

Boeing Employees Model Rocket Club

Sanctioned Section of the National Association of Rocketry (N.A.R.) Number 627

Newsletter for September, 2004

Location: Kent Recreation Center
Time: 2nd Saturday of Every Month
at 10:00 a.m.

President: Bruce Johnson
Vice President: Dave Davis
Secretary / Treasurer: Bob Turner
Librarian: Mark Shelton

News items and editorial comment in this publication do not necessarily reflect the views and opinions of the Boeing Company



Iranian Shahab-3 mobile IRBM in its launcher

***** **BEMRC Launch Schedule** *****

August 14 th (Saturday)	Kent, WA Launch Session
August 21 st (Saturday)	60 Acres Park, Redmond, WA Launch
September 5 th (Sunday)	Monroe, WA Launch Session
September 11 th (Saturday)	Kent, WA Launch Session
September 25 th (Saturday)	60 Acres Park, Redmond, WA Launch
October 9 th (Saturday)	Kent, WA Launch Session
November 13 th (Saturday)	Kent, WA Launch Session
December 11 th (Saturday)	Kent, WA Launch Session

***** **On The Cover** *****

On August 11th, Iran carried out a successful field test of the latest version of its Shahab-3 medium-range ballistic missile, which defense experts say can reach Israel or U.S. bases in the Gulf.

Based on the North Korean Nodong-1 (which is a derivative of the original Soviet SS-1 Scud) and modified with Russian guidance technology, the Shahab-3 is thought to have a range of 810 miles, which would allow it to strike anywhere in the middle east. Shahab means meteor in Persian. Staying with the SS-1 design, the Shahab uses RFNA and kerosene for fuels and can easily loft a 1,000 pound delivery bus. The major improvement in this design, is the detaching warhead with its own independent guidance. The SS-1 did not have this capability and closed to target as a complete vehicle.

Israel successfully tested its Arrow II anti-missile project in the United States in July. It was the seventh time the Arrow II had worked, but the first time it had destroyed a Scud missile.

Iran deployed the Shahab-3 missiles to its Revolutionary Guards last July after preliminary field tests were successfully completed. A senior Israeli defense source said Israel believed Tehran was developing a Shahab-4 missile with a range of 1,056 miles capable of reaching Europe. Iran has denied this.

***** **Quote(s) of the Month** *****

“You might think it irresponsible of me to drink with a shot of rum in one hand and a beer in the other, but relax -- I've got my good knee on the wheel.” - Travis Ruetenik

“I was going to put some towels in a dye bath to brighten them up, but the box of dye recommends "30 minutes of continuous agitation," so I guess I'll just have to wait until the kids come home.

