

---

## Richard Nakka's *Experimental Rocketry* Web Site

---

### Links to other Websites



- |  |
|--|
| <ul style="list-style-type: none"><li>• <a href="#">Experimental Rocketry</a></li><li>• <a href="#">General Rocketry, Engineering &amp; Science Resources</a></li><li>• <a href="#">Chemical Suppliers</a></li><li>• <a href="#">Tool, Hardware &amp; Rocketry Suppliers</a></li></ul> |
|--|

---

### Experimental Rocketry

#### [SugPro Sugar Propellant Discussion Forum](#)

Have a question relating to "sugar propellant" rocketry? Join the *SugPro* e-mail discussion forum to learn from the experience of others who are involved in sugar propellant rocketry. Tell others about your successes and failures. Learn from others and find out about the latest developments and experiments that are being conducted to continually improve the art & science of sugar propellant rocketry.

**The Amateur Rocketry Link Library**, maintained by Hans Olaf Toft.

[ARL Library](#) is probably the best page on the net for amateur rocketry related web resources, including lots of useful downloadable software and links to every known experimental rocketry web site.

The [NEAR](#) group of **Norwegian experimental amateur rocket builders** have recently launched a large rocket to an altitude of over 10 km. This impressive rocket was powered by 40 kg. of KN-Sorbitol propellant. Check out the details and video in their GALLERY page. Also check out the FILES page for some great technical reports on some of NEAR's rockets.

The nicely made website of the Danish Rocketry Group [DARK](#) contains plenty of interesting information on their rocketry activities, as well as an excellent *Technical Notes* page. Some of the downloadable articles are:

- Basic Rocket Aerodynamics
- Mechanical Design of Rocket Motors
- Non parametric Burning Rate Estimation
- The Recovery of Rockets
- Rocket Motion During Vertical Powered and Coasted Flight

- Mechanical Design of a Strain-gage Based Loadcell
- DARK's Wind Tunnel

**VRO Belgian Amateur Rocketry** -- One of this group's projects is the development of a successful KN/Sorbitol/Sucrose motor. Other projects include a hydrogen peroxide/methanol motor, cast zinc/sulphur/aluminum propellant and AN composites. [VRO](#)

[NERO](#) is a long-standing Dutch amateur rocketry organization. Although their web site hasn't been updated in awhile, it still worthwhile to take a look, as this groups activities have encompassed many interesting aspects of rocketry. This includes KN-Sorbitol motors, AP composite motors, hybrid systems, electronic recovery systems, and motor test apparatus.

The Aerocon website page [Examples of Test Stands for Solid, Liquid, and Hybrid Motor Testing](#) features a real "dog's breakfast" of test stands. A "must see" for anyone interested in the amazing diversity & ingenuity that goes into the design and construction of rocket motor test rigs.

The experimetal rocketry web site of [Guillermo Descalzo](#) features a modified design of the B-200 rocket motor, fitted with BATES grain for longer burn time. In Spanish.

#### [Inverse Engineering](#)

This is a new website created by Dan Pollino, who has been doing extensive work on KN-Sugar rockets for the past 5 years. Dan has come up with many innovative ideas for rockets, motors and testing, such as a steam rocket, 'pulse rocket', 'box' rocket, and a water tank for static testing. Also included on Dan's site are detailed instructions for making the IGNIS rocket motor from 2" PVC tubing. This rocket incorporates a clever nozzle design, being cast in a simple to make mould. Also, lots of great photos and videos of Dan's rocket tests and flights.

#### [Stuart's Rocket Motor Development Pages](#)

A new website, Stuart's site is a 'must see'...he features the design of a handsome 1/2 inch reusable aluminum motor. All of the parts are "turned" on his drill press. Included on his site are the technique for making fuel grains by rolling them out and cutting to length. His latest variation of the motor includes a Delay Element for parachute ejection.

[TAAX](#) is a new Spanish amateur rocketry group which has developed and tested several rockets, including PVC sugar propellant motors.

[Recrystallized Rocketry](#) is Jimmy Yawn's inimitable rocketry website. Jimmy has developed a novel method of preparing sucrose based propellants, based on recrystallization. But more than that, Jimmy is a highly devoted rocketry experimenter who has come up with a whole bevy of unique and clever motor making & testing techniques.

### [South African Rocketry](#)

Johann Grobler's website focusing on rocketry in South Africa .

### [Shaz Au Amateur Rocketry](#)

Excellent website that provides plenty of detailed information on the construction of PVC rocket motors powered by the sugar propellants.

### [Solid Rocket Motor : SRM - Experimental](#)

Amateur experimental rocketry in Spain. This webpage covers development work on rocket motors and flights, and deals with rocket theory, as well.

