

Information for the Pyrotechnically Enthusiastic

# Blasted

*Can't Wait until Number Eight!*

Submitted by Larry Homan

You may not have noticed me, but I was there, eavesdropping on your conversations at the recent WWB VII. I am brave enough to share some of my experiences and thoughts with you, except I should have written this when I still remembered them. It is interesting to look at my notes, all on 100% virgin wasted paper, now so much pyroglyphics. The business meeting-did I attend that? So I've decided to just make this all up. Therefore, I am not responsible for the facts, rather stated or omitted. If anyone catches you with this article, don't let it fall into the wrong hands-eat it immediately. They hardly ever pump your stomach for pyro articles.

My first impression is, "Who are all these people and what are they doing here?"

The first day and night had some nice shells: break shells by Chris Simonsen, rounds shells by Devon Dickensen and Jim Widman, and many others. A hail of test shells from Tom Mattrocce. Get your orders in early. There was a nice seminar by the Kosankes on black powder. These people can test your homemade powders and quantify the results; just drive your samples to Colorado. An outstanding thirteen-time report by Frank Feher. Such elegance and simplicity can be quite effective. At Italian feasts such timed shells (in reports, spiders and shells) are often stepped through five, seven, nine and eleven time as a display of tech-

nique. Thirteen, I don't think ever. Fifteen is rare indeed. I always made even numbers, no bottom, until persuaded to change by my Italian friends, so sixteen was my best.

I'm going to control myself when discussing the anvil demonstration. Ten...nine...eight...BOOM! This is one thing my ears will never forget. I do want them to know WWB VIII will be in Hawaii. Sam Zarcoff sends me an article from Smithsonian magazine documenting this as a real old-time pastime. I have this mental picture of Ken Kosanke at the entrance gate holding a large meter and announcing with a sheepish-serious grin, "One hundred and thirty-two decibels." These guys cannot be discouraged. It's as if they expected the next shot to suddenly plunge the anvil into a slow arcing orbit. I think they should have been limited to one hundred attempts.

Continued on page 11

*The first homeless pyro to take up residence in the WPA's new Lake Havasu, Arizona, condo. Now available for frugal family vacations.*



### In This Issue

- 2 Notes from the Overground
- 3 Letters to the Editor
- 4 Pyro Rumors Ablaze
- 5 Improvements and Such
- 6 Officer's Corner
- 6 On-line
- 7 Competitions
- 8 Reviews
- 9 Electric Matches
- 12 Luna Tech Matches
- 13 Quick Match
- 14 Announcements and Notices
- 16 Calendar



The Western Pyrotechnic Association Newsletter is a publication of the Western Pyrotechnic Association, Inc. Membership dues are \$30 per year. Requests for membership forms should be sent to: W.P.A., 2230 Aralia St., Newport Beach, CA 92660

#### Officers

President.....Dave Steinau (408)662-2958  
Vice-President.....Steve Wilson (707) 485-5122  
Secretary.....Forrest Rhoads (714) 640-5395  
Treasurer.....Sam Zarcoff  
Publications.....Larry Homan (209) 227-7819

#### Area Vice-Presidents

Southern.....Jill Cayot (818) 348-1048  
Valley.....Frank Guidi (209) 591-3763  
North.....Tom Cloud (510) 778-1455  
Arizona.....Mark Devon (408) 725-0943

#### Important Notice For All Readers:

The Western Pyrotechnic Association, Inc., also known as the WPA, is a non-profit group of firework professionals and their apprentices. Fireworks are inherently dangerous. Readers are urged to learn and obey all laws and regulations of all federal, state and local jurisdictions and of their agencies and representatives. Some information herein may contain incomplete descriptions of firework techniques based on the experience of its author(s) in a controlled environment with circumstances and conditions different from a reader's. This information is not intended as an instruction manual. Readers must form their own opinion as to the application of this information. This information is considered documentary in nature and no opinion is given as to its suitability or use. No warranties are made either expressed or implied, including but not limited to warranties of the accuracy of the information herein. The Western Pyrotechnic Association is not responsible for the opinions of authors or mistakes in printing. All information is intended solely for viewing by members of the Western Pyrotechnic Association, Incorporated, and its associates. The WPA's entire liability and anyone else's remedy shall be a refund of the subscription price. In no event shall the WPA, or its officers or the editor be held liable for any damages whatsoever arising out of use or inability to use the information in this publication, even if said parties have been advised of the possibility of such damages.

This newsletter is published by and is the sole property of the copyright owner, and is not to be sold, distributed or reproduced in whole or in part without written consent of the editor and publisher. The contents of this newsletter is © Copyright 1996 All Rights Reserved by The Western Pyrotechnic Association, Inc. or by the author(s), if so indicated, and is republished by permission of the copyright owner. Distribution is limited to paid subscribers.

## Notes from the Overground

Larry Homan, Editor

Pheew! I thought we had spent all the money. But it now appears as if you will receive some Newsletters this year. The present issue has been delayed waiting for the OK to proceed. Of course, the membership rule that requires that you read each one entirely also remains in effect. Fortunately, most of the information is designed to only utilize brain cells for a day or two; then they can go back to thinking about sex and money. I am told that there will be a complete financial report by this August.

There has been some discussion of the changes that were made at the last business meeting. Fortunately, the minutes of the meeting were lost, so no one can document their version of events. There seems to be some confusion about the new membership dates. The change was made in order to relieve some of the stresses on the secretary, who must handle both the renewals and Blast registration at the same time. Since there is only one volunteer for this job, we need to accommodate Forrest Rhoads and make his task as bearable as possible. Hopefully, for existing members, there would be no real change. We want everyone now a member to be a member for next year's Blast without renewal, I think. So far, so good, or so it seems until one begins to think about it. Last year we carried 150 members for six months. The problem arises with new members. In the past, new membership was retroactive, from the beginning of term until the present, including back issues, if any, of the Newsletter. Now the proposition is to let all new members join until November, 1997. Anyone have any suggestions to make this all fair, reasonable and economic.

As editor I have decided to print on a space available basis announcements and notices from the membership. Until I receive a copy of the membership I will assume everyone is a member. These items could be conceived as advertising. The By-laws do not prohibit it, but there are policy decisions covering this topic. After reading these policies and reviewing the present process of how the

Continued on page 15

### If You Can't Live Without It, The Newsletter Is Available!

Former issues of the WPA Newsletter from 1995-96 are available for \$4 from the Secretary of the Association. There should be five issues for 1995, so a complete set is \$20. Supplies are limited. Allow a few weeks for delivery. They make good gifts.

### Submissions:

Larry Homan, Editor, P.O. Box 162, Fresno, Ca. 93707

Submissions of written material and graphics and photographs dealing with pyrotechnics or fireworks, related technologies or activities of, and information to the benefit of the members of the WPA, Inc. are gladly solicited. All submissions become the property of the Western Pyrotechnic Association, Inc. and may be edited or rejected for any reason and such material may not be returned. No payment is made for submissions. The editor knows nothing about subscriptions. Contact the WPA secretary for the proper information.

### Newsletter Exchange Available

Any editor of any fireworks or pyrotechnics publication, who would like to exchange issues, please contact the editor and let me know that you are there. We are happy to oblige anyone with an interest in fireworks. There might be a delay in receiving your copies. Notify us if you haven't received one.



# Letters to the Editor

**Write me! I'm a very lonely guy.**

*There has been an upsurge in letters to the editor, but not in additional room to print all of them. Don't take it personally, I am making arrangements to publish them on-line. Favorable comments insures publication.*

Hello Editor,

Would you please enclose this in the next WPA Newsletter. You may edit it as you see fit.

I'd like to thank everyone involved with the seminars. A special thanks to everyone who attended and participated in the hands on classes and the attempt to break the world's record for a bottle rocket barrage.

Thank you,  
Paul Bregel

*I saw fit to remove all the gushing praise of me as a human being and pyrotechnist. I do want to thank you and your friends for so much quality fireworks this year. The whole WPA owes you and yours a resounding round of applause. All WPA members reading this, please stand and sing with me the national anthem: God save the star-spangled skies of fireworks over America.*

Dear Editor:

Good to meet you briefly at WWB VII. As I mentioned, your newsletter is really great. Thanks from someone who understands what it takes to do what you are doing.

Following is some fodder you may elect to use in the Newsletter, if you choose. Feel free to edit. I have no pride of authorship.

As new card-carrying WPA members, Ken Barton and I want to thank the WPA for the Blast, and for a chance to do our experiment with cracker strings.

The cracker experiment is part of an ongoing study to see how to get the most bang for a buck-to coin a phrase. Ken and I wanted to watch at close hand and get video, sound level and duration measurements.

Although we have shot strings before, this time we learned a lot of new stuff-most of which was not what we set out to get. The main problem was with inferior crackers. We have prior experience with Tiger Head brand. The ones we got for this trial were Horse brand. They came in a battered case, were shorter strings than the Tiger Head brand, and burned extremely erratically. Comparatively crappy product.

We are studying the video. In spite of the problems, the stop frame pictures show a clear mandate on how a display like this must be configured. That is, all strings must hang vertically and be spaced from each other, I will submit some sketches to the PGI Bulletin showing the normal and desired burn pattern.

Duration of the display was 37 seconds. Should have been 50 to 65. Sound level at 65 feet was a short sustained peak of 118 dB A scale. For the first time we had some small fires in the chaff. This could be due to the dry conditions and the fact that all previous strings were fired over green grass. Again, there were virtually

no unexploded crackers-which is a result of the vertical configuration of all strings.