- Duxall Inarow

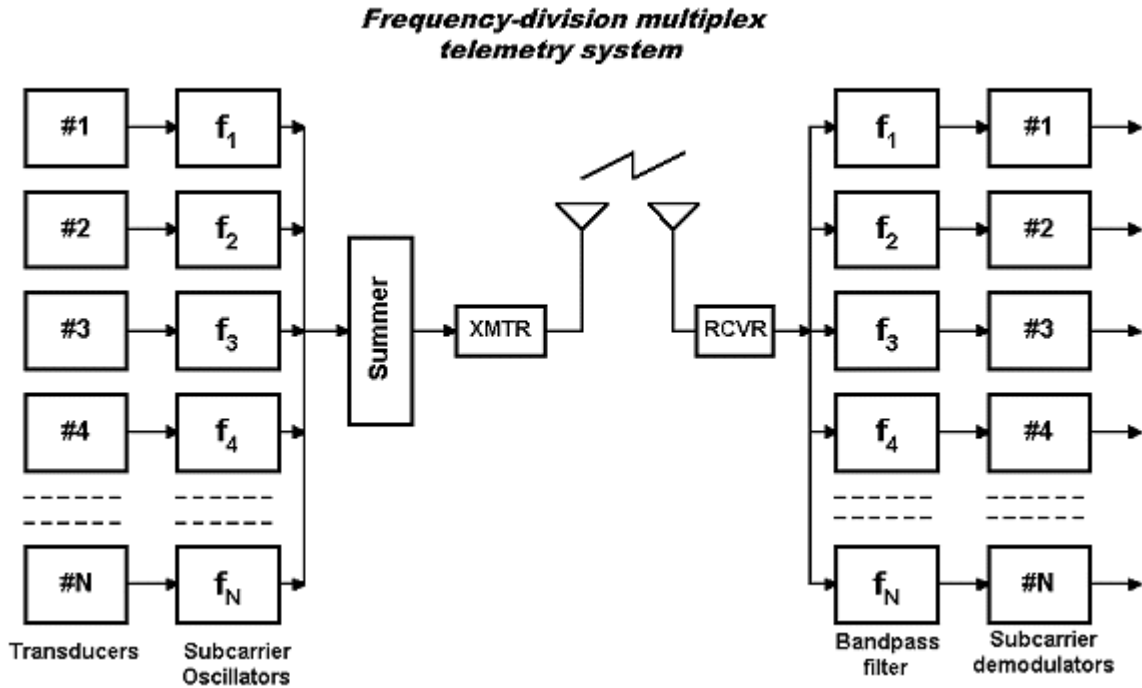
“After excitedly explaining to my wife how I planned to rid our yard of every last hedge, bush and tree, she pointed out that particular item on her honey-do list didn't actually say "landscraping." - Brad Simanek

“Sometimes I wish there were a "Alcohol, Tobacco, Firearms, Video and Bait" store. Then I could get all my shopping done in one stop”. - Don Hunter

***** **Frequency Division Multiplex Telemetry – A Few Fundamentals** *****

by: Sven Grahn

The basic operation of a frequency-division multiplex telemetry system is illustrated in the figure below. The measurement signals from transducers modulate "subcarrier" oscillators tuned to different frequencies. The output voltages from the subcarrier oscillators are then summed linearly. The composite signal is used to modulate the downlink transmitter.



In the receiving station the composite signal is available at the output of the receiver demodulator, which is then fed to bandpass filters that are tuned to the center frequencies of the subcarrier oscillators. The outputs from the filters are the demodulated and the original transducer signals are recovered.

All types of modulation can be used for both the subcarrier oscillators and the prime carrier. The transmission system for frequency division multiplex systems is designated by first giving the modulation for the subcarriers and then the prime carrier. Thus FM/AM would indicate a frequency-division multiplex system in which the subcarriers are frequency modulated and the prime carrier is amplitude modulated by the composite subcarrier signal.

The most commonly used frequency-division multiplex system is FM/FM. Standards were established in the U.S: for FM/FM systems shortly after World War II and they later became known as the Inter-Range Instrumentation Group (IRIG) standards. The FM/FM standard established the center frequency for subcarriers and how much bandwidth each subcarrier can occupy. The table on the next page shows the IRIG FM/FM subcarrier channel assignments.

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(telemetry continued)

***IRIG FM/FM
subcarrier standard***

Channel #	Subcarrier center freq. (Hz)	Channel Bandwidth (Hz)	Frequency Response (Hz)
1	400	60	6
2	560	84	8
3	730	110	11
4	960	145	14
5	1300	196	20
6	1700	256	25
7	2300	346	35
8	3000	450	45
9	3900	586	59
10	5400	810	81
11	7350	1102	110
12	10500	1576	160
13	14500	2176	220
14	22000	3300	330
15	30000	5500	450
16	40000	8000	600
17	52500	7880	790
18	70000	10500	1050
A	22000	7100	660
B	30000	9000	900
C	40000	12000	1200
D	52500	15760	1600
E	70000	21000	2100