### [Avangers Rocketry Team](#)

This webpage covers development work on rocket motors and flights of this Brazilian Amateur rocketry group.

### [TOPUS Group](#)

This webpage covers development work on rocket motors and flights of the Brazilian rocketry group TOPUS, which was formed by the students of Aeronautical Engineering of the University of São Paulo. Their objectives include design and construction of rocket components and launching techniques. Currently they are working on two parallel projects: static test of rocket motor of 900 N. thrust, powered by potassium nitrate and sucrose; secondly, a rocket that will reach 4 km height and 2100 km/h top speed.

### [AIR -- Amateur Icelandic Rocketry](#)

This group of enthusiastic rocketeers recently launched the first amateur rocket ever in Iceland. The flight, which received much local attention and support, was highly successful and reached a peak altitude of 1 km. This group's next project is a larger rocket which has the goal of attaining supersonic speed

### **NEW** [Bulgarian Rocketry Forum](#)

Discussion forum dealing with all aspects of Experimental Rocketry. Currently in Bulgarian language only.

### **NEW** [GCCE \(Grupo Científico de Cohetería Experimental\)](#)

An extensive and well-documented Spanish website devoted exclusively to amateur experimental rocketry, aimed at designing, developing and the building of experimental rockets for recreational and scientific purposes. Additionally, this website is aimed at establishing relationships and friendships with people and groups who share a similar interest in rocketry. In Spanish language only.

### **NEW** [Randy's Rocketry](#)

The website of Randy Dormans, a fellow rocketeer that I have known for several years. Randy has a talent that has culminated in many awesome rockets and related hardware. He is currently working on a new "camera rocket" that is expected to soar to 18,000 feet.

**NEW** [YAKAMIM Experimental Rocketry](#)

Website of Brazilian rocketeer Bruno Ferreira Porto. Contains information on rocketry basics, theory, recovery system, propulsion as well as Bruno's latest projects. Discussion forum. In Portugese.

**NEW** [Serge 77 - My Rocketry Workshop](#)

In his web site, Serge documents his innovative experiments relating to many facets of amateur rocketry, including development of various propellants (mainly sugar based). Be prepared for many hours of enjoyable and rewarding reading. In Russian, but can be automatically translated into English.

---

## General Rocketry, Engineering & Science

**Rocketry**, the world's oldest hobby?! [A Brief History of Rocketry](#)

[Wind Caused Instability](#) is an excellent technical article by Bob Dahlquist that describes the phenomenon of rocket instability caused by a shifting of Centre of Pressure. A must read for anyone who launches their rocket in conditions other than dead calm!

**Dr. Robert Goddard** -- rocket pioneer [NASA, Goddard Space Flight Center](#)

**Orders of Magnitude** -- A concise history of the NACA and NASA, 1915-1990. [SP-4406](#)

**A Science Odyssey -- People and Discoveries**, a databank consisting of 120 names of 20th century scientists and their stories, such as Albert Einstein, Wright brothers, Stephen Hawking, Rosalind Franklin, Edwin Hubble, J.Robert Oppenheimer, Charles Best, Francis Crick and other remarkable discoverers. [People & Discoveries](#)

**Columbia Accident Investigation Report** *Eighty-two seconds into STS 107, a sizeable piece of foam debris struck the left wing of Columbia.* This brief report provides an excellent example of how a simple engineering analysis, using fundamental principles of physics, can be used to substantiate far more complex and indepth analyses. In this case, to estimate the impact velocity of a piece of foam that separated from the ET and struck the Space Shuttle, possibly causing catastrophic damage. [Impact\\_velocity.pdf](#)  
The complete final CAIB report may be found here [CAIB report](#). Extremely detailed.

**Gallery of Videos** of the RocketCam™ aboard various launch vehicles...a must see!  
[Ecliptic Enterprises](#)

**NEW Rocketdyne Technical Consulting**, a collection of Pratt & Whitney Rocketdyne (PWR) technical reports and presentations, featuring downloadable articles on liquid rocket engines and engineering in general.  
[Data & Resources](#)

---

## Resources

Lots of great links to reports and web pages that deal with rocket stability, including Barrowman method, "cardboard cutout" method, extensions to the Barrowman equations, wind induced instability, purpose of fins, weathercocking, and a whole lot more. [Apogee's Model Rocket Educational Guide](#)

**Rocketry Online** --Comprehensive source of rocketry related material including HPR, model rocketry, as well as amateur experimental rocketry. Great links to useful software. [Rocketry Online](#)