It was good to participate this time as a WPA member. I wonder how many others will think it a good idea to encourage Frank Feher to build some shells for part of a future finale. Did you hear his 13 timed report with 1-1/2 pounds of flash for a bottom shot? And how about that 16-incher?

Another great time in the desert! Way to go guys!

Fred Johnson

*Fred and Ken:*

*When we were boys we spent a great deal of ingenuity attempting to maximize the results from the single pack of lady fingers once-in-a-while-acquired. Remember vegetables, tin cans, garbage cans, etc. Obviously, we have here two very old boys. In some, the pure joy of fireworks is never lost. May all of you return to that pure feeling. Just be careful not to get caught! I have a similar feeling about authorship. Frank Feher, the master of fireworks from simple household items, does not need to be encouraged. If you invite him to dinner, don't leave him alone in the kitchen. Who knows what could happen.*

*I have two letters from Doc Barr. I have sent them to Boston where experts from MIT and Harvard are attempting to decipher the symbols. I think we should all chip in and get Doc a typewriter. Fortunately, I have a computer or no one would be able to read this. I write notes to myself about tasks to be completed that even I can't read; therefore, I never have anything that needs to be done. Basically, Doc likes fireworks, fireworks people and fireworks people gatherings. And all those things like Doc.*

Dear Editor:

I keep having this dream. Everything is going normally. I am having no special thoughts. Then I notice everything seems to be too real. So I give it my infallible test. I will everything to catch slowly on fire. This always works, although in unpredictable ways. Usually, just the clothes start to slowly burn off people or their hair catches slowly on fire. They respond as if it is an inconvenience but not too dangerous. Then they begin to look like big clown dolls, subtly at first. They start exploding into individual unique little fireworks displays, always with these manic smiles on their faces. This all used to frighten me, but now I just enjoy. This is the only way I can tell if things are real. If it were a dream, there wouldn't be any pyrotechnic response

I dream of fire.

*Being naked at a fireworks display can certainly be embarrassing. I should know, it has happened to me. When I was at college I wanted to impress a certain dazzling coed with something special on our first night together. She said she was looking forward to the fireworks, but I think I chose the wrong kind. Well, things didn't go exactly as planned, but it wasn't really out of hand until the blanket caught on fire. I don't know why she chose to take this with her as she fled the apartment. I wish as I ran after her that*

Continued on page 15



## Pyro Rumors Ablaze Column

Pyro rumors, musings, factoids and tales.

The proposed trip to Malta to see the festivals is still going forward. I is scheduled for second week in August. This is not a tour but a group traveling by individual initiative trip. Call Tom and Susan Nolen (518) 373-1614 or (614) 584-6618.

\*\*\*\*\*

Hotels and casinos in Las Vegas have been prohibited from using lasers in displays. Apparently the bright lights were too bright for pilots landing at nearby airports, who prefer to do their gambling on the ground.

\*\*\*\*\*

Fireworks Festival, Auburn/ Weedsport, New York. See the calendar for details. Registration by July 1st is \$75.00, after \$100.00.

\*\*\*\*\*

It is possible to acquire publications covering Standards Regarding Fireworks by the National Fire Protection Association (NFPA). Call 1-800-344-355. Ask for:

- NFPA 1123 Fireworks Display They want \$17.50.
- NFPA 1124 Manufacture, Transportation and Storage of Fireworks \$21.00.

\*\*\*\*\*

Fireworks have been banned from several major Chinese cities. There is even a call to ban fireworks from China altogether. The report is that 60,000 people are injured or killed each year. (Why does anyone group killed with injured under combined casualties. This tactic has always annoyed me. Big difference, you know.) A total of 100,000 fires are asserted with annual loss of \$56,000,000. Very inexpensive fires. In America, this buys you a few minutes with a fire hose. The situation is very bad there, but I doubt the authenticity of the numbers. Ironical that a major export, for which the country is famous, is now considered too dangerous for its own citizens. It will be increasingly difficult for American importers to justify the product. I predict a demise for the Class C (UN 1.4) industry by 2080.

\*\*\*\*\*

Weren't there some great T-shirts available at the Blast VII. Unfortunately, no one thought to give me one, so I can't specifically mention any herein. Any vendor with an excess should take advantage of our new free advertisement section. Just send a free T-shirt for the correct information. See box elsewhere.

\*\*\*\*\*

The BATF Orange book is being rewritten. Politicians are hovering like vultures. Possible that the ATF will be merged into the FBI. Or the FAT FIB, as it will be known.

\*\*\*\*\*

There is some talk about the Parabola of Salutes at the PGI convention. A parabola is described as a half circle. This qualifies you to spend one high school math study hall with me, if I can only find the time machine. Since shock waves decay in a spherical fashion, I would guess the best choice is a circle. The ideal position to maximize the result is to stack the salutes in a big pile then sit on them when they are set off. Of course, if you want to actually hear them, you must be about  $A \times D^{1/3}$  away, where A is a factor related to the ratio of the speed of sound to the blast wave velocity and D is

the mass of salutes. They must have been thinking about the Cocktail Party Rule: There is some best spot at the party, while not having to listen to any one boring person, all the conversations merge into something worth hearing.

\*\*\*\*\*

Bill and Cindy Ofca of B & C Products, Inc. are planning a demonstration of their newly developed fireworks firing material, NOMATCH, at the Summer Fireworks Festival in New York by firing 880 three-inch effects along a one-half mile front. This will be divided into four sections, so by its listed rate of 6,500 feet per second, it should take about 100 milliseconds to initiate. Compentent volunteers are being solicited.

(914) 452-9036

(914) 452-9047

Ofca@mhv.net

\*\*\*\*\*

I have come to the conclusion that one useless man is called a disgrace, two are called a law firm, and three or more are a Congress.

John Adams

(Courtesy of Dave Noturo???????? via NHPAN)

This should read: ...one shiftless man is called a pyrotechnician, two are called a display, and three are called a convention.

\*\*\*\*\*

The law may be ammended in Northern Ireland to allow backyard displays of fireworks without the presently needed expensive permit. I met someone who owned several hundred acres of land in Northern Ireland. Now we must plan a display commensurate with the size of his backyard.

\*\*\*\*\*

In a recent experiment, a group of scientists at Livermore National Laboratory have produced for one-millionth of a second liquid metallic hydrogen which conducted electricity. They achieved this by using gunpowder to to compress gas in a sixty foot tube that fired a projectile at 16,000 miles per hour (6990 meters per second) into a container of hydrogen. The shock waves created pressures of greater than one million atmospheres, temperatures of 4500 degrees and a ninefold increase in density. Although probably not relavent in this example, but as a slightly related subject, I have often wondered if all the technology firms that manufacture pyrotechnic devices in California have state manufacturer licenses. I never see their names on the official lists.

\*\*\*\*\*

I received a nice letter from Karen Lynch, publicist for Benson & Hedges, Inc. She stated that she planned to attend WWB VII. Unfortunately, I didn't meet her, but maybe you did. The letter includes an offer to meet competitors and tour a barge in Toronto at this year's Benson and Hedges Symphony of Fire. I am only too familiar with the barge and many of the competitors I know one way or another. Mr. Frank Furtado does do an excellent job with this event; and it is well worth seeing, if you are in the area. See a previous newsletter for the dates. Admission to Ontario Place amusement park is \$12.00 and special reserved seating is \$18.50. I wish I

Continued on page 5



had the room to publish the accompanying Fireworks Facts. Who writes this stuff? I especially liked the comment of how the 500 foot long barge (used to be two barges) is stabilized by six 8,000 pound anchors. Obviously, they have never been on this barge when the weather sets in. I have. Good event though.

Ontario Tourist Information 1-800-Ontario  
Karen Lynch (416) 968-9320

\*\*\*\*\*

Warren Kloforn is proposing a national fireworks archive for the preservation of literature, writings and effects concerning fireworks and its practitioners. He thinks the PGI has the members to achieve this goal. This idea was first proposed about fifteen years ago and went nowhere, something I take most responsibility for, since it was my idea and responsibility. This was about the time of the first PGI safety committee (Tom Mattroce and I were the first members), the upgraded bulletin, the control of hand salutes, the shooter certification program and the codification of the competitions (a mistake). The most important idea had the least success. Out of guilt and genuine regret, I still think it is a very fine idea and am willing to give your time to Mr. Kloforn. Please contact him at:

warren@fileserv2.kcom.edu

\*\*\*\*\*

The PGII financial report is published in the last bulletin. In the most sincere measure of our society, money, the PGII continues to be a well supported success. They are doing so many things well. A surplus of \$118,324 for 2856 members, or \$41.43 per member. There were 835 (32%) new members and 599 non-renewals (23% didn't) for a gain of 236 (+9%). The north and heart of the country are definitely the strongholds, although California is the most stable. There are sudden moves in Illinois, Russia, Czechoslovakia, Israel and the Virgin Islands. What do these places have in common? Whatever is happening, the membership is continuing to vote a loud "Yes" to the PGII. All good news for a well-run, diverse, premier fireworks club.

\*\*\*\*\*

The WPA Safety Requirements written for the WWB VII were surprisingly good. You should have read them before signing the COMPLIANCE-WITH-RULES CERTIFICATION. Remember the purple paper. I was just wondering what was meant by the Rule of Thumb: Treat every device as if it were an aerial bomb with an instant time fuse! You mean sell it to someone else?

\*\*\*\*\*

After a fireworks display, don't put anything except fireworks in your DOT approved UN 1.3 Explosives boxes; to do so is a serious and enforceable regulation violation.

