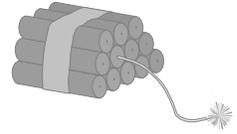


# The Primer



Newsletter of the Golden West Chapter, International Society of Explosives Engineers  
23633 Brewster Drive, Columbia, CA 95310

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Issue 2

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## ***President's Message...***

Hey members, if you haven't renewed your annual MSHA refresher, don't miss out on this great opportunity for renewal that our chapter is putting on for you. Details can be found on page 3.

Mike Burneson is your contact for the workshop, but he needs to hear from you no later than April 15th, so get on the phone and give him a call at (707) 558-1510, or by email at [mburneson@syar.com](mailto:mburneson@syar.com). Do it ASAP. April 15th is coming up fast.

Also, the deadline to reserve your spot for the salmon fishing trip is May 27th. See the flyer on page 6 or else call me at (916) 645-3377 for details. We are looking forward to a bunch of the members getting together at these two events, so please contact us.....

Looks like it's going to be a good year for the GW Chapter. Let us know how we can make it better for you.

*Mike C.*

## The Primer

### Editor's Notes...

As promised, this issue of *The Primer* contains the Chapter's schedule of events for 2011. The first event is the workshop planned for April 30th, with details on the opposite page. Be sure and contact Mike Burneson to make your reservation **before** April 15th, so Mike can have everything in order ahead of time. This workshop qualifies for MSHA refresher training for miners, but will also prove beneficial to those in other industries as well.

The second event marks a return of the Chapter's very popular Salmon Fishing Trip. This year, instead of departing from Berkeley, a boat has been chartered from Bodega Bay on June 11th. This event usually fills up fast, so check out the event details on page 6 and reserve your spot early. We'll remind you again next issue, but by then the boat might be full.

I received a suggestion to include in *The Primer* the U. S. Chemical Safety and Hazard Investigation Board's digest of the 1998 explosions at Sierra Chemical Company's Mustang facility. I decided to do so, primarily to wake people up and make sure they don't become complacent when dealing with the hazards that we face in our industry. The explosives industry can be just as safe a place to work as any other, as long as we understand the hazards and properly address them. After you have read the Investigation Digest (summary), review your activities and make sure that you aren't becoming complacent in some area that could turn around and bite you. Safety is paramount in our industry.

Several years ago we ran an article on a deep hole shot at the Kaiser Cement quarry at Permanente. Last year our good friend Ed Criley, who was instrumental in arranging the details of that project, passed away. In addition, Gordon Coleman came across some slides that he took on the day that the first shot was loaded. I decided that it would be appropriate to honor Ed's memory with an updated version of the article, including Gordon's photos. It starts on page 11.

No one has submitted any alternative initiation designs for the Ramelli Pit blast depicted in the previous issue of *The Primer*, so I have to conclude that there just wasn't sufficient interest and let it go at that. Is there any creativity left these days in blast design, or is it all pretty much 'cookie cutter' stuff now?

By the time you read this, Claudia and I will be in transition mode up to the cabin in Alpine for the summer. For the first month or so, the answer to about every other question is, "I think it's at the other house." Eventually, we get everything sorted out and then it's time to come back down to Green Valley in the fall. I'd be dead without checklists.....

Stay Safe,  
Wes Bender

## **GOLDEN WEST CHAPTER WORKSHOP**

Title 30 / 30CFR section 48.28 - 8 hour Annual refresher training of miners

The Golden West Chapter of the ISEE is offering Annual Refresher Training on Saturday April 30, 2011 at the Lake Herman Quarry, 885 Lake Herman Road in Vallejo, California.

Training will start at 7:00 a.m. and end at 3:30 p.m. We will take lunch from 11:30 a.m. to 12:00. Training certificates will be mailed to participants.

Cost will be \$25.00 per person. This will cover lunch and printing costs.

Note: We need a minimum of 20 people to sign up by April 15, 2011 or we will have to cancel this event.