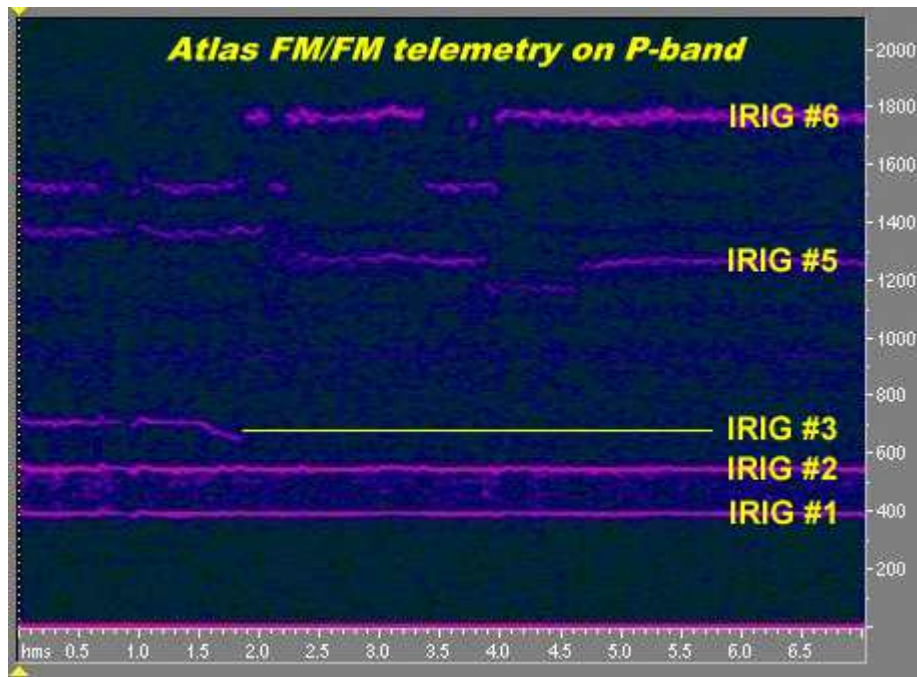
The most noteworthy variants frequency-division multiplex systems used in addition to FM/FM are FM/PM and SS/FM (for Single-Sideband/FM). An FM/PM system was used in the early days of the U.S. space program under the name of Microlock, because phase-locked receivers were used to acquire and detect the main carrier. The early Explorer and Pioneer probes used this system.

However, the amount of information transmitted in these early systems was very limited. By using single-sideband subcarrier signals much more data could be compressed in a narrow bandwidth and the SS/FM systems were used in early Saturn 1 flights.

The figure on the following page shows about seven seconds of FM/FM telemetry from an Atlas rocket launched from Cape Canaveral in the early 60's. The carrier frequency was in the P-band region, i.e. 215-260 MHz. The figure shows five subcarriers and their behavior at the time of booster engine separation. We can easily spot IRIG subcarriers 1, 2, 3, 5 and 6. It seems that IRIG 3 disappears at 1.9 seconds into the recording.

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(telemetry continued)



Normally, the outputs from the subcarrier demodulators in the receiving station were applied to banks of meters or to multi-channel strip-chart recorders. These recorders were either of the type with ink pens writing on moving paper, ultra-violet light beams drawing traces on UV-sensitive paper or so-called Sanborn recorders which used heat pens (hot wires which made black lines on special paper). I have myself been crawling on the floor at the Swedish rocket base Esrange analyzing strip-chart recordings from a sounding rocket as they rolled out of the recorders in real time!

In the early days of telemetry Analogue Time-Division Multiplex systems were used in conjunction with frequency-division multiplex systems. A very common type of time-division multiplex was the Pulse-amplitude modulation (PAM) system. The output of the commutator in such a system is a series of pulses, the amplitudes of which correspond to the sampled values of the input channels from the transducers. At the receiving station the process is reversed. The demodulator output from the receiver is passed through a decommutator that produces outputs corresponding to the sampled measurement signals.