**Parachute Prep & Packing Guide** -- An excellent guide on how to pack a parachute into a rocket which will help ensure successful and tangle-free deployment.  
[Dura-Chute](#)

**Parachute Tips** -- Calculating parachute drag, impact forces and terminal velocity.  
[Aerocon Systems](#)

**Nichrome Wire Technical Data** -- Provides tables giving current vs temperature, resistance vs gauge, resistance vs temperature, as well as wattage and mechanical properties.  
[Wire-Tronic Inc](#)

**O-Ring Gland Design** -- All the information you need to properly design O-ring glands ("grooves").  
[Allorings.com](#)

**Materials Database** -- Free online database of over 15,000 different materials such as metals, polymers and ceramics. This database provides detailed physical properties data, such as mechanical strength and thermal properties. [MatWeb](#)

[MatWeb Weight Calculator](#) allows for on-line weight calculation of metallic or plastic tubing and other shapes.

**Chemicals Database** --The NIST Chemistry WebBook provides users with free access to chemical, physical and thermodynamic property data for many chemical species. The data provided in the site are from collections

maintained by the NIST Standard Reference Data Program and outside contributors. [NIST Chemistry WebBook](#)

**Build Your Own Scale Models of JPL Spacecraft** Galileo, Cassini, Mars Pathfinder, Mars Odyssey, Genesis, Near and other Jet Propulsion Laboratory spacecraft. *"An excellent way to learn more about a JPL space exploring machine, and its mission, is to build a scale model. Spend some time assembling one, and you'll be sure to know the spacecraft very well indeed! The scale models offered here have parts for you to download and print on card stock, instructions for putting them together, and links to mission information. Everything you need, such as white glue, scissors, etc. is listed. Some are quick and easy to assemble. Others require several hours' time and great care. Sometimes you'll find copies of these assembled models on the desks of engineers and scientists, using them for reference in their space mission. "*

[JPL \(California Institute of Technology\)](#)

**Language translator.** Instantly translate text from English to : French, German, Italian, Portugese and Spanish. Also, translates to English from those same languages. [SYSTRAN personal language translator](#)

#### **NEW Golden Days of Model Rocketry - Vern Estes Story**

Although he is best known as the archetypical model rocketeer, it is important to recognize that Vernon Estes' foray into rocketry started out at the level of an amateur rocketry experimentalist. Vern's web site ( <http://www.vernestes.com/> ) contains a link to a fascinating three-part interview in which Vern (and his wife Gleda) describe the "Golden Days" when they started their own company to develop and manufacture hobby rocketry supplies over 50 years ago. Included are detailed descriptions of "Mabel", the ingenious machine that churned out model rocket motors at a rate of one every 5.5 seconds. An interesting snippet reveals how Vern mistakenly deemed his model rocket motors as "engines", a term that has adhered to this day.

[The Golden Days of Model Rocketry](#)  
[Estes historical video footage](#)

---

## **Chemical Suppliers**

[PVC ONLY](#) -- Sam sells sorbitol and potassium nitrate, as well as other *AmEx* rocketry supplies and kits. The current price (Jan./06) for sorbitol is \$3.25 USD per pound. I recently bought a 20 lb. lot from Sam and was very pleased with the prompt and personalized service.

[Oshun](#) -- Cosmetic ingredients & packaging supplier. Chemicals such as red iron oxide, black iron oxide, yellow iron oxide, ascorbic acid, chromium oxide, citric acid, clay, epsom salts are stocked by this on-line ordering

company located in B.C., Canada. Minimum order is \$100 CAD.

[FIREFOX ENTERPRISES](#) -- Vast selection of chemicals for rocketry and pyrotechnic needs (e.g. potassium nitrate & other oxidizers, sorbitol, dextrose, etc.), as well as other rocketry components, such as igniters, nosecones, body tubes, etc. Also a great selection of interesting and informative literature relating to rocketry.

[PAINTING WITH FIRE](#) -- Potassium Nitrate source in the U.K. Purchase online, £2.50 per 100 grams.

[HYDROPONICS.CO.NZ](#) -- On-line source for Potassium Nitrate and other oxidizer chemicals in New Zealand.

[1-Stop-Sugarless-Shop](#) specializes in sugar-free products and supplies. The price current price (Jan./06) is \$5.39 USD per pound. This is where I originally obtained my sorbitol.

Another source for Sorbitol is [HerbsMD](#) where the current price (Jan./06) is \$3.57 USD per pound. I have not yet attempted to purchase any from here, however, so I do not know how reliable their service is.

