APPLIED TECHNOLOGY

CONSIDERATIONS FOR THE CERTIFICATION OF BLASTERS

Prepared for

UNITED STATES DEPARTMENT OF INTERIOR
BUREAU OF MINES

BY

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FINAL REPORT

on Contract J0285012:

Considerations for the Certification of Blasters

Submitted February 1980

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Each State and the Federal Government was surveyed for existing certification requirements, the industry was surveyed for the needs for training blasters, and the training that was available. Recommendations for training and certification for blasters were made.

17. Document Analysis a. Descriptors
Existing certification requirements for blasters, needs for training, available training, recommendations for training to certify blasting.

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FOREWORD

This report was prepared by E.I. du Pont de Nemours & Co. (Inc.), Applied Technology Division, Clayton Building, Concord Plaza, Wilmington, Delaware 19810 under USBM Contract Number J0285012. The contract was initiated under the Metal and Nonmetal Health and Safety Program. It was administered under the technical direction of the Division of Industrial Type Hazards with Larry R. Fletcher, Twin Cities Mining Research Center, Twin Cities, Minnesota as the technical project officer. Mr. Frank Pavlich was the contracting officer for the Bureau of Mines.

This report is a summary of the work that was completed for this contract during the period September 27, 1978 to November 16, 1979. This report was submitted during February 1980.

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1. INTRODUCTION

The scope of work performed under this contract was to: (1) determine the existing federal and state requirements for blasters working on the surface or underground in (large and small), metal, nonmetal and coal operations, (2) determine industries needs for blasting personnel and recommend licensing requirements for blasters, (3) determine the types of training now available and compare the training needs with the training available and, (4) consolidate the above and make final recommendations.

The contract required that the existing licensing requirements for surface coal mines be collected first, and in the performance of that and the subsequent other three tasks, to gather as much information related to surface coal mines as is feasible prior to fully addressing the concerns of the other mining activities.

All information contained in this report is current as of December 31, 1979.

Since some of the terms that are used in this report are unique to the industry, the following definitions will be used:

Blaster Certification -- A document or license granting a person the right to practice the art of blasting.

Blaster in Charge -- The individual who is a certified blaster and is assigned the responsibility by mine management to ensure that the blasting job is performed efficiently, technically correct, legal and safe.

Validate -- Corroborate on a sound or authoritative basis that a procedure is necessary and covers the essential elements to meet the requirements of a specific operation.

After reviewing the licensing requirements from all the states, the eight most common items (as related to this survey) were summarized and are shown in Table 1. It is worth noting that the requirements in a particular state varied widely with those from other states. Some states certified blasters by registration while others required a training course and passing an examination with a specified percentage of correct answers.

TABLE 1. - Blaster certification requirements of individual states and the Commonwealth of Puerto Rico

STATE	LICENSE REQUIRED SURFACE COAL MINES	LICENSE REQUIRED OTHER BLASTING	EXAM REQUIRED	TRAINING COURSE REQUIRED	TRAINING COURSE OFFERED	CERTIFICATION FEE	CERTIFICATION TIME LIMIT	CERTIFICATION RENEWAL	OTJ EXPERIENCE REQUIRED	AGE REQUIREMENT
AL	Yes	No	Yes Surface Only	Yes Surface Only	Yes	$25	1 Year	By Fee	Yes	None
AK	Yes	Yes	Yes	No	No	$10	1 Year	By Fee	Yes	21
AZ	No	No	No	No	No	None	None	None	No	None
AR	No	No	No	No	No	None	None	None	No	None
CA	Yes	Yes	Yes	No	No	$15(1)	5 Years	By Fee & Exam	3 Years	18-21 with Supervision
CO	No	No	No	No	No	None	None	None	No	None
CT	Yes	Yes	Yes	No	No	$25 New $10 Renewal	1 Year	By Fee	Yes	21
DE	No	Yes	Yes	No	No	$10	1 Year	By Fee	Yes	None
FL	Yes	Yes	Yes	No	No	$25	1 Year	By Fee	No	18
GA	No	No	No	No	No	None	None	None	No	None
HI	No	Yes	Yes	No	No	None	1 Year	Application	Yes	None
ID	No	No	No	No	No	None	None	None	No	None
IL	Yes	Yes(2)	Yes	No	Yes	$5	None	By Fee & Exam	No	21