To sign up call **Mike Burneson** at **(707) 558-1510**. You can pay at the workshop, but attendees will need to pre-register with Mike. Checks should be made payable to the **Golden West Chapter**.

We have several certified trainers that will review the following topics:

**Mandatory health and safety standards.**

**Transportation controls and communication systems.**

**Escape and emergency evacuation plans; fire warning and firefighting.**

**Ground control.**

**First aid.**

**Electrical hazards.**

**Prevention of accidents**

**Health.**

**Explosives.**

**Self-rescue and respiratory devices.**

Although this training is specifically intended to fulfill annual safety training requirements for miners, it is also useful for employees in other industries.



# Sierra Chemical Co. High Explosives Accident

Mustang, Nevada January 7, 1998

On January 7, 1998, two massive explosions just seconds apart destroyed the Sierra Chemical Company's Kean Canyon explosives manufacturing plant ten miles east of Reno, Nevada, killing four workers and injuring six others. The initial explosion occurred in a room where workers made "boosters" — small explosive devices used in the mining industry to detonate larger explosives. A second, more powerful blast destroyed a building used for drying explosives, leaving a 40-by-60-foot crater that was up to six feet deep.

The two explosions destroyed buildings, blew down walls, and hurled debris as far as a thousand yards. Of the 11 Sierra employees who were at the site when the accident occurred, only one escaped without injury. The explosions killed all four workers who were in or near Booster Room 2, the production room where the first blast occurred. In nearby Booster Room 1, one worker was blown 14 feet by the force of that initial blast. He and four others were trapped as the room collapsed, but all survived.

The explosions had the force of a magnitude 2.0 earthquake and were felt some 20 miles away from the plant. Fearing further blasts, firefighters did not attempt to extinguish fires at the site, and the flames burned for more than a day. Sierra Chemical estimated that in all, 47,000 pounds of explosives were consumed during the accident. The facility was never rebuilt.

## MIXER BLADE LIKELY DETONATED EXPLOSIVE

Producing boosters involved melting, mixing, blending, and pouring trinitrotoluene (TNT) and other raw materials into cardboard cylinders. The work was performed inside Booster Rooms 1 and 2, which were located in two adjoining buildings. In a separate building the chemical pentaerythritol tetranitrate (PETN) was dried before being transferred to the booster production buildings. PETN is one of the strongest high explosives known, and due to its instability it is transported wet.

Although there were no surviving eyewitnesses in Booster Room 2, the CSB used seismic evidence and other techniques to reconstruct what happened on the morning of January 7. Booster Room 2 had housed four large freestanding mixing pots, where explosive materials were melted and blended. The day before the accident a worker had departed early, leaving 50 to 100 pounds of melted base material in the bottom of one of the mixing pots. The base material consisted of TNT and other high explosives.

The worker apparently believed that another operator would use the leftover base material later that afternoon. Instead, the material remained in the pot and solidified over-

night as outside temperatures fell below freezing. The next morning the worker returned to Booster Room 2. He probably assumed that the pot had been emptied, and without checking its contents he turned on the motor to the agitator blades, setting off the initial explosion.

Using metallurgical analysis, CSB investigators determined that the heavy mixer blade had probably become embedded in the hardened explosive. Investigators theorized that as the blade started to turn, it either struck or pinched the explosive material, causing it to detonate. Another possibility is that the explosive contained a foreign metal object, which initiated the blast by scraping along the inside of the pot. Indeed, survivors reported that Sierra's raw materials — which were purchased as demilitarized munitions from the U.S. Department of Defense — frequently contained foreign metal objects like nuts and bolts. Because the reclaimed explosives were not screened prior to use, metal objects commonly found their way into the mixing pots.

The shock wave from the initial blast detonated several thousand pounds of explosives stored inside the booster room. Heavy debris from this explosion likely rained down onto the PETN drying building 220 feet away, piercing the roof or skylight and initiating an even larger secondary explosion, the CSB concluded.