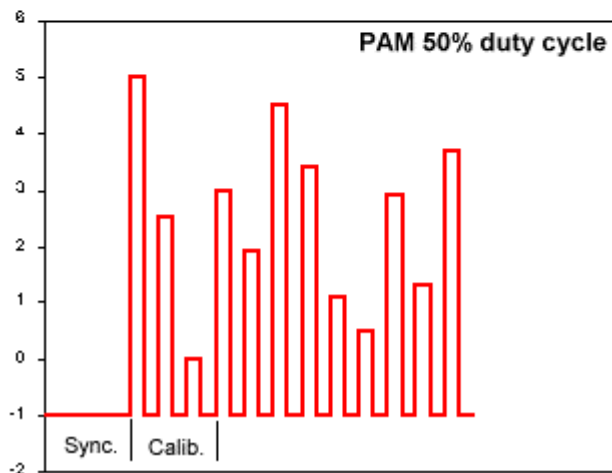
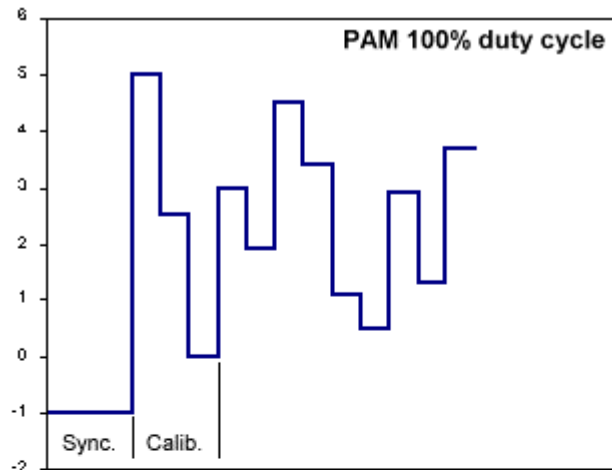
The pulse-amplitude waveform may take several forms as can be seen on the following page. The principle difference lies in the duty cycle of the pulse. In the figure on the right the top diagram shows a 100% duty cycle system while the lower diagram shows a 50% duty cycle system.

The length of time necessary to sample all channels is called the "frame time". In order to identify the channel corresponding to a sample at the receiving station, it is necessary to provide frame synchronization.

Several different methods can be used to designate the beginning of a frame. The method illustrated on the right consists of forcing several consecutive channels to a level below the minimum allowable data value. Since drifts and non-linearities cause errors, it is also common practice to transmit calibration pulses as shown in the figure.

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(telemetry continued)



Bill Obenauf, who worked at Lockheed with Agena-based spacecraft recalls *"the commutators which were used to monitor 30 or 60 voltages (temps, positions, etc.) and fed to one of the higher frequency oscillators. The output at the ground station was a complex square wave, recorded and read by hand using a Gerber Scale. It was a cumbersome task. The early Agena Satellites used a vacuum tube version of FM/FM Telemetry. I worked on calibration of these oscillators in the 1950's at Lockheed in Van Nuys, California."*

In addition to the primary time- and frequency-division multiplex techniques described here, there are cases in which these techniques are combined. One of the most common combination has been that of PAM and FM/FM to form PAM/FM/FM. In this case a PAM time-division multiplex signal is used to modulate an FM/FM subcarrier. Several other subcarriers may also be modulated with separate PAM signals. Usually the higher frequency subcarriers are used for PAM signals and the lower frequency subcarriers are used for direct measurements.