---

## Tool, Hardware & Rocketry Suppliers

[PRINCESS AUTO & MACHINERY](#) -- I'm like a kid in a candy shop when I visit Princess ! Many of the items sold are surplus or used, so the prices are greatly reduced. Items includes all kinds of electric motors (AC & DC) including gearhead motors of all sizes, electrical and electronic components, power supplies, hardware including hi-strength fasteners, snap rings, O-rings, springs, roll pins, safety clothing, welders supplies, hydraulics and pneumatics, valves, pipe fittings, pressure gauges (great surplus selection), bargain priced machinist tools such as calipers, micrometers, rules, depth gauges, steel and aluminum, etc. All kinds of hand tools and hobbyist tools. Stock is always changing, so you'll never know what you'll find...on my last visit, I picked up half a dozen small (2') surplus parachutes (\$3.50 ea.) and a 10' weather balloon (\$10)! Over 20 locations across Canada. Purchases may also be made online.

[METAL SUPERMARKET](#) -- A good source of metal products (steel, aluminum, brass, etc.). This is where I usually shop for my metal supplies. They typically have a good selection of 'cutoffs' in 1018 mild steel and 6061 aluminum alloy (cheaper to buy cutoffs, which are sold by weight, rather than length). Locations in Canada, USA and UK. No minimum purchase.

[ACTIVE SURPLUS](#) -- Bins and bins of surplus and used items, mostly electronics, but also a good selection of surplus hardware. Fasteners sold by



the pound, including hard to get mil-spec fasteners. Good source for metals and plastics...I got the tubing for my Kappa motor casings here, for a steal. Located in downtown Toronto (Queen St.).

[CP TECHNOLOGIES](#) -- CP Technologies publishes a bookset entitled *How to Make Amateur Rockets* that is sold to amateurs, junior high schools, high schools, universities, government agencies and contractors in the United States and around the world. CP Technologies sells supplies needed to make amateur rockets, such as propellant chemicals, motor making supplies, rocket body tubes, nosecones, fin material, rocket recovery electronic and more. CP Technology's motors are based on an ammonium nitrate/magnesium/polymer system.

[AUSTRALIAN EXPERIMENTAL AE](#) -- Variety of low cost products for experimental rocket motor and propulsion research, such as constant pressure strand burner, phenolic & graphite rod for nozzles.

[MR. FIBERGLASS](#) -- Discount supplier of epoxy resins and related supplies. Epoxy brands carried are *West System* and *Mr.Fiberglass*.

[OnlineMetals.com - The Small Quantities Specialist](#) -- Source for a wide variety of metal products such as pipe, tubing, bar, sheet, plate, etc., including 6061-T6 alum. alloy tubing in sizes up to 5 inch diameter. No minimum order size, and purchases may be made online.

[E-COM PLASTICS](#) -- Source for all kinds of plastic material, including PVC rod, sheet and pipe. Minimum order size is \$25 USD, and purchases may be made online.

[BRAFASCO](#) carries a vast selection of hardware, fasteners, adhesives, cuttings tools and more. Minimum purchase \$10. Stores in Canada and USA.

[MCMaster-CARR](#) -- Supplier of a vast array of hardware related products, such as: gaskets (including ceramic paper), plastic including PVC rod and pipe, tools (including micrometers and calipers), fasteners such as screws, bolts and rivets, O-rings, seals, welding rod, springs, lubricants, pipe and tube fittings, metals of all shapes and types, thermometers, heat-shrink tubing, and much, much more (370,000 products!). No minimum order size, and purchases may be made online. Prices are a bit high, but service is very good and fast, I usually receive my shipments in a couple of days. UPDATE: NO LONGER SHIPPING TO CANADA (apparently they can't be bothered, thanks to ITAR).

[DIGI-KEY](#) -- Great source for any kind of electronic parts, including microprocessors, IC's of all types, transistors, relays, switches, sensors, circuit boards, project boxes, battery holders, wire and cable, and a whole lot more. Purchases may be made online. A nice feature of online ordering is that you'll know immediately if an item is in stock. Service is great, I usually



receive my shipment within a couple of days.

Metal Working Machinery Tools

[HARBORFREIGHT](#) New metal lathes, \$400 & up (U.S.A.)

[SHERLINE](#) \$550 & up miniature lathes, milling machines, etc. (U.S.A. & Canada)

[BUSY BEE TOOLS](#) Good prices on "offshore" machinery tools. I bought my 12x24 metal lathe at Busy Bee. Seven stores across Canada.

[KBC TOOLS & MACHINERY](#) Vast inventory of both high quality and reasonably priced "offshore" machinery tools & supplies. Stores in both Canada & USA.



**Last updated January 15, 2009**

[Return to Index Page](#)

---