## INADEQUATE SAFETY CONTROLS AND OVERSIGHT

The U.S. Occupational Safety and Health Administration (OSHA) requires that explosives manufacturers like Sierra

## LANGUAGE BARRIERS TO SAFETY

The majority of workers at the Kean Canyon plant spoke only Spanish, but the plant had no operational policies or procedures in that language. Among the employees, only the production supervisor and three other operators were bilingual. Although the plant's generic OSHA training program included a few Spanish videos, material safety data sheets (MSDSs) identifying the hazards of the explosives were only provided in English. Likewise, safety training sessions and tests were developed and conducted in English and then translated by one of the bilingual personnel. Sierra's reliance upon informal translation created opportunities for error and miscommunication.



Sierra Chemical facility burns after massive explosions.

Chemical follow the Process Safety Management (PSM) standard, which mandates a variety of safety systems for hazardous chemical operations. But the CSB's investigation revealed a lack of adherence to various process safety principles at Sierra Chemical. No workers from the Kean Canyon plant were involved in conducting the company's process hazard analysis for the booster operation, and the scope of that analysis did not extend to Booster Room 2. Plant managers did not understand the hazards of the materials in use — incorrectly believing that they were almost impossible to detonate without using a blasting cap. Raw materials, equipment, and work procedures were altered without an analysis of the hazards of these changes.

Enforcing federal workplace safety rules was the responsibility of Nevada state authorities. However, Nevada workplace safety inspectors in the Reno office had little formal training in explosives, and the state's most recent safety inspection of the Kean Canyon plant (in 1996) had focused on industrial hygiene. Local fire inspectors also lacked relevant training and expertise. Although Nevada had experienced a massive explosion at a rocket fuel plant almost a decade earlier, by 1998 the state still had not identified businesses at risk for catastrophic accidents or established inspection priorities.

#### WORK PRACTICES RISKED DETONATION

Workers in both booster rooms used practices that have long been recognized as hazardous at military explosives facilities. Workers regularly used metal tools, including steel hammers and rods, to break up rejected explosive boosters or to clear out pipes and valves that were blocked with explosives — despite the hazard of an accidental detonation.

None of the operators at Kean Canyon recalled seeing any written operating procedures. Without written procedures, training was conducted in an informal, on-the-job manner, relying upon physical demonstration and word of mouth. Work procedures varied among different operators. For example, CSB's interviews showed that while the normal practice was to check the mixing pots for residual material before starting the motors, not all workers did so.

#### PLANT DESIGN, CONSTRUCTION FLAWED

The CSB noted that explosives producers should ensure that there are safe distances between buildings to prevent an accidental explosion from propagating. The structures at Sierra Chemical were built on separate terraces cut into the slope of a bowl-shaped desert canyon, but they were located too close to each other. Although the terraced design afforded some protection from horizontal ballistic fragments, the buildings remained vulnerable to falling debris.

Based on guidelines from the Institute of Makers of Explosives, the two booster rooms should have been located at least 245 to 295 feet from the PETN drying building. The actual distances ranged from 185 to 220 feet. The two booster rooms should have been sited at least 490 feet apart, but the actual distance between them was just 80 feet.

Department of Defense guidelines cited by the CSB recommend that explosive operations be separated from extraneous work activities by at least 1,250 feet. But at Sierra the production buildings had multiple uses, including unrelated mixing, packaging, and administrative operations. In fact, one of the workers killed was involved in non-explosive-related activities outside Booster Room 2.

Building construction was also deficient. For example, the PETN building should not have had a skylight, which could be penetrated by explosion debris. The production buildings should not have been constructed from concrete blocks, which can fragment in an explosion to form potentially lethal projectiles.

#### RECOMMENDATIONS

On September 23, 1998, the CSB issued a number of safety recommendations to prevent similar accidents in the future.

##### To Sierra Chemical:

The CSB recommended that Sierra Chemical and other explosives manufacturers ensure that their process safety programs include comprehensive hazard analyses, specific written operating procedures, management of change (MOC) procedures, periodic audits, and appropriate safety training and certification for workers and managers. Operating procedures and hazard information should be communicated in languages understood by the workforce.

