalli and I choose these propellants in our rockets.

LOX/Alcohol, usually cut with water to a 75% alcohol/25% water combination, is another attractive choice. This combination was used in the Redstone and V-2 engines. The alcohol is more expensive, about \$6/gallon, but it possesses some nice features. One feature Scott Claflin liked was the appearance of the LOX/Alcohol plume. After observing the bright yellow "ratty fox tail" of LOX/Kerosene, he knew something had to change. And thus, the choice of LOX/Alcohol was made. An additional benefit of this combination is that at a mixture ratio of 1.35, equal volume tanks can be used. It was this attraction that led Steve Palm to choose these propellants. He had two old "breathing oxygen" tanks of the same size that he could use in his rocket. This propellant choice would allow him to use these tanks efficiently with no excess ullage. In addition, the increase of fuel flow, compared to LOX/RP would provide extra cooling margin in his Atlas Vernier thrust chamber. This combination has a theoretical specific impulse equal to 238 seconds at sea-level (mixture ratio of 1.3, a chamber pressure of 300 psi). Again, you can expect to obtain about 200 seconds.

Although more expensive, there is a commercially available version of a 75%/25% alcohol mixture in the form of "151 rum". The added benefit here is that this propellant is fit for human consumption in the event the test is cancelled and the propellant must be off-loaded.

The choice of Nitric Acid/ Furfuryl Alcohol has many benefits as well as a host of disadvantages. Dan Ruttle successfully used these propellants in his rocket launch in 1987 at Smoke Creek Nevada. Since this combination is hypergolic, spontaneous combustion of the two liquids upon contact, no ignition system is required. Also, since the two propellants are storable at ambient temperatures, no handling of cryogenic liquids is required. However these propellants, in particular Nitric Acid, are expensive, difficult to obtain, and toxic. Furfuryl Alcohol can be purchased

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