TABLE 1. - Blaster certification requirements of individual states and the Commonwealth of Puerto Rico - CONTINUED

STATE	LICENSE REQUIRED SURFACE COAL MINES	LICENSE REQUIRED OTHER BLASTING	EXAM REQUIRED	TRAINING COURSE REQUIRED	TRAINING COURSE OFFERED	CERTIFICATION FEE	CERTIFICATION TIME LIMIT	CERTIFICATION RENEWAL	OTJ EXPERIENCE REQUIRED	AGE REQUIREMENT
IN	No	No	No	No	No	None	None	None	No	None
IA	Yes	Yes	No	No	No	$60	1 Year	By Fee	No	21
KS	No	No	No	No	No	None	None	None	No	None
KY	Yes	Yes	Yes	No	Yes	$10	1 Year	By Fee	Yes	None
LA	Yes	Yes	No	No	No	$10	1 Year	By Fee	No	21
ME	No	No	No	No	No	None	None	None	No	None
MD	Yes	No(3)	Yes Surface Only	Yes	Yes	$5(4)	1 Year	By Fee	No	21
MA	Yes	Yes	Yes	No	No	$20	2 Years	By Fee	Yes	21
MI	Yes	Yes	No	No	No	$1	1 Year Temp. 5 Years Perm.	By Fee	No	18
MN	No(5)	No	No	No	No	None	1 Year	None	No	18
MS	No	No	No	No	No	None	None	None	No	None
MO	No	No	No	No	No	None	None	None	No	None
MT	No	No	No	No	No	None	None	None	No	None
NE	Yes	Yes	Yes	No	No	$5	1 Year	By Fee & Exam	No	20

TABLE 1. - Blaster certification requirements of individual states and the Commonwealth of Puerto Rico - CONTINUED

STATE	LICENSE REQUIRED SURFACE COAL MINES	LICENSE REQUIRED OTHER BLASTING	EXAM REQUIRED	TRAINING COURSE REQUIRED	TRAINING COURSE OFFERED	CERTIFICATION FEE	CERTIFICATION TIME LIMIT	CERTIFICATION RENEWAL	OTJ EXPERIENCE REQUIRED	AGE REQUIREMENT
NV	No	No	No	No	No	None	None	None	No	None
NH	Yes	Yes	Yes	No	No	$4	2 Years	By Fee	No	18
NJ	Yes	Yes	Yes	No	No	$10-100(6)	1 Year	By Fee	No	21
NM	No	No	No	No	No	None	None	None	No	None
NY	Yes	Yes	Yes	No	No	$30	3 Years	By Fee & Exam	Yes	21
NC	No	No	No	No	No	None	None	None	No	None
ND	No	No	No	No	No	None	None	None	No	None
OH	Yes	Yes	Yes	No	No	$10	Indefinite	By Fee & Exam	No	None
OK	Yes	Yes	Yes	No	Yes	$5	Indefinite	--	No	None
OR	No	No	No	No	No	None	None	None	No	None
PA	Yes	Yes	Yes	No	Yes	$5	1 Year	By Fee $3.50	Yes	21
PR	No	Yes	No	No	No	$5	1 Year	By Fee	No	18
RI	Yes	Yes	Yes	No	No	$10	1 Year	By Fee	Yes	21

TABLE 1. - Blaster certification requirements of individual states and the Commonwealth of Puerto Rico - CONTINUED