##### To the Nevada Occupational Safety and Health Enforcement Section:

The CSB recommended that Nevada increase the frequency of safety inspections for explosives manufacturing facilities.

##### To the Institute of Makers of Explosives (IME):

The Board called on the IME, which is a safety association of the U.S. and Canadian commercial explosives industry, to develop guidelines for training workers and for screening reclaimed explosives.

##### To the U.S. Department of Defense:

The Board recommended that the defense department develop a program to ensure that reclaimed munitions are free of hazardous foreign materials and also communicate with industry and government agencies about the lessons learned from past explosives accidents.

*Published August 2004*

#### NOTICE:

The CSB is an independent federal agency charged with investigating industrial chemical accidents and hazards. The CSB determines the root causes of accidents and issues safety recommendations to industry, labor, and other government agencies. CSB Investigation Digests are not intended to substitute for the official, Board-approved reports, which can be obtained from the agency's web site, [www.csb.gov](http://www.csb.gov). The web site also has complete, up-to-date information on the implementation status of all CSB safety recommendations. Comments or suggestions, please write to [info@csb.gov](mailto:info@csb.gov).

## The Primer

# ATTENTION BLASTERS



A Salmon Fishing Trip has been chartered for Saturday June 11, 2011 for all members, family, friends and associates of the Golden West Chapter ISEE.

We will meet at the Bodega Bay Sportsfishing Center at 5:30 a.m.  
Port of Bodega Marina  
1500 Bay Flat Road  
Bodega Bay, CA 94923

We can take 30 anglers on this adventure. If you would like to attend you must prepay \$95.00 and your check must be received by May 27, 2011. Make your check out to **Golden West Chapter ISEE** and mail it to:

Alpha Explosives  
P.O. Box 310  
Lincoln, CA 95648  
attn: Mike Chiurato

Call 916-645-3377 to reserve your spot but remember, we must have your check by May 27<sup>th</sup> or we will fill the boat with others. Bring your own food and drink and something to take home your fish in. **Remember to bring your fishing license.** They are not available to purchase. Rod rentals are \$10.00 Tackle Packages are \$25.00. **Bring CASH.** No credit cards or checks can be accepted.

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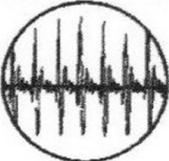


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**Chapter Activities - 2011**

MSHA Refresher Training - Syar Industries, Vallejo	April 30
Salmon Fishing Trip - Bodega Bay	June 11
Barbecue - Pioneer Park, Nevada City, CA	September 10
Annual Dinner Meeting (to be announced)	January 2012

**Publication schedule for *The Primer***

Summer issue - deadline: April 27 - posting date: May 2  
 Fall issue - deadline: August 5 - posting date: August 10  
 Winter issue - deadline: Dec 1 - posting date: early Dec 2012

### Seismic Shooting at Permanente...

by Wes Bender

*(This article has been reintroduced to honor the memory of the late Ed Criley, a member of the GW Chapter and employee of the U. S. Geological Survey. Photographs in this article appear courtesy of Gordon Coleman.)*

Sometimes a blaster or blasting engineer encounters situations where blasting technology or the capabilities of the explosive products are being pushed to the limit. Such a situation developed quite a few years ago when the U. S. Geological Survey was selected to conduct some research that involved detonating large charges in deep holes.

Ed Criley of the USGS was in charge of determining what explosives to use and how to load them. Ed's problem involved the detonation of a 1000 lb charge of high velocity explosive in a partially cased hole drilled 1000 ft deep in (then) Kaiser Cement's quarry at Permanente, CA. The depth involved and the need for reliable detonation, coupled with safety considerations (if the charges didn't fire, they would have to be retrieved) all contributed to Ed's problem.