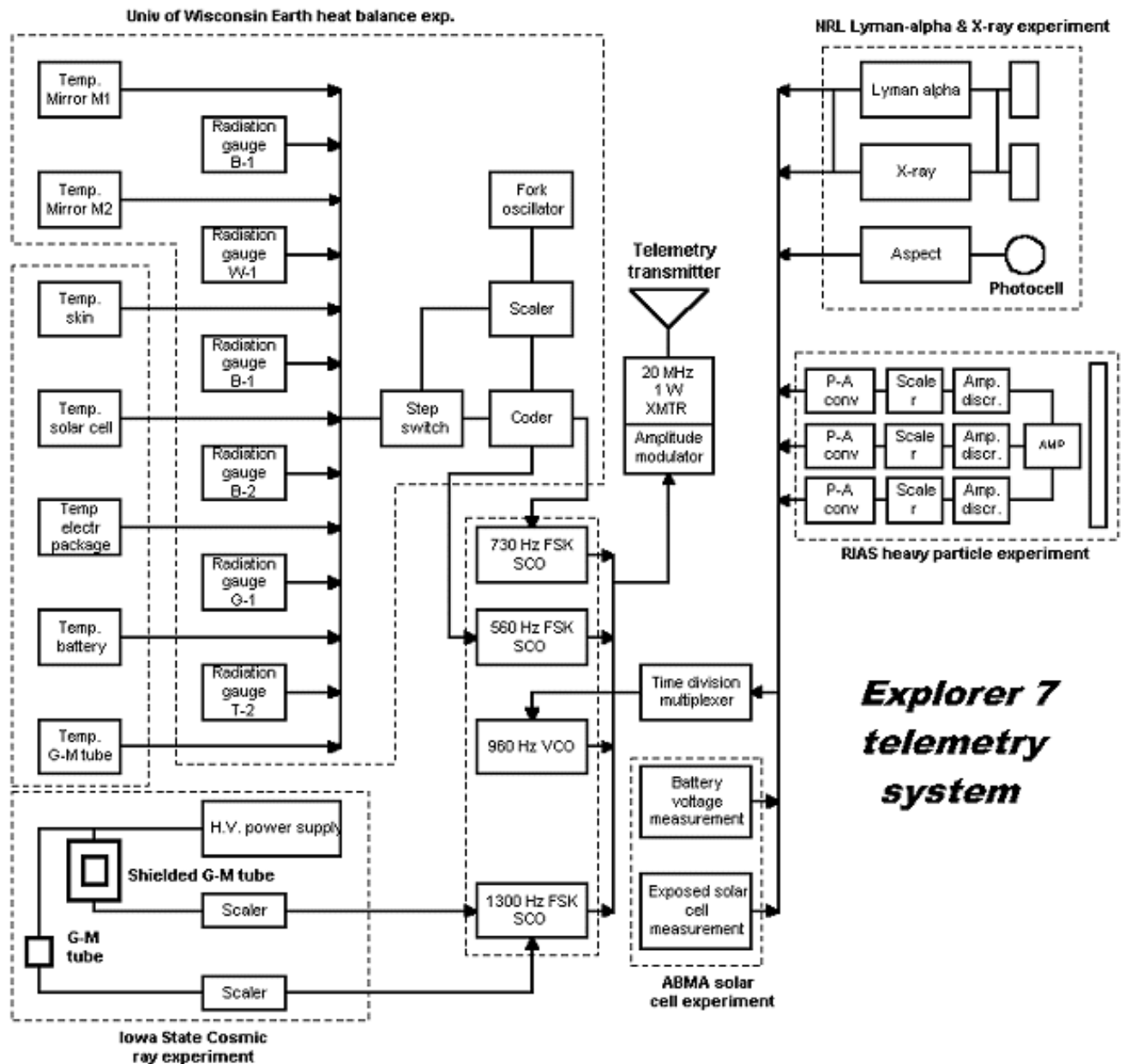
As an example, the PAM sampling rate for IRIG channel 5, with a subcarrier center frequency at 1300 Hz, is 10 samples per second.

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(telemetry continued)

Explorer-7, a real-life example of PAM/FM/AM

In real-life applications many sensors were multiplexed on each subcarrier. Explorer-7 is a good example of this. This spacecraft was also called S-46 and it used a PAM/FM/AM system on 20 MHz and PAM/FM/PM system on 108 MHz. The 20 MHz system using PAM/FM/AM is shown in the figure below. Explorer-7 was launched on a Juno-2 rocket from Cape Canaveral on 13 October 1959 into an orbit at 556-1088 km with an inclination of 50.3 degrees. It transmitted on 19.9904 MHz for nearly 2.5 years. The choice of 20 MHz was very unusual for U.S. satellites. In this case this frequency was selected to permit reception of signals by amateur radio as part of activities connected with the IGY.