\*\*\*\*\*

On-line information. Occasionally, I get the chance to browse the online pyro discussion groups. So far I have stayed out of the fray. It's a great opportunity and resource but beware. If you do read this information, be aware that there is a large amount of false or misleading information, even from people who should know better. Sorta like this column. It is an example of where you must be fairly knowledgeable to separate the gems from the rocks. Humorous examples of relative nonsense are extracted and sent from pyro to pyro for amusement. This is a wonderful development in the

future of the pyro world, but don't let it misdirect your future development.

\*\*\*\*\*

A report from Internet: The first pyrotechnic book is an Egyptian hieroglyphic saying "a 'firebrand' made by packing a 'thick' rush haulm (?) with a mixture of powdered zinc and sulphur, which remained alight under water, and was used for illumination before the great Sphinx of El Giza was built.

\*\*\*\*\*

Quote from the CPA News, speaking of the WPA in an article about the WWB VII, which eight CPA members attended: "The Western Pyrotechnic Association deserves an enormous amount of credit for preserving this event. It puts a smile on the face of all their West Coast members and provides a welcome fair-weather haven for East coasters in need of a winter fireworks fix. This is a fireworks club that all others can look up to."

\*\*\*\*\*

Reportedly, the first family of fireworks has purchased a former army ordnance factory in Virginia, so that they can actually make those shells they are always bragging about.

\*\*\*\*\*

I recently received a letter from Steve Wilson and Mary McCavit who are in charge of soliciting a PGI ALL-STAR TEAM display at the Muskegon, Michigan convention. They have sent to me a list of potential participants. An impressive list of people I know or of whom I have heard. I have only one large shell: First break is five-time spangle shells, then a ring of hard shells, then a ring of hard shells. Second break is cluster of ciatines followed by a double ring of red shells, each with a circle of ti whistles to ti reports. Third break is a multi-pistil/petal chrysanthemum. I have been saving this one for my annual tribute. Think I should give it to them? I am promised a golf shirt commemorating the event and a group photo. This does sound like something worth seeing for anyone with an interest in American fireworks skills. If everyone shows up, it could be a once in a lifetime event. Good idea from the indefatigable promoter and WPA founder, Steve Wilson.

\*\*\*\*\*

An exemption from the prohibition (DOT-E11685) from placing electric matches in the leaders or lift of transported aerial shells applies until July 31, 1996 for APA members and applicants.

### Didn't Receive The Current WPA Newsletter?

Anyone who is not now reading this section has probably not received the most recent issue of the WPA Newsletter. There is a new absolute policy: if you don't pay, then you don't receive. Because it takes time to process applications, your present copy may be delayed. Contact the WPA Secretary about any subscription problems. If you're really mad, contact WPA President Dave Steinau.

## Write The Sixth Time

These are not mistakes, apologies, admissions of responsibility or corrections but instead think of them as

## Improvements and Clarifications

as well as sharing the blame. I don't open my own mail anyway.

*The last issue was perfect, i.e., no one complained to me; and that is all that counts.*



## Officer's Corner Editorial

Message From President Dave  
Music and Fireworks, Please

Dave Steinau

Well, it's been a couple of months since the Blast and (almost) everybody is probably wondering, "Where's my newsletter?". We're going to try to get out as many as possible this year, but the scheduling may be a little inconsistent. Multiple reasons for this, the main one being that Larry and I are both working a lot harder and more frequently (in the pyro world) than last year; consequently, neither of us have as much time to put into it as we did then. We're going to need a lot more input from the members to keep our newsletter as alive and interesting as it has been in the past.

Quite a Blast this year. More people than ever, there were around a thousand. Some great Class C vending, dozens of new problems and an incredible Public Display added up to one of the most challenging Blasts we've had. Quite a few changes in policy were made at the Business Meeting, and we're still trying to figure it all out. Two major changes were the decision to require WPA membership to attend the Blast, and a change in the renewal period from Feb. 1st to Dec. 1st. This is already resulting in confusion and will be resolved shortly. Stay tuned.

Safety was better than I've ever seen, thanks to Noye and Crew! The Class C shooting area has never been so well planned. I think we need to go to two open B sites and drop an electric system for the big stuff. We need a water truck (major oversight) and at least one more ATC with a good driver. With this many people, safety needs to be even better. Suggestions are welcome. There were the usual problems of not enough volunteers, especially Friday, and a shortage of radios and general unexpected logistic nightmares. Other than that, things seemed to go pretty well.

I would like to thank a couple of people for their labors over the years. We all owe a lot thanks to Steve Rhoads for his work this year and in years past. Steve and the Rhoads families have been part of the WPA from the beginning. He handles a lot of the transportation and trucking planning, routing, loading, unloading, set up and clean

Continued on page 16

wpa@cruzio.com  
www.valleynet.com/~coldfire/

## Lost in Cyberspace Construction Zone

Dave Steinau

Beam me out of here, Captain!

Things are changing out there in the world of the Internet, and they're changing fast. The WPA has had an Internet address since last Thanksgiving, and we've had a "home page" on the World Wide Web since New Year's day, thanks to the efforts of Central Area VP Frank Guidi. The Internet address, basically a place to send e-mail, is receiving approximately 6 to 15 messages a day, with many questions about the Association and a lot of pyro related subjects being discussed. Our e-mail address is wpa@cruzio.com. And if I'm in town, I respond promptly to messages.

Are you still unsure what all these buzzwords mean? Let me try and "demystify" some of the ideas. The Internet is a collection of 7000 plus computer networks, linked together, and is growing everyday. This allows worldwide communication with anyone connected to the Internet for the price of a local phone call (unless you're with Prodigy, America Online, Compuserve, or any of the other "pay by the minute" providers). The World Wide Web is an area of the Internet used to provide text and graphic links to other web pages (a web page is an address on the World Wide Web). What this means is, if you connect with any Web Page and you see a subject you're interested in and it's highlighted, you can "click" on the highlighted word and your computer will automatically go to that address. For example: you're on the WPA web page reading Joe Pyros article on black powder and the word "charcoal" is highlighted. You click on the word and all of a sudden you're at the "Worlds Largest Charcoal Supplier" web page. You can do this for every highlighted word, graphic or feature on a web page. These highlighted items are called "buttons" and are linked through the wonder of "hypertext."

So the WPA has a web page. What's it good for? Well, to start off, there's some great WWB photos and we're always looking for more. There's some good links to other Pyro web pages. There's an open forum dedicated to questions and answers re-

lating to formulas, shows, jobs in pyro, and other subjects. There's a really cool background. There's also hypertext links to other officers, our WebMaster, and El Presidente himself, yours truly. The address is www.valleynet.com/~coldfire/. Dial us up and look around.

There is a world of other pyro stuff out there on the 'Net. Some are incredible and informative, some are just okay and some are downright dangerous. New software makes it possible for the 'Net to be used with almost no computer knowledge whatsoever; and it's getting more user friendly every day. The 'Net is a fast growing, rapidly changing environment with too much going on worldwide to even begin to keep track of. Need a little excitement in your life? Want to spend hours with your machine, seeing what other pyros are up to? DaveBob says, "Check it out!"

\*\*\*\*\*

**There are a number of other interesting pyro on-line addresses, which I will print as I acquire them. Perhaps someone can save me the trouble and provide a list?**

The excellent Connecticut Pyrotechnic Association home page: <http://tad1.cit.cornell.edu/Tom/CPA/cpaHome.html> The work of Jim Widman and Tom Dimock.

\*\*\*\*\*

Other than the regular charges for your on-line service, there is no additional charge for joining a mailing list.

Vnet Internet Access, Inc. provides the facilities for several pyro related mailing lists. The oldest and most active pyrotechnics list is the Pyro Mailing List (PML). The main focus of PML is display fireworks including such topics as safety, chemistry, construction, pyro events, new products and regulations. Show-Fire covers a similar range of topics for all special effects including pyrotechnics, mechanical effects and special lighting. The PGI mailing list is an unofficial on-line forum for the Pyrotechnics Guild International discussions cover-

Continued on page 16



# WPA WWB VII Competitions

Competitors are nearly anonymous heroes who fearlessly demonstrate their disputable reputations as master fireworks makers.

Refer to Write the Seventh Time in the next issue of the WPA Newsletter for any additions or corrections; I expect to hear from misrepresented competitors. The winners only are listed. No prizes were awarded the first year. Actually, no competitor expressed interest in potentially large cash awards available from beer and cigarette sponsors. They do it for the love of light and sound. Descriptions were taken from competitors when available or memory when available.