I had worked with Ed Criley and Jack Van Shaack, branch field operations manager, on several USGS projects and had been doing the blaster training for their shooting crews. Ed contacted me to see if a satisfactory product was readily available, both for the explosive and for the detonating system, and to pick my brain regarding a process whereby the charge(s) could be retrieved if necessary. The explosive product and the need to have the capability for retrieval were fairly straight forward. We selected Hercules' Gas Well Explosive in 5" x 100 lb 23G cartridges with internal stainless steel aircraft lowering cables. The cables had a swaged loop top and bottom. The cartridges were to be coupled together and lowered to the bottom of the hole with a small truck-mounted crane. Ten cartridges would give us a 1000 lb column approximately 100 feet long. I was somewhat concerned about the ability of the internal cables in the upper cartridges handling the full 1000 lb weight, so we made the decision to fill the hole with water. The specific gravity of the explosives was 1.35 grams/cc, so the effective weight of each 100 lb cartridge when submerged was reduced to about 26 lbs, for a total weight for the column of 260 lbs. This eased the strain on the cables sufficiently.

Flooding the hole, however, brought about another problem: Finding a detonator that would function properly under a pressure of approximately 435 psi under 1000 ft of water at the bottom of the hole. None of the manufacturers in those days rated their seismic detonators to shoot reliably above about 250 psi. I contacted an inside source at Hercules who told me (unofficially) that they regularly tested their Vibrodets to 1000 psi, thus I felt comfortable that they would function satisfactorily at about half that.

(continued on the next page)

## The Primer

### Permanente Deep Shot (cont.)...

Enough explosives and detonators for at least three shots were ordered and Ed arranged for the necessary crane, cable, firing lines and other accessories. Ed and I got together at Permanente the day before the scheduled blast and made up the detonator assemblies. My plan was to put three caps in one circuit for the bottom cartridge and another three on a separate circuit for the top cartridge. If there was ever a situation that begged for double-priming, this was it. I didn't want splices in the firing lines, but couldn't avoid the underwater splices required to tie the detonators to the two firing lines. These were made up carefully, with the splices crimped and sealed with silicone sealer which was overlaid by heat-shrink tubing. After the silicone sealer took a partial set, we shrunk the tubing tightly around each splice.

On the morning of the shot, we inserted the cap assemblies into the cartridges (see photos 1 and 2), taped them securely and started the loading process. The crane would pick up the first cartridge (with detonators inserted) and lower it into the hole until the upper cable loop was at the top of the casing. A rod was installed to hold it (see photo 4) while the next cartridge was hoisted and coupled to the first with a screw-pin anchor shackle. The rod was removed and the assembly lowered to the next loop. This process was repeated until the top cartridge with its detonators was attached to the column and the whole lot lowered carefully down the hole.



Photo 1 - Ed making the initial cut



Photo 2 - Ed and Wes inserting detonators

Both firing circuits were monitored continuously with galvanometers as the column was lowered. Unfortunately, at some point near halfway, one circuit opened. The reason was unknown, but we suspected that the wire probably caught on slag or a burr on the inside of the casing. A discussion ensued as to whether or not we should retrieve the column and either repair the wire break or re-prime, or to just continue the lowering process. Time was a consideration as the scheduled firing time was rapidly approaching. Numerous seismic lines had been laid out with recording devices that were programmed to wake up and record at a specific time.

**Permanente Deep Shot (cont.)...**

I was reasonably confident that one set of detonators would do the job so we elected to continue the lowering (with fingers crossed that we wouldn't snag the remaining circuit).