***** A Micro-Maxx Adventure *****

by: Dave Davis

When Quest introduced the “Micro Maxx” product line a few years ago, I basically ignored it. “How could such an itty bitty rocket, be any fun at all.” I was wrong. Micro-Maxx is cool. Earlier this year I was contacted by the Blue Mountain Rocketeers to see if Micro Maxx (MM) rockets could be flown off of a “conventional” type launch pad. MM products are designed to fly off of their own GSE, have their own ignitors and have little compatibility with existing systems. Somewhat curious about the situation, I took up the task.

The first major problem was procuring some MM hardware. I scored some Starter Sets which were bound for the dumpster and started to see if they could be brought back to life. The entire starter set consists of a 4” canister about a foot long containing the Ready to Fly model, some motors and the GSE with launch controller. Literally, it was rocketry in a can. There was only one good launch rod in the pile, so it was out to the garage to find the 1/16” stainless wire that Mark Shelton gave me a year ago to see if we could get some MM GSE built. Guess what? 1/16” wire doesn’t work. It was off to the local hobby shop with the only launch rod in hand. \$2 later, a tube of .047 wire was mine and it was cut into several of the 11” spec length from the original. That solved the launch rod problem. The MM rod fit easily in drill chucks and the BMR and BEMRC clamping launch pads.

We had a workable launch pad. Now, to solve the electrical problem. MM birds are designed to fly off of their own launch pads using a custom ignitor which plugs into the base of the launch pad. A major problem, since we were no longer using the MM starter set GSE. The nozzles on the 1/8th A motors are so tiny, that Estes Solar ignites do not fit. However, there is a solution. While looking through my range box, I came across a container of ignitors I had not used in close to 30 years. Back in the “fossil” days of the hobby, Estes had not yet invented Solar ignitors. We used two inch lengths of 36 gauge nichrome wire placed in the nozzle to where it just touches the propellant. Nichrome wire is the stuff used in toasters that glows when you pass current through it. It’s non-pyrotechnic unlike an Estes Solar. It just gets real hot. It was time to go test.

Over at the May Blue Mountain launch, The rod slipped nicely into their GSE, and a small ball of Estes wadding kept the nichrome wire in place within the nozzle. The micro clips hooked up easily, and we had continuity. When the launch button was pressed, the MM bird leaped off of the pad to close to 200 feet. Incredible performance for just a 1/8th A. There was a minor glitch on recovery, so a quick repair and the second flight was a perfect success. We had flight hardware.

At the next Kent launch, there were two successful flights using the Quest MM GSE powered by a nine volt battery. What an amazing system in such a small package. At the following 60 Acres launch, I attempted a third flight on the existing GSE and nothing would light. Not enough power. After a quick swap out of the rod to my main launch pad, and the installation of a nichrome wire ignitor, we were back in the air. Looks like you need to bring along more fresh batteries for a day of flying.

I’m having a lot of fun flying these rockets. The motors are exempt from ATF, and the ignitors are non-pyrotechnic, so they’re exempt also. The entire GSE fits in the front seat of the car and sets up in seconds. There are rumors out that Quest has dropped the MM line and are bringing it back under another name. I hope they keep it around. It’s a great product for people new to the hobby, as well as, for crusty fossils that have been around for a few years. Great job Quest.

by: Dave Davis

BATFE Situation

On August 9th, BATFE released their latest Q&A page concerning our hobby, and it's included in this issue in its entirety. Basically they haven't changed their position very much. Motors with an assembled mass of over 62.5 grams are still regulated, which means that for anything over a "G" motor, you have to have an LEUP with approved storage. The folks who are really taking a hit are the EX folks. One of the loopholes in the Homeland Security Act was that people could make their own motors without an LEUP. This is cool. Only one problem. ATF requires storage for these homemade motors, and if you move them off of your own property, you need an LEUP for transport.