## Aerial Shell Classes

### Smaller Shells (2-4 items)

Roger O'Neil

*Four-break, five-inch with (1) hummers, (2) whistles, (3) timed salutes and (4) bottom shot*

*Eight-break four-inch (1) white, (2) purple, (3) blue, (4) green, (5) yellow, (6) orange, (7) red, (8) white*

### Larger Shells (2-4 items)

Dan Howlett

## Individual Shells

### Small

Dave Martin

*Three-inch hummer shell*

### Medium

Jim Widman

*Three-break, six-inch Red stars with crackle micros*

### Large

Dave Peters

*Twelve-inch with rising glitter comets, Kamuro to magenta to silver wave with*

*mixed color core with glitter effects*

## Ground Display

### Gerb

Dave Martin

*One and one-half inch whistle to cast steel to titanium*

### Wheel

Dave Martin

*Six drivers with whistles*

## Class C Items

Sanford Margolies

*Assembled cake device*

## Rockets

### Black Powder

Dave Martin

*Eight ounce with blue go-getters and whistle*

### Whistle

Sanford Margolies

## Composite

Guy Lichtenwalter

## Rocket Classes

### Black Powder

Sanford Margolies

### Other Smaller

Larry Hughes

*Three-quarter inch with reports*

### Other Larger

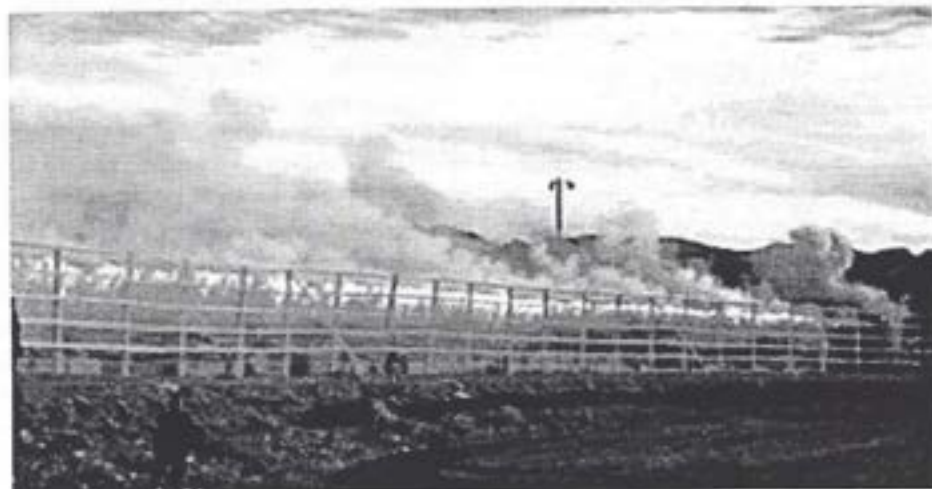
Mike Carter

*Up to 1" whistling rockets*

## Grand Prize

The Sparkler Unlimited Award goes to Paul Bregel and friends for their waterfalls constructed out of sparklers. Very clean and nice, despite the anxieties of certain safety people (who by the way did another excellent job this year, myself included: no accidents, injuries or fires that weren't basically fun, except maybe the trash pile). Also this group of fireworks enthusiasts is cited for general excellence for other efforts, big and small. They are this years group of Master Blasters.

## Grand Prize Winner Unlimited Sparkler



## Reviews

Larry Homan takes full responsibility, but please send all comments to his agent, Dave Steinau.

It has been said that there isn't a piece of pyrotechnic literature that Larry Homan doesn't like. That is not precise: there isn't a firework or a pyrotechnist that Larry doesn't like. The former is simply a route to the latter two.

---

The second issue of the *Journal of Pyrotechnics* has arrived. In fact, by the time you read this, the third will probably have been published. Fortunately, good pyrotechnic material does not go stale. Forty-eight pages this time, easy to read, cleanly done but with one annoying characteristic: because of the binding method, it won't lay open by itself (it does have sufficient central margins). I suggest using a couple of six-inch salutes to hold down the pages.

There is an article about the use of semiconductor bridge igniter or SCB as it is known amongst those working on projects funded by the government. This is a hot topic for military and commercial use: possible increased RF protection, coded firing, and electric static discharge protection. Electric match technology is improving, but most fireworks companies are still using matches of questionable safety.

I found particularly useful the article on new mortar racks. This is something that is sorely needed to protect operators. If it is possible that a rack failure can injure a spectator, then they are too close. Approval of these innovations takes a long time. I worked on one such revision in California law, gave up after five years, then saw it finally enacted through the efforts of others a decade later. This is important.

Clive Jennings-White and Ken Kosanke discuss reactive chemical combinations which might present hazards to the pyrotechnist. Many of the practical problems have been worked out over the years, but clear and comprehensive chemical explanations are just beginning to be assembled in the fireworks community. This article is very useful for the working pyrotechnist.

There is a reprint of one of the articles that restores your faith in the basic research capabilities of public officials. It determines

the susceptibility of fireworks to ignition by rifle fire, certainly one of the great hazardous unknowns in the modern world. Fireworks shells are placed against a metal plate and shot at a distance of 100 feet with a 150 grain 30 caliber ball ammunition with a muzzle velocity of 2700fps. Most things perform as expected. Moral: if you get in an urban gunfight with a preteen intent on having your tennis shoes, don't have a fireworks aerial shell in your pocket.

This issue is varied, interesting and useful; what else have you bought recently that was all that. Think about getting one. It is well worth the price of admission: \$15.00.

Journal of Pyrotechnics, Inc.  
1775 Blair Road  
Whitewater, CO 81527  
(970) 245-0692 v & f  
em: 71061.2066@compuserve.com

---

The *Arson and Explosives Incident Report 1994* has fallen into the wrong hands-mine, and I am avidly reading it. It's not as bad as you would expect, being rather well published and full of photos, charts and information. The whole thing is fairly slick, written in an official version of barely comprehensible government gibberish. Do you want to understand it anyway, as opposed to my brand of incomprehensible non-government gibberish? I dare you to read this cover to cover without your mind wandering off.

There are all kinds of details: threats to Treasury facilities in 1994-one. This could not possibly include the tens of millions of utterances against such facilities by people calculating their income taxes. In five years the Virgin Islands have had no incidents. Rhode Island as a state has the least. There were five states with no thefts. I guess the citizens there already had all they needed.

From the locations of bombing incidents list, the home is remarkably dangerous; but aircraft are perfectly safe, despite all the hype about potential plane bombings (read more money for government agents with little to do). Bombing incidents in restrooms: men's-136, women's-3. So next time use the women's. There was even an incident in a closet: I hate my clothes?!!

Unfortunately, when considering the composition of such bomb ingredients, fireworks and flash powder (there is a combination again) make up 15% of total. Bad news, maybe. Who would make a perfectly good fireworks into a bomb? No one. So

these are either not fireworks makers or these are very bad fireworks.

Surprisingly, this all reminds me of a story. I once met a man whose business had just burnt down. I commiserated with him, but he announced that he was very pleased with the insurance settlement. After a time, he admitted that he had burnt his business himself. Astonished, I asked what he used and how he expected to escape. He said barrels of gasoline were the fuel, but to throw the investigators off, he had tossed a few bottle rockets around the site. Sure enough, the investigators looked no further than their favorite cause, and issued a report that added another fireworks-caused fire to the statistics.

### Fireworks Incidents 1990-94

Type	Legal	Illegal
Explosions	19	13
Killed	10	6
Injured	36	12
Damage	\$1,323,500	\$97,500

Call your local BATF office or write:

Department of the Treasury  
BATF  
Explosives Division  
650 Mass Ave. N.W.  
Washington, DC 20226

---

### Bundesanstalt Fur Materialforschung und-Prufung (BAM)

I had the unusual opportunity to borrow a couple of BAM research reports summarized in English translation (I have since returned them). When the owner of a German fireworks company saw that I had these reports, she was very impressed, saying that they were hard to obtain. I somehow doubt this, I simply removed them from a bookshelf.

The first paper, delivered at the Seventh International Pyrotechnic Seminar, was "Safety Characteristic Data and Hazard Numbers of Binary Mixtures of Oxidizing and Combustible Substances," H. Treumann, et al. It considered the common oxidizers (and some) with lactose and aluminum (occasionally cellulose, magnesium and sulfur). Also included was my favorite pair: aluminum and sulfur. The idea was to develop a single number which represented the danger of each mixture. The following

Continued on page 10



# Electric Matches

Larry Homan

© Copyright 1996 All Rights Reserved

The basic design of electric matches has changed little in the last fifty years. The original demonstration of electrical bridgewire firing was by Dr. Robert Hare in 1830-32. The general parts of a modern electrical match are illustrated in figure one.

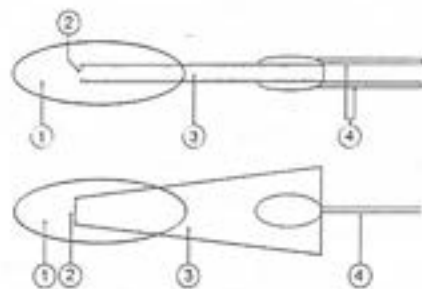


Figure One

- 1-Pyrotechnic compositions
- 2-Bridgewire
- 3-Board substrate
- 4-Legwires

The match head is fabricated from a PC board sandwich design. Two outer copper layers (and sometimes further layers) enclose an insulated inner layer of phenolic resin. The shapes are stamped out with a cutting die. A bridgewire of suitable resistance is soldered from one conductive layer to the next. The heads then go through a multiple dipping process to coat the various layers on the head. Later leg wires are soldered to the individual heads. The whole process can be done automatically or by hand. In modified forms these devices can be made quite easily to different standards by experienced manufacturers. Care must be taken in such experiments to limit oneself to bridgewire compositions of known characteristics. Many of these compositions are dangerous to handle and should be treated with respect.

This is an interesting pyrotechnic subject with good educational opportunities. However, despite the seeming high cost of electric matches, this is not a good area for the pyro enthusiast to attempt to economize. In displays where delivered power might be low (e.g., long leads or parallel loads), a series of matches is to be used or a particularly important part of the display depends

on a single match, then one should always use the appropriate commercial electric match.

The working principles of the electric match are simple. The basic relationships are described by the simple equation

$$V = IR$$

where V is electrical potential in volts, I is current in amperes and R is resistance in ohms. This illustrates the relationships of these properties.

A current is connected to the match through the leg wires. A conductive bridge in the head heats up until the ignition temperature of the pyrotechnic composition is reached. The flame, heat and debris produced ignites the pyrotechnic device. The details dictate the characteristics of a specific electric match.