STATE	LICENSE REQUIRED SURFACE COAL MINES	LICENSE REQUIRED OTHER BLASTING	EXAM REQUIRED	TRAINING COURSE REQUIRED	TRAINING COURSE OFFERED	CERTIFICATION FEE	CERTIFICATION TIME LIMIT	CERTIFICATION RENEWAL	OTJ EXPERIENCE REQUIRED	AGE REQUIREMENT
SC	No	No	No	No	No	None	None	None	No	None
SD	No	No	No	No	No	None	None	None	No	None
TN	No(7)	No	No	No	No	$2	1 Year	By Fee	No	None
TX	No	No	No	No	No	None	None	None	No	None
UT	No	Yes	Yes	Yes	Yes	$3	Indefinite	By Fee	Yes	None
VT	No	Yes	No	No	No	$2	1 Year	By Fee	No	Age of Maturity
VA	Yes	Yes	Yes	Yes	Yes	$10	None	—	Yes	None
WA	Yes	Yes	No	No	No	$3	1 Year	By Fee	Yes	21
WV	Yes	Yes	Yes	No	No	None	1 Year	Application	Yes	21
WI	Yes	Yes	Yes	No	No	$20	4 Years	By Fee & Exam	Yes	21
WY	No	No	No	No	No	None	None	None	No	None

(1) Mining and Tunnel Blasting Only
(2) If No Storage License Is Held
(3) Only Dealers Are Certified
(4) Dealer Pays Fee
(5) Permit Required to Possess Explosives
(6) Depending Upon Class
(7) Permit Required

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Federal Agencies

1. Department of the Interior - Office of Surface Mining
2. United States Department of Agriculture - Soil Conservation Service
3. Department of the Army - Office of the Chief of Engineers
4. The Department of Labor - Mine Safety and Health Administration
5. The Department of Agriculture - U. S. Forest Service

State Agencies

1. All 50 states
2. Commonwealth of Puerto Rico

Trade Associations

1. Institute of Makers of Explosives
2. National Crushed Stone Association
3. Interstate Mining Compact
4. Bituminous Coal Operators Association, Inc.
5. National Limestone Institute

3. SURFACE COAL MINES - FEDERAL AND STATE REGULATIONS

3.1 Introduction

The Office of Surface Mining of the Department of the Interior requires that each person who is responsible for blasting operations have a valid certification as required by 30 CFR 850 (Vol. 44 - No. 50, 3-13-79, Book 3). However, 30 CFR 850 has not been issued but is expected sometime during the year of 1980.

In the United States, 25 states have surface coal mines (Table 2). Twenty of these states produce 99.4 percent of the surface coal mined while four states produce 48 percent of the surface coal mined. Fourteen of the 25 states which produce 47 percent of the total surface coal do not require blaster certification. Eleven of the 25 states producing 53 percent of the surface coal require blaster certification.

A certification examination (written or oral) is necessary in nine states producing 52 percent of the surface coal. The two remaining states certify blasters by registration and account for only 1.3 percent of the surface coal (Table 3).

The certification examination content and degree of coverage vary widely from state to state. In some states certification is accomplished by registration while in other states a prescribed curriculum, passing an examination with a prescribed grade, and previous blasting experience is required.

Previous blasting experience is another variable and is not adequately described.

3.2 Alabama Requirements

The Surface Mining Reclamation Commission of Alabama started a certification program for all blasters engaged in surface coal mining in 1977. Previous blasting experience is required but not specified as to type and amount. The employer has the responsibility for sponsoring each applicant based on the employer's judgment of the applicant's experience and education. This certification program includes 40 hours of classroom lecture, laboratory demonstrations and field work related to surface coal mining. Upon successful completion of the course, the student is required to score 70 percent or higher on a written examination before receiving a certificate, decal and identification card. The enrollment fee for the course is $100 which includes a textbook, technical references from the U. S. Bureau of Mines and explosives manufacturers, safety publications, information packet and a

TABLE 2. - Surface coal mining states

Alabama	Montana
Alaska	New Mexico
Arizona	North Dakota
Arkansas	Ohio
Colorado	Oklahoma
Georgia	Pennsylvania
Illinois	Tennessee
Indiana	Texas
Iowa	Virginia
Kansas	Washington
Kentucky	West Virginia
Maryland	Wyoming
Missouri	