Another nasty wrinkle is that ATF is also holding to their position that ignitors are also explosives. This is real bizarre when you've got an Estes type motor that's exempt as it's under the 62.5 gram propellant threshold, while the ignitor that it takes to fly it is regulated. To me, if the motor is exempt, then the ignitor that comes with it in the same package is exempt. If people have a problem flying Estes type motors with a potentially illegal substance, they can ignite the motors using non-pyrotechnic nichrome wire. A two inch length of either 30, or 36 gauge works fine. The existing ignitor plug will probably work much better than the ball of recovery wadding we used to use.

ATFE is still stressing their stringent locking requirements for magazines, so magazine holders have another hoop to jump through.

The TRA and NAR are passing this latest document by their legal counsel as ATF seems to have ignored the "Propellant Actuated Device" exemption handed down by the judge to the hobby in federal court and continues to impose requirements without following its own rulemaking process.

Winter Seminar Series of Classes

The 2004/2005 Winter Seminar Series of classes is coming up fast. If you're interested in participating, or express any interest in even having classes this year, contact any BoD member.

Monroe Launch Site Situation

After regaining access to the Monroe site, we've had to scrub several launches this season due to the lack of the site being mowed. As of this writing, the site hasn't been fully mowed since June and is real ratty. We have one more launch date on the calendar set for the first Sunday in September. If the site gets mowed, and it's safe to fly, word will be spread accordingly.

With the tenuousness of both the Kent and Monroe launch sites, keep your eyes open for good candidates. 60 Acres has been our primary launch site this summer, and we have used it accordingly. If you have a site in mind, contact any BoD member.

Site parameters are pretty basic. Two thousand feet on a side or close to it. Cleared of trees, and hopefully away from swamps and power lines.

Questions and Answers

Hobby Rocket Motors

8/09/04

ATF has received a number of questions about the applicability of Federal explosives law and regulations to hobby rocketry.

The following frequently-asked questions and answers are set forth to provide rocketry hobbyists with guidance to enable them to enjoy their hobby in compliance with the safety-and-security related requirements of the law and regulations.

ATF looks forward to continuing to work with the rocketry community to help ensure that hobbyists understand and are able to comply with all applicable requirements. Hobbyists who have additional questions should feel free to contact ATF's Explosives Industry Programs Branch at 202-927-2310.

1. Which rocket motors and reload kits are exempt from ATF regulation?

Fully-Assembled Motors

Any fully-assembled rocket motor containing more than 62.5 grams of propellant is subject to the permitting, storage and other requirements of Federal explosives law and regulations as set forth at 18 U.S.C. Chapter 40 and 27 C.F.R. Part 555. Any other fully-assembled rocket motor (*i.e.*, any fully-assembled motor containing up to 62.5 grams of propellant) is exempt from regulation pursuant to longstanding ATF policy. Pending rulemaking, certain fully-assembled motors containing 62.5 grams of propellant or less are also considered to be exempt as propellant actuated devices.

Reload Kits and Propellant Modules

Any reload kit or propellant modules that can be used in the assembly of a rocket motor containing a total of more than 62.5 grams of propellant (even if the individual propellant modules each contain 62.5 grams of propellant or less) are subject to the permitting, storage and other requirements of Federal explosives law and regulations. All other reload kits and propellant modules (*i.e.* reload kits and propellant modules that can be used only in the assembly of rocket motors that contain a total of no more than 62.5 grams of propellant per assembled motor) are exempt from regulation pursuant to longstanding ATF policy. Pending rulemaking, certain reload kits and propellant modules that can be used only in the assembly of rocket motors that contain no more than 62.5 grams of propellant per assembled motor are also considered to be exempt as propellant actuated devices.

2. Is a person who manufactures propellant or electric igniters for his own use required to obtain an ATF permit or license?

Questions and Answers Hobby Rocket Motors

No, a license or permit is not required to manufacture explosive materials (including propellant, igniters, etc.) for one's own use. A person manufacturing for his/her own use is, however, required to store non-exempt explosive materials in an approved storage magazine. Additionally, a permit is required if a person wishes to transport non-exempt explosive materials, and a license is required if a person wishes to engage in the business of selling explosive materials that he/she manufactures.