The production of heat is illustrated by the following equation:

$$H = RI^2t/4.18$$

where if a static current (I) of one amp is applied through a resistance (R) of one ohm by a potential of one volt (V) for one second (t) then one calorie of heat (H) is produced. The source of the potential and current is the firing system through the connecting wires and leg wires. The resistance of importance is that of the bridge wire. This resistance is given by the following equation:

$$R = (R_{\text{specific}} * L) / S_{\text{cross}}$$

The specific resistance is a property characteristic of a specific material and is temperature dependent. Thus, as the current is applied, the temperature of the bridgewire increases and the resistance varies with this temperature. The total resistance is controlled by the length of the bridgewire between the plates and the wire's material and cross-sectional shape. The factors are varied to give the desired resistance thus firing characteristics appropriate for the system. In an actual match the resistance varies with heat gain and loss (to system including the composition) and the situation is much more complicated.

The bridgewire composition is selected for its sensitivity to the heat produced by the system. The temperature of the composition rises based on the heat supply and the heat capacity of the mix. The relationship is variable depending on the rate of energy transfer. A common graph relates the firing time (from initial application of current to ignition) versus the current applied. The result is generally the more current applied, the faster the firing time. Specification firing times are quoted for a standard amount of current. It is proper to state the work required to achieve this firing. For electrical systems, the unit is a joule per second which is equivalent to one watt. Typically, it takes millijoules to fire an electric match.

Since a calorie is equal to approximately 4.2 joules, one can estimate the amount of heat needed to warm your morning coffee.

$$500 \text{ ml} \times \text{cal./ml.} \cdot \text{degree} \times 50 \text{ degrees} \times 4.2 \text{ joules/calorie}$$

This shows that a lot of electric matches could be fired with this energy.

Thus the standard electrical formula variations

$$\begin{aligned} \text{Power} &= I^2R \\ \text{Power} &= IV \\ \text{Energy} &= I^2 * R * t \\ \text{Energy} &= I * V * t \end{aligned}$$

gives the relationship people often mention of a one watt match. A watt is the power that which gives rise to the production of energy at rate of one joule per second. A current of one amp through one ohm for one second defines one joule.

Bridgewire composition heating can be estimated and examined using the following equation.

$$Cp(dT/dt) + rT = FR_0(1 + aT)$$

where Cp is heat capacity of system in watt-sec./C°

T is the temperature rise above ambient C°

t is time in seconds

r is heat loss factor in watts/C°

I is current in the step function

a is temperature coefficient of resistance in ohm/ohm/C°

Continued on page 10



This equation is only an example of one that might be used to examine bridgewire composition performance and is not an absolute description of the process. Empirical measurements are made, particularly to determine T and  $\alpha$  and then analyzed to discover deficiencies in match function, thus fabrication. Two major factors in the transference of heat between the wire and the composition, thus its ignition properties, are retained solvent in the head and bubbles or contact faults between the wire and the composition. Another prime area of performance degradation is faulty bridgewire soldering. Often other layers are dipped onto the match head to provide greater secondary ignition or sealing and color coding.

An alternative to using a bridgewire is to include a conductive substance in the first fire composition. Both conductive carbon black and finely divided metals have been used. This greatly increases the resistance of the head. From the above equations, less current will flow and less heat will be produced. It takes more voltage to fire these matches, even if the mix might seem more heat sensitive, thus typically taking less energy to fire. An example would be a composition that contained potassium chlorate and carbon black.

Matches are subjected to various tests to determine their safety and reliability characteristics. They are exposed to elevated temperatures for various amounts of time and then tested for firing properties. Friction and impact tests are difficult to quantize but can be performed. Most of the tests involve the matches' reaction to applied electrical currents. Stepped currents are applied to the electric match to determine its stability over time. Thus 250 milliamps might be applied for thirty seconds. If the match survives this test, it then is tested for firing normally. The IME specifies standards for safe testing of electric matches. On site it is a current less than one fifth of the minimum firing current. For a 250 milliamps no fire match rating, this would be 50 milliamps. This is often reported, erroneously, as a property of the match rather than a universal standard. As an aside, one can see that continuity checking on-site is a very unreliable method of testing firing circuits. One should always check the resistance of the circuit and compare it to expectations. Excellent recommendations are given in the DuPont Blaster's Handbook.

A more sophisticated test involves

applying successive stepped pulses of current to a series of matches, then analyzing the results statistically. The median firing current is estimated, say 500 milliamps for 50 milliseconds. Thus, this current is applied to the first match. If it fires, then the next match is tested at a lesser current. If it doesn't fire, the next match is tested at a higher current. This pattern is repeated for a sufficient sample to give some acceptable degree of confidence in the reliability values thus obtained. The results are statistically analyzed by standard methods. This is called a Bruceton test. There are several assumptions made: 1) the results will show a normal distribution 2) there is some current at which no match will fire called the no-fire current level 3) there is some current above which all matches will fire called the all-fire current level. This method has several inherent problems, including giving only reliable information around the mean, and is only the beginning in the analysis of the characteristics of a match. Several of these statistically derived characteristics acquired by various sampling techniques give the published specifications of the match.

Matches are also tested for their sensitivity to stray currents such as static. Again this has been a property that remains difficult to define and standardize. Sensitivity to RF (radio frequency) has become a central concern in the transportation of electric matches already installed in fireworks. The power and frequency of the source are major considerations. Also the length (wavelength multiple), orientation and shunting affect the results. Practically, electric matches have shown a susceptibility to marine band radios. Again, an excellent source of information in this area is the Blaster's Handbook or IME publications.

All matches are expected to be precise in their operation. Generally, a variation of 10% in firing current sensitivity is acceptable for a series of matches. If the firing times vary greatly, one match in the series might fire and break the connection before the other matches have a chance to fire. For this reason, one never mixes matches from two or more different manufacturers or specifications in one series. For matches in parallel, the problem is that the current will be divided between circuits and matches to the point that insufficient current is applied to any one match to initiate the firing. There is a further complication if the cur-

## Review

Continued from page 9

formula was used to generate the number,

$$G = k_{\alpha} + k_{\sigma} + k_d$$

where  $k_{\alpha}$  is sensitivity to thermal stress,  $k_{\sigma}$  is sensitivity to mechanical stress and  $k_d$  is sensitivity to detonation. The maximum number assigned to each factor is 100 for a possible combined 300. Anything over 50 for a single factor is considered notably sensitive. One immediately wonders if a substance with three factor values of 100, 0, 0 is less dangerous than a substance with three values of 50, 50, 50. I would think some kind of nonlinear scale might be warranted. Interestingly, the  $k_{\alpha}$  value is made up of individual measurements for ignition temperature, loss of mass after time at temperature, ignitability by four possible sources, combustion time, and heating under confinement (Koenen test). Each measurement is made for various ratios of the binary mixtures. So you get the point, there is a great deal of data, minutely displayed on fold out pages. Here we have some quantification we can mine.

The highest number for the potassium chlorate/lactose pair is 244 for an 80/20% mix. As for potassium nitrate/lactose, it is 69 for about 65/35% (interpolated). Those of you making strontium nitrate/lactose mixes will be reassured that they are considered rather safe.

I provide a chart for the aluminum mixes at maximum G with percentage range in parenthesis.

Aluminum alone	as high as 32
Potassium Nitrate (60-70/40-30%)	83
Ammonium nitrate (70/30%)	155
Sodium Nitrate (70/30%)	147
Strontium Nitrate (80/20%)	110
Nitroguanidine (60/40%)	122
Nitroguanidine (70/30%)	134
Sulfur (50-60/50-40%)	42
Barium Peroxide (60-80/40-20%)	60

The aluminum was Carl Schlenk AG, Th/hell Type I, pyroschliff (0.05 mm) Mesh 270 or P fine as we used to call it in Australia.

The most interesting comparison is a mix of ammonium perchlorate (80) and lac-

Continued on page 16

Continued on page 11



## WPA WWB VII

Continued from page 1

Clive Jennings-White and Steve Wilson gave a demo of color flames. Things like boric acid or lithium carbonate or chloride in methanol and chloroform. Just ask for it at you local pharmacy. This is an old-time effect from my youth and the pyro evenings with my chemist father. There was an excellent seminar on sports cannons by Ron Dixon. Is this ever on Wide World of Sports? The handout was very informative. I particularly like the recommendation, "Know your powder." I sleep with mine and talk to it daily-the secret of my success. There was a demonstration of willows, comets and shells, made with various charcoals. All very subtle. In appreciation, the membership chanted, "Hemp! Hemp!" and crowded forward to smell the smoke. There was also a demonstration of sticky match. The one set piece I saw burnt rather cleanly. The stuff is very wide, in order to stick to them pesky recalcitrant lances. There were unusual aqua stars, good orange, very good blue aluminum and more blue strobe from Eric McCaskie.

The competition entrants and I held our secret blast within a Blast. Man, it's dark out there in the desert. We are the few but the proud. Not one single complaint, at least that we are noticing. Paul Bregel and crew (Chuck and Sharon Gardas, Hal Kantrud, Bill Marky et al.), successfully broke the Guinness Book of World Records total for bottle rockets simultaneous launched, intentionally. I think 23 cases times 25 gross, along with a lot of other stuff. This does not include the attempt at the factory in China a few years back. Remarkably good. There was a guy on a bicycle with a pulse rocket attached to his back end. Gas from a pressurized tank passes a spark plug and sucks kerosene into a long reaction chamber. The whole thing glows as he motors around the track. The amazing thing is not that it works, but that he does it.