Photo 3 - Lowering the first cartridges



Photo 4 - Jack waiting for the next cartridge

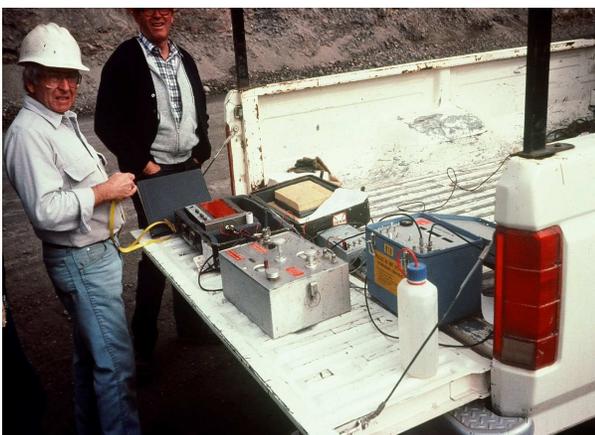


Photo 5 - Ed and Jack with their shooting box and related gear



Photo 6 - Conventional blasting seismographs

(continued on next page)

## The Primer

### Permanente Deep Shot (cont.)...

The shot went off successfully and on schedule and resulted in a geyser of water a couple of hundred feet high. Most of the lowering cable was ejected with the water (photos 7 and 8).



Photo 7 - Water ejection shortly after detonation



Photo 8 - Water still raining down with mostly steam coming out of the hole

I captured the results on videotape and a couple of blasting seismographs and the USGS people recorded the results with their seismic lines. The next day we loaded a second shot in the same hole. It took nearly a tanker truck of water to fill the cavity from the previous shot and we lowered the charge to only 900 feet to keep it in competent rock. A third shot was also loaded and detonated. After that, the cavity volume had become so large that further shots in this hole were not attempted.

One has to wonder what future mining people will think when they encounter that huge void down there. It's unlikely that anyone will see it though. Mining to that depth would require a considerable expansion of the pit and that isn't likely to happen at Permanente due to the proximity of the surrounding communities.

**How Come???**

The foregoing United States Chemical Safety and Hazard Investigation Board (CSB) report on Sierra Chemical's unfortunate incident was presented because it contains some very good safety recommendations that I felt would be appropriate for our members.

One aspect of the CSB report has me puzzled, however. Although it has no real impact on the findings, the statement is made that the incident had the force of a magnitude 2.0 earthquake. The full report is available at [http://www.csb.gov/assets/document/Final\\_Sierra.pdf](http://www.csb.gov/assets/document/Final_Sierra.pdf). The seismic analysis commences at page 67. The analysis dwells considerably on how the specific locations and timing of the two explosions were determined seismically but, unfortunately, there is no indication of how the magnitude 2.0 was derived. 2.0 seems much too high, given the specifics.

The total amount of explosive that detonated (in two distinct explosions) is listed as 47,000 lbs. Using information gathered from nuclear events, further clarified and massaged by Dr. Doug Anderson in his ISEE paper on magnitudes, the actual Richter magnitude should have been on the order of 0.37, and then only if all of the explosives had detonated simultaneously (which they didn't).

Dr. Anderson's simplified formula is given as:  $M_{ce} = (\log W) - 1$

where  $M_{ce}$  is the magnitude equivalent of a chemical explosion and W is the explosive weight in tons.

To reach a Richter magnitude of 2.0 would have required the detonation of approximately 2,000,000 lbs of explosives rather than 47,000 lbs. Granted, the ladies across the highway at the Mustang Ranch may have thought they were experiencing a magnitude 2 (or higher) earthquake, but the calculations don't quite bear out that conclusion.

WB

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**Helpful Old Men....**

An old guy was in Costco, pushing his shopping cart around, when he collided with a young guy also pushing a cart. He said to the young guy, "Sorry about that. I'm looking for my wife and I guess I wasn't paying attention to where I was going."

The young guy said, "That's OK. It's just a coincidence. I'm looking for my wife, too. I can't find her and I'm getting a little desperate. The old guy said, "Well, maybe we can help each other. What does your wife look like?"

The young guy said "Well, she is 24 years old, tall, with long blond hair, green eyes, long legs, well-built and she's wearing tight white shorts, a halter top and no bra. What does your wife look like?"

The old guy said, "Doesn't matter. Let's look for yours."

Most old men are helpful like that.....