3. I would like to manufacture and distribute single use rocket motors and/or propellant reload kits. What ATF license is required?

Only a manufacturer's license is required. Licensed manufacturers may engage in the business of manufacturing explosive materials for purposes of sale or distribution or for their own use. It is not necessary for a licensed manufacturer to also obtain a dealer's license to engage in business on his or her licensed premises as a dealer in explosive materials. *See 27 CFR § 555.41(b)(3).*

4. How are rocket motor igniters classified?

Igniters are classified as explosives. Federal explosives law defines the term "explosives" as follows: "any chemical compound mixture, or device, the primary or common purpose of which is to function by explosion; the term includes, but is not limited to, dynamite and other high explosives, black powder, pellet powder, initiating explosives, detonators, safety fuses, squibs detonating cord, igniter cord, and igniters." *See 18 U.S.C. § 841(d).*

5. Must ammonium perchlorate composite propellant (APCP) be stored in a magazine?

Yes; however, single use rocket motors containing no more than 62.5-grams of APCP and/or rocket motor reload kits and propellant modules that cannot be used in the assembly of a rocket motor containing more than 62.5-grams of APCP 62.5 grams, do not require storage.

Accordingly, the following items must be stored in accordance with the requirements of the Federal explosives regulations:

Single use rocket motors containing more than 62.5 grams of APCP or other explosive material (not including pyrotechnic delay or ejection charges)

Reload kits and propellant modules that can be used to assemble a rocket motor containing more than 62.5 grams of APCP or other explosive material.

6. When attending a rocket launch overnight, how should one store one's non-exempt rocket motors, reload kits, and propellant modules?

Questions and Answers Hobby Rocket Motors

In accordance with the requirements of Subpart K of the Federal explosives regulations found at 27 C.F.R. Part 555.

7. *May a rocket motor dealer engage in the business of selling non-exempt rocket motors or non-exempt reload kits/propellant modules away from his/her licensed premises (e.g. at a launch site).*

No; however, delivery may be made at launch sites if the transaction/sale has occurred previously at the licensed premises.

8. *Are motors containing ammonium-nitrate explosive mixtures and/or potassium-nitrate explosive mixtures considered explosives?*

Yes.

9. *What type of magazine would I use to store my non-exempt rocket motors or other explosive materials?*

All persons who store explosives must store them in conformity with the provisions of Subpart K of the regulations. APCP rocket motors are, by way of example, considered to be low explosives. At a minimum, therefore, they must be stored in type 4 storage magazines.

10. *My rocket motors are being stored in a type-4 magazine with two flush mount locks on the lid with a lever mechanism that rests under a small piece of metal on the edge of the magazine wall (typically 18-gauge sheet metal), to secure the lid. Is this acceptable?*

No, the flush mount locks fail to meet the locking requirements set forth in 27 CFR § 555.210.

ATF has examined the flush-mounted bolt style locks, which secure the magazine by means of a bolt-type mechanism. The cylinder portion of the lock mounts in the lid of the magazine in such a manner that, when the key is turned, the bolt slides toward the outer wall of the magazine. This bolt engages in a slotted locking block attached securely to the inside of the magazine wall. Because this locking mechanism relies upon interlocking solid metal parts, operating in a fashion similar to a deadbolt lock, it provides a level of theft resistance that is substantially equivalent to that required by the regulations.

Boeing Employees Model Rocket Club (B.E.M.R.C.) Membership Form

Last Name _____ First Name _____ M.I. _____

Boeing Mail Stop/Mail Code _____

Boeing Phone Number () _____

Boeing Email Address _____

Optional:

Home Address _____

City _____ Zip Code _____

Home Telephone Number () _____

Names of Family Members likely to participate in club activities:

Spouse _____

Children _____

Membership dues are \$5.00 per year per family. Completed forms and checks can be sent to Bob Turner, M/S 8J-49. Checks are payable to BEMRC.

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