The high point of the flea market was the number of outstanding T-shirts available. The days were full of activities and seminars this year, no way to do it all. Karen Wilson held a children's workshop this year. Fred May tested an HDPE twelve-inch mortar by setting off an unlifted (or was it upside down with one and half times the normal lift). Just some mild damage from the Chinese shell; he is applying for acceptance

from California State Fire Marshal. The WPA has bought a new container magazine. Who lives in it during the year? The usual good supply of Class C from Gary Lillich and Chuck Gardas, but the customers seemed subdued this year compared to last. Mark Wray did his usual excellent job of holding it all together with his announcing. The afterglow's were...well I didn't make the first two. The Revaks did it all as usual, with help from everyone else. I get tired of saying the obvious: some people do an excessive amount of work so we can have fun. Richard Cole. The Rhoads. Imagine that I have included a list of the attendees here. I thank you, for what it's worth.

There were lots of interesting fireworks. Paul Bregel, Marvin McDaniel and Rudy Schafner with barrages of salutes. A 2 million candle power, 200 second, 17 pound, sodium nitrate/magnesium flare from TPL. Peters with a excellent kamuro. A huge gas explosion with detcord and other things from Larry Roberts, Jay Combs and crew. Bill Page had some nice crossettes and a big shell of shells. A sixteen inch shell was like "Waiting for Godot" and when it happened, timed willow SOS, green SOS and willow SOS, it was over other shells. One of Garry Hanson's employees made a nice planet shell. At the end, Bill Page shot some outstanding Spanish candles. Some very good shells were shot after the public display, including a Taiwanese 12".

I think we might consider seating for members next year. We need to give something to the public but we are at Havasu for ourselves, with money which we freely spend.

I have notes and notes, many I can't read or don't remember the reference. There was a great many more things to do and see. You should have been there. And if you were, don't read this article. There are several articles published on the net. Some are on the WPA home page.

The closing display was excellent, tightly choreographed and full of fireworks. Thanks to Dan Ramsauer, show designer Mike Morris, Pyrolectrics' firing system and all the people who did the work. The diversity was great. And my experience was only one. I hope you had as good as time as I did. I might have had a lot of photos to publish, but I lost my rolls of film. Of course, you were there anyway, right? I did like the panorama I took over the parking lot as the sun was setting and the first fireworks were breaking in the clear gray sky against the desert mountain background. Wonderful. This is real fireworks the way we do it.

## Review

continued from page 10

tose (20) with a mix of potassium perchlorate (70) and aluminum (30). The former is  $G_{max}$  213 and the latter is  $G_{max}$  168. I once made color fountains from a mix of the former. Perhaps it would have been safer to press flash powder.

There are endless comparisons: 240 different mixtures times 22 columns of information. You do the endless evaluation.

The second paper is **Safety Characteristic Data And Thermochemistry of Ternary Pyrotechnic Systems**. The systems were Barium nitrate-sulfur-aluminum and potassium nitrate-sulfur-lactose.

For the first, the fastest burning is about 60/10/30%, if I am reading the data correctly. The maximum expansion in lead block (Trauzel) is for the same formula. The highest hazard number for the BNSA is 173 for a 70/10/20% mix.

For the KPSL it is 199 for 60/10/30%. The fastest burning is about 60/10/30% or 60/20/20%. The maximum expansion in lead block (Trauzel) is for 60/10/30.

Both ignition temperatures were above 360 degrees centigrade. The calculated heats of reaction for assumed reaction products made interesting triangle diagrams. The calculated values for potassium nitrate-sulfur-charcoal suggest a maximum heat of reaction for 82/13/5%, which indicates that the real products are probably much different.

This is worth obtaining simply to test your memory the day after you read it.

The feeling of reading the **Case-Former** is reminiscent of the one I used to feel, armed with high school Latin and in conspiracy with some other budding initiates, when we would leave our descriptive invectives around the campus in our secret language. This is for someone who is amused by cleverness and feels nothing is above satire and lampoon. This is not for someone offended by the over-the-top art of keen insight, endless grudges and intellectual elitism. A good read for the pyro anthropologist. I unashamedly enjoy it, to the extent that I understand it; and I am more in awe of the effort than appalled by the vitriol. Good fun if you are not a perceived target (this review was written by

^). The thus obtained celebrity of the

Continued on page 16



# New Fireworks Electric Matches

Larry Homan

© Copyright 1996 All Rights Reserved

Luna Tech of Alabama, a special effects company, developed an electrical control and firing system, the Pyropak I, for the display of its pyrotechnic devices. This was an AC system with step down isolation transformers. The system delivers 8 amps firing current in order to fire multiple electric matches in parallel. Estes Solar Model Rocket igniters were used. They were modified by insulating the leg wires for use with the Pyropak system. Unfortunately, they exhibited a one-tenth second delay before firing and were not mechanically tough. After a while, the matches supplied by the manufacturer no longer met specs.

For awhile, the Atlas gasless match, the MD-105 (military designation), was useful for certain product ignitions but not for flash powders. It was nominally a 500 milliamps all fire and 250 milliamps no fire. Then ICI bought Atlas and, after a while, the electric matches distributed to the industry were made in Scotland. These matches were available only in limited quantities and did not meet the specifications required by many fireworks users. There are currently only a few manufacturers and distributors of electric matches in the United States. The primary brands are, excepting model rocket matches, Daveyfire, Oxral and Pyropak LCZD. There are ongoing efforts to upgrade these matches to meet new needs and regulatory requirements.

The original ZD, Zero Delay electric match, was developed to insure the supply of an electric match that would not have a delay when used with the Pyropak I firing system and would ignite any Pyropak product. The pyrotechnic mix was based on a potassium nitrate and boron system. It was designed as a safety match, extremely static resistant, with great impact and friction resistance. It worked well with the system but needed more current than the standard match and did not meet the needs of some fireworks users with other firing systems.

Based on experience in lighting systems, Luna Tech developed a controller-remote (master-to-slave) system based on light dimming operations. This was to eliminate the tangle of firing wires common in an industry that often utilized nail boards. This system, the Pyropak II, has a controller that can run on 110 volt AC or 24 DC and downline is a DC system. The new limited

current system needed a lower current electric match, particularly for long cable runs. Originally, it used the Atlas matches, but when they became unavailable, a system was designed to provide more safety in match use. Since the advent of electrically fired fireworks displays, there has been a need for a reliable nontoxic electric match readily available at a reasonable price.

The corresponding low current match was developed, the Low Current Zero Delay (LCZD). This match met the industry standards of 0.5 amp all-fire and 0.25 amp no-fire. The recommended current for series firing is 0.8 amp. All pyrotechnic compositions in the electric match are lead free. These matches are friction and impact safe under ordinary conditions. As a practical test, these matches will resist moderate blows from a hammer and being scratched across sandpaper. The leg wires are tin coated for corrosion resistance during long term storage. The zip wire insulation on the legs is polarity coded by a stripe on each wire. This is intended to help insure proper connections during series wiring. Leg wires come in various lengths, but the most useful on site may be the six-foot (two meters) coiled leg wires. The wires have been rolled into a small non-tangling "one-size-fits-all" coil which allows only the amount of wire that is needed to be withdrawn; the rest remains neatly coiled. The arrangement also seems to reduce RF sensitivity in preliminary tests.

The LCZD is the first match developed and mass produced by fireworks people specifically for fireworks people. There were three main goals motivating this fifteen year project: 1) Supplying the need for a specific electric match for Luna Tech events and appropriate for use with Pyropak systems. 2) Provide an electric match for customers of Pyropak systems and product. 3) Develop an electric match that would exceed anticipated regulatory requirements.

More agencies are implementing standards for the use of electric matches in fireworks use. The Department of Transportation has recently prohibited the transportation of electric matches in the leaders or lift of aerial shells. The American Pyrotechnic Association is attempting to resolve some of the problems associated with the use of electric matches in aerial shells and has ob-

tained a temporary exemption from this requirement. The Bureau of Alcohol, Tobacco and Firearms has prohibited the storage of electric matches in the same magazine as fireworks. On the contrary, recent developments in regulations may require the use of electrical firing for large caliber aerial shells.

A derivative product developed as an offshoot of the original experimentation with bridgewire compositions led to an even safer electric match, the Flash Match. This match can be heated in a microwave oven until the wire insulation melts, then cooled and fired in the normal fashion. It will also survive 50 shots from a piezoelectric igniter. It will survive the sand paper and hammer test. Holding the match head in the flame of a common cigarette lighter melts the solder of the lead wires, the head falling to the ground, before it will ignite. This is hardly definitive but is something any fireworks operator can do in order to get some rough idea of the safety of matches. These matches have been HERO certified and approved for use on AEGIS equipped naval vessels. It is the closest thing to a safe match ever developed, specifically for the use of the pyrotechnics industry. It is being examined for exemption from several regulations now applying to all matches. These matches take a higher current to fire under normal usage.

Match developments by Luna Tech, as well as other manufacturers, to meet the changing needs of the industry are a continuing process. The successes are going to play an important role in the near future of fireworks display, especially the preparation and transportation of fireworks. Safety, reliability and compatibility will be the most important properties. It remains to be determined, by testing in the market place, whether these, or any, efforts have been successful. One thing is probable; some aspects of hand-fired shows will be rarer.

## Specifications LCZD Flash Match

All Fire	0.5 amps	4 amps
No Fire	0.25 amps	1 amp
Resistance	1.4-1.6 ohms	0.9 ohms
Thermal/	48 hours at 75 °C	
Stability	24 hours at 100 °C	
Test current	<50 mA*	<200 mA*

\* Level recommended by Du Pont Handbook is one-fifth of the minimum firing current. This value gives a five fold level of safety. The IME recommends a permissible maximum test current of 25 milliamps.



## Quick Match: Its Construction and Manner of Functioning

K.L. and B.J. Kosanke

The last few years, we have occasionally investigated some questions about quick match. We plan a series of short articles on this work, reporting on: methods used to slow its burn rate, the length of time for the cotton strings to lose strength after burning, the effect of humidity on its performance, the reasons for its failure to function properly, and some suggestions for possible improvement. However, before presenting those things, this first article will set the stage by discussing the manner of construction and functioning of quick match.

Quick match consists of black match in a thin loose fitting sheath of paper, generally the paper sheath is called the "match pipe" and sometimes quick match is called "piped match." See Photo 1 for the appearance of black match and quick match. The match pipe may be pre-made and a length of black match slipped into it. However, while this works well for making short lengths of quick match, such as needed for shell leaders, longer lengths, such as needed for fusing lancework, would need to be spliced together. As an alternative, and the most common method used commercially, the match pipe can be formed in a continuous process around a very long length of black match. Traditionally, the match pipe included an inner wrap of thin wax impregnated paper for moisture protection of the black match core. More recently, some manufacturers have used plastic laminated paper or other similar means to provide the moisture protection.

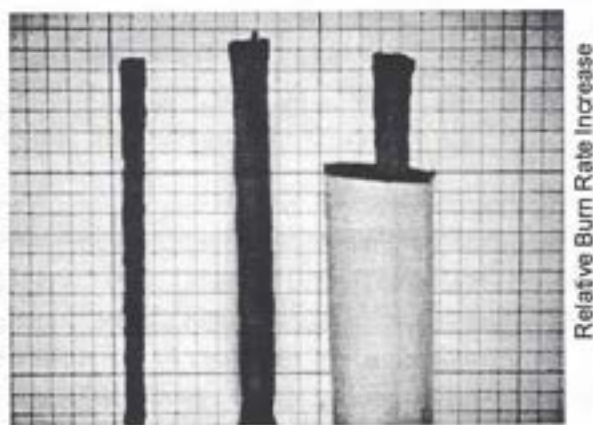


Photo 1. Two examples of black match (left) and an example of quick match (right).

Black match consists of a collection of thin strings, most commonly cotton, that have been coated with a slurry of Black Powder and binder in water. Manufacturers may use commercial meal Black Powder, a mixture of commercial powder and rough (hand made) powder, or rough powder alone. The individual strings are typically pulled over a number of rollers immersed in the slurry, then brought together as a bundle and pulled through a funnel shaped orifice to remove the excess Black Powder mixture. The wet black match is usually wound on a frame for drying before it is used to make quick match. However, some oriental manufacturers use wet, or at least damp, black match to make their quick match. One varia-

tion in making black match is to apply a dusting of meal powder to the black match while the match is still wet. This so-called "dusted" match is reputed to ignite easier and burn faster when made into quick match.

Black match typically burns at approximately one inch per second. The same black match, when sheathed to make quick match, typically burns about 100 times faster, at 10 to 20 feet per second. One hears three common explanations for the accelerated burning of black match when wrapped to make quick match, specifically:

- 1) The black match burn rate increases because of its being starved for oxygen under the paper wrap.
- 2) The increase in black match burn rate is the result of burning under increased pressure because of the paper wrap.
- 3) The burn rate increase is the result of a transition from parallel burning to propagative burning induced by the presence of the paper wrap.

In large part, the first explanation can be dismissed on theoretical grounds; there is no scientific basis for burning accelerating because of the lack of oxygen. In the first place, Black Powder is not dependent on atmospheric oxygen for burning. More over, atmospheric oxygen is a more energetically favored source of oxygen than potassium nitrate, and if anything, can only serve to increase burn rate. However, the main reason for rejecting this explanation is that it is contrary to common experience. For example, consider a case where a thin trail of fine (mixed particle size) commercial Black Powder is burned on a surface. The rate of burning will be at least several inches per second. When this same powder is tightly wrapped with threads to make visco fuse or when compacted into a casing as a rocket motor, its burn rate falls to less than half an inch per second. This slowing is contrary to the prediction of accelerated burning when Black Powder is starved for oxygen by encasing it.

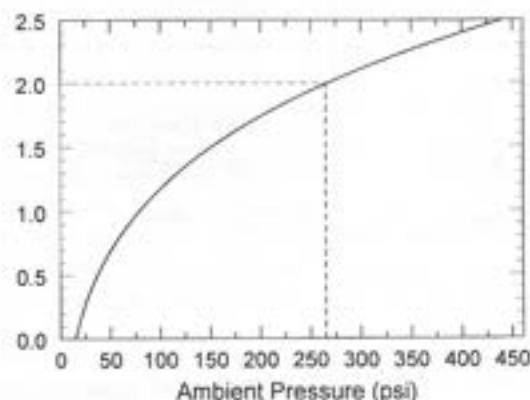


Figure 1. Graph of Black Powder burn rate as a function of ambient pressure.

The second explanation has a potential theoretical basis to support it; burn rate does generally accelerate in response to increasing ambient pressure. This is expressed in the burn rate or Vieille equation (1)

Continued on page 14



$$R = A P^B,$$

where

R is linear burn rate,

P is ambient pressure, and

A and B are constants.

For Black Powder, burn rate increases with pressure as shown in Figure 1, previous page, (based on the constants given by Shidlovskiy). Two things should be noted in Figure 1: first, ambient pressure must rise to approximately 265 psia for the burn rate of Black Powder to double; and second, that the effectiveness of rising pressure to increase burn rate lessens with increasing pressure. Obviously, the pressure increase needed to even double the burn rate for black match is much greater than could ever possibly be contained by the paper match pipe, let alone the horrendous pressure increase needed for a 100 fold increase in burn rate. Accordingly, this second possible explanation must also be rejected.

The third explanation for the accelerated burn rate of quick match is that it is a transition from parallel to propagative burning. This explanation was articulated by Shimizu (2), without using the terms parallel to propagative burn type transition. (For a more complete discussion of these terms, see reference 3.) Shimizu uses the analogy of a candle flame. When a barrier obstructs a candle flame, see Figure 2, the flame tends to spread out along the barrier.

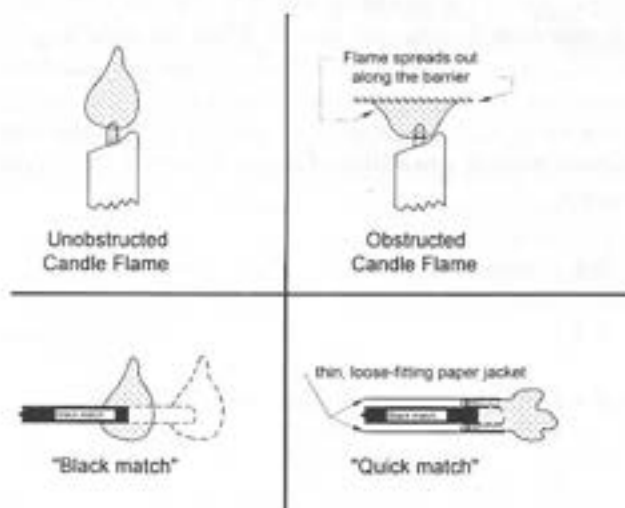


Figure 2. The analogous burning of a candle and black match in the presence of an obstruction.

He likens the unobstructed candle flame to the burning of black match. When the black match has burned to the start of the match pipe, the pipe at least temporarily obstructs the flame. Some of the flame is deflected out of the match pipe, but some flame is also deflected into the "fire path" between the pipe and black match. This flame entering the match pipe causes the ignition of an additional amount of Black Powder on the surface of the black match. Because more black match has ignited, additional flame is produced. Some of this flame exits the match pipe, but some penetrates deeper

into the pipe igniting still more black match and producing still more flame. The process continues accelerating as the flame races along the fire path between the black match and match pipe. In the process, the pressure inside the match pipe does increase, but very much less than that which would be required to explain even a small fraction of the increase in the rate of burning. Nonetheless, the increase in pressure has important ramifications. The acceleration of burning of black match increases to the point where the internal pressure exceeds the strength of the match pipe, at which time the pipe ruptures and further acceleration of burning ceases.

In addition to there being a sound physical basis for believing Shimizu's explanation, he conducted some supporting experiments. In these tests, the paper match pipe was replaced with metal tubes. As expected, burn rate increased beyond that found for paper-piped quick match, because of the higher pressures tolerated by the metal tubes before rupturing. Further, the studies we have conducted on quick match support or are consistent with that explanation.

With Shimizu's explanation as the basis for understanding the manner of functioning of quick match, future short articles will report on methods that can be used to slow the burning of quick match, the time delay between the burning of quick match and the loss of strength of the cotton strings, the effect of absorbed moisture on the performance of quick match, a discussion of malfunctions associated with quick match, and some suggestions for possibly improving the performance of quick match under conditions of prolonged high ambient humidity.

#### References:

- 1) A.A. Shidlovskiy, *Principles of Pyrotechnics* 3rd edition [translated from Russian] Mashinostroyeniye Press, 1964.
- 2) T. Shimizu, *Fireworks, From a Physical Standpoint. Part I.* Austin, TX: Pyrotechnica Publications, 1981.
- 3) K.L. and B.J. Kosanke, "Parallel and Propagative Burning," *Pyrotechnics Guild International Bulletin*, No. 79, 1992.

## Announcements and Notices

**On a space available basis, members of the WPA may place announcements and notices in the Newsletter. They should be related to fireworks and be of use to the membership. Neither the WPA nor the editor endorses any of the products so listed. The following announcement is placed as an example, but is also a real notice. There is no charge for this service.**

Now available, a professionally shot video of the Western Winter Blast VII (1996) festivities and the entire spectacular public display to animated music. See the interesting sections of lectures, flying anvils, Class C firings and the record number of bottle rockets shot at once! Order today and receive the first run of this new video. Only \$16.95 + \$3.00 Shipping/Handling (\$6.00 Canada/Mexico). Make check or money order payable to: Flamingo Land, P.O. Box 13659, St. Paul, MN 55110 Ask for the WWB 96 video.



## Notes from the Overground

Continued from page 2

association runs, I have noted that much of this policy is commonly ignored. So I see no reason to honor some and ignore others. During my fireworks career I have benefited greatly from things I acquired through ads in pyro-related publications. In the age of twenty million dollar a year actors and basket ball players, I think it rather elitist to presume that we are too pure in our enthusiasm to deny others who might not be. Most of the things offered in such ads do not make the purveyors wealthy but disproportionately enrich the recipient.

These notices must be rather small and provide something of value to the membership. For now I will be the judge of merit. If there is serious objection to this policy, please contact me; I don't want to do something that offends a significant number of the members. There is always the type of member that prefers to object by rumor. As always I will ignore such malcontents.

The daunting thing about fireworks is that each year we must begin again, fighting and working to see our efforts in display. Fireworks don't just happen like Spring, but face constant and determined opposition from often reasonable and otherwise intelligent people. I would be naive to suggest that we did not need to continue incessant political activities, mainly organized through industry groups. Yes, as flaky and self-serving as these groups initially appear, they are ultimately effective. Government regulation is often a dynamic balance between competing ideas and economics. If everyone is selfish enough and vociferous enough, then all will get some fair amount of attention.

Nonetheless, I still feel that our best weapon is the safe and legal public display of fireworks. Nothing works better than beautiful fireworks safely viewed; nothing works worse than children injured. I am enthralled with Class C fireworks. There is nothing like it. I like to watch them, then disassemble them in order to see what makes them work-very instructive. But if the industry does not promote more safety and is seen as constantly opposing efforts at safety improvements, then I will be sorry but amenable to seeing open Class C go.

The Blast was a blast for me. See my comments elsewhere. I am amazed that there are people who find something to make them mad, disappointed or bored with the weekend. This is it, folks: fireworks, plain and simple. It doesn't get any better except in your imagination. Just enjoy yourself or make room for someone else at the firing line. I certainly had my moments of enjoyment and intend to be there next year.

I had several inquiries about things scheduled for the Newsletter. In all things to do with Love, as in the Love of Fireworks, many promises are made in the moment of passion, with all good intentions of carrying them out. Alas, in the days that follow, some of the ardor subsides and the realities of life intrude. In other words, I haven't gotten it done yet.

I want to thank all that are helping with the Newsletter. I have acquired quite a lot of material, enough for several issues. I hope to make arrangements to put some of it on-line. I am hoping to begin publishing again the Shell and Formula of the Month and the Pyro Celebrity articles, personally favorites of mine that often get bumped. I appreciate all the support I have received, it helps me decide what to publish. I am always glad to hear criticism of my

meager efforts, because that means I am about to receive some material from someone more capable than I. As always, I am looking for a variety of interesting items. I would particularly like very short articles on any subject with an accompanying photograph. Very good is some aspect of a display or a device. Put the body or face of a WPA member in the photo. That makes us think we have something to do with fireworks. Otherwise, it's the pyro diary of Larry Homan with travel photos.

## Letters to Editor

Continued from page 3

*I had remembered to take something along, like the keys. Why do locked doors always swing shut? This is when I discovered that a lot of adults are up late at night. One should not put any false fronts up when meeting new people. I was sincerely sorry about her hair, although it was a different look. I too think fireworks are a good test of reality. I have often used them at important moments in my life, with variable success. Unfortunately, I still have to make mine.*

## Thoughts on Quickmatch

Larry Homan

Many years ago I had need to manufacture my own match for setpiece construction. During that time I was eager to learn how match burnt. I considered it as a pyrotechnic composition burning in a container (the piping), which produced hot gases and particles that tended to expand into the container. As the gases expanded, they traveled down the container. If the temperature of the gases and particles remained high enough then more remote black match (down the piping) ignited and sustained the continuous reaction until the match was exhausted. As the gasses expanded they would cool. Heat was also loss to the system through heat transfer. The biggest loss might be due to the rupture of the piping. But some estimate of what was happening could be made.

As experiments, I placed a short piece of black match in one end of the piping and another in the far end, sealing both ends, and determined how far the reignition could occur down the empty piping. I attempted to time the speed of the match under various conditions, but with inadequate equipment. I did wind some back and forth on a sheet of vertically supported plywood and video taped the burning. Some timing could be estimated from a calibrated tape playback. I attempted to calculate the effect of the ruptured piping by using tubing that would not rupture, but the times were very hard for me to record, even with tiny wire sensors.

To estimate the thermodynamics involved, I used textbooks on steam from the family business. We had boilers and steam pipes. In such texts, heat loss and transfer are covered in detail, although for water at high temperature and pressure. Using this simple model, a reasonable agreement between prediction and reality could be reached. However, this was all based on the estimates of heat loss and transfer. The biggest factor seemed to be the rupture. One could get about any answer one wanted.

The point is not to offer a solution to the problem but to suggest that the model might be relatively simple. There might not be any special effect from the tubing other than containment (or rupture) and heat transfer. This may simply be a gas going down a pipe, and if hot enough, relighting the gas producing composition.



## On-line

Continued from page 6

ing convention news, competition rules, elections and more. There are two recently formed rocketry lists, HPR for high powered rocketry and AmRocNet for amateur rocketry. Each of these mailing lists is administered by a list owner. You may contact the mailing list owner of information about joining these mailing lists.

PML list owner, Frank Heasley  
<fheasley@chemistry.com>

Show-Fire list owner, Murr Rhame  
<murr@vnet.net>

PGI list owner, Mark Buda,  
<buda@star.enet.dec.com>

HPR & AmRocNet list owner, Jerry Irvine  
<jjirvine@cyberg8t.com>

For quicker response, you can get detailed information about these mailing lists by sending the following Email to <listproc@vnet.net>. The listproc will automatically send a replay for each list requested.

To: listproc@vnet.net  
subject: .

Info pml  
info show-fire  
info pgi  
info hpr  
info amrocknet

Excerpted from an on-line article by MurrRhame, address, <murr@vnet.net> of wpa@bbs.cruzio.com and submitted by Dave Steinau.

## Reviews

Continued from page 11

disapproved might be actually some kind of honor of distinction. One has to be amongst the chosen to receive it but one can buy a compendium. The Casing Former is something you would get if you had everything else and still were not happy. The S & M opportunities are twofold: feel a mob inclination toward difference or risk difference. Or one can simply enjoy a good effort at equalizing the pretense of authority. Beware of misbehaving in the fireworks world, we now have our own watchdog. Keep an eye out for periodic advertisements for the publically available version.

## Message from Dave

Continued from page 6

up EVERY year. And he does so with a smile. Thanks Steve. Many Thanks to Forrest Rhoads (Steve's dad) for all of his time as Secretary last year and for stepping up to do it again. It really helps, and I really appreciate it.

Matt Riley has loaned us his lighting and sound expertise almost every year; his wife Susan has always stepped in to help wherever necessary. Thanks Rileys! And last but not nowhere near least...Richard Cole. This guy has been running the vending at the Blast for every single one, and he has done a helluva job. The flea market is always a hit; and the class C vending this year was excellent. Rich, you just keep getting better. Thanks.

I think that's all folks. If you've got a problem, comment or suggestion, feel free to contact me, preferably late at night or very early in the morning. We can always use the input.

Till next time,  
David

## Electric Matches

Continued from page ten

in parallel, the problem is that the current will be divided between circuits and matches to the point that insufficient current is applied to any one match to initiate the firing. There is a further complication if the current pulse is not long enough to allow a cascading sequence of matches to fire, leaving some unfired. This can result from unbalanced resistance or variation in match sensitivities. Also match heads can be fused after firing, greatly altering the resistance values of the circuits.

There are several other kinds of electric ignition devices not covered in this article. One of the newest is the SCB (Semi-conductor Bridgewire). Another uses a clasp to hold the leg wires, not a PC board.

Technical information can be reviewed in the **Encyclopedia of Explosives and Related Items**, the source of some of the information in this article, including the equation for testing bridgewire compositions.

## Calendar

WPA or Fireworks

### Larry's Birthday

June 21, 1996

No live gifts this year.

### July 4, 1996

Official anything goes day.  
Must be disguised as display.

### Summer Fireworks Festival

July 15-19, 1996

Auburn/Weedsport, New York  
Holiday Inn

Contact: Charles Hill

4533 Foster Valley Rd  
Endicott, NY 13760  
Ph. (607) 748-0667  
Fax (607) 748-0899

### PGI Convention registration

Deadline: July 22, 1996

### July 31, 1996

DOT match exemption expires

### PGI Convention

Muskegon, Michigan  
August 11-16, 1996  
Sec.-Treas. Ed Vanasek  
18021 Baseline Avenue  
Jordan, MN 55352  
(612) 492-2061  
edvanasek@aol.com

### The International Symposium on Fireworks

September 16-20, 1996

Orlando Florida

Contact: Your bank.

### Deadline for UN Shipping

October 1996

### Guy Fawkes Day

November 5

### St. Barbara's Day

December 4

Patron saint of gunners and pyrotechnicians

### Proposed Fireworks Day

Longest Night of Year

Alternate: Larry's Birthday

December 20, 1996