TABLE 3. - Certification requirements (1979) and coal produced by U.S. surface coal mining states (1977)

State	Production M Tons	License	Exam	Training Required	Training Offered
KY	78,930	X	X		X
PA	44,860	X	X		X
WY	44,500				
OH	32,280	X	X		
MT	29,320				
IN	27,470				
IL	24,290	X	X		X
WV	21,375				
TX	16,765				
AL	14,640	X	X	X	
ND	12,165				
VA	11,650	X	X	X	
AZ	11,475				
NM	11,255				
CO	7,715				
MO	6,625				
TN	5,645				
OK	5,345	X	X		X
WA	5,055	X			
MD	3,030	X	X	X	
AK	665	X	X		
KS	630				
AR	550				
IA	525	X			
GA	185				
Total	416,945	221,270	215,690	29,320	153,425
Percent		53	52	7	37

TI-30 model electronic calculator. Meals are included and are supplied by the Walker State Technical College where the course is conducted.

There is only one class of license issued for a surface coal mine blaster and only the blaster-in-charge needs to be certified. All other workers involved in explosive handling must work under the direction of the certified blaster.

In the opinion of the authors, the certification program has a well-balanced curriculum that meets the requirements of the state regulations. The type and quality of the certification examination questions assure that the student receives training in safety and techniques. A passing score of 70 percent is required for certification.

Certification is valid for one year and is renewed without re-examination by paying a $25 fee.

Enforcement is accomplished by spot check by the Surface Mining Reclamation Commission of the state of Alabama.

3.3 Alaska Requirements

The state of Alaska requires all blasters to have previous blasting experience (type and amount not specified) and pass a written examination for certification which is valid for all types of blasting. There is no separate certification for surface coal mine blasters.

The examination questions are prepared in sets. Each relating to a different subject. This method allows tailoring the examination to stress any particular subject. The applicant is required to score no less than 75 percent or 45 questions answered correctly. A review of the examination questions by the authors indicates the quality of the examination to provide satisfactory knowledge in safety and techniques.

Formal training is not required or provided in the state of Alaska.

Certification is valid for one year and is renewed without examination by paying a $10 fee.

Enforcement is accomplished by spot check by the Department of Labor of the state of Alaska.

3.4 Arizona Requirements

The state of Arizona does not require certification of a surface coal mine blaster.

3.5 Arkansas Requirements

The state of Arkansas does not require certification of a surface coal mine blaster.

3.6 Colorado Requirements

The state of Colorado does not require certification of a surface coal mine blaster.

3.7 Georgia Requirements

The state of Georgia does not require certification of a surface coal mine blaster.

3.8 Illinois Requirements

The state of Illinois has two blaster certification requirements: (1) a certificate of compliance is required for persons conducting a blasting operation that involves storage and possession of explosives, (2) a license is required for persons conducting blasting operations but do not store explosives. Surface coal mine blasters are governed by both of these requirements.

As can be seen with the above requirements, the main concern is with storage and handling and the examinations are directed in this direction. The license costs $5 and is valid for an indefinite period. The cost of certification of compliance is based on quantity as follows:

Blasting caps (regardless of quantity) $15.00
Explosives to 20,000 lbs. $15.00
Explosives 20,000 to 100,000 lbs. $40.00
Explosives 100,000 to 300,000 lbs. $50.00

No previous blasting experience or formal training is required. An 18-hour training course is offered but is not mandatory to obtain the license or certification of compliance.

No enforcement program is reported.

3.9 Indiana Requirements

The state of Indiana does not require certification of a surface coal mine blaster.

3.10 Iowa Requirements

The state of Iowa certifies surface coal mine blasters by registration. No previous blasting experience, training or examination is required. There is only one class of license issued and only one blaster is required to be certified at each blasting site. The certification is good for one year. The cost is $60.00 and is renewable by payment of the fee.

Enforcement is by spot check by the State Fire Marshal, sheriff, or local police.

3.11 Kansas Requirements

The state of Kansas does not require certification of a surface coal mine blaster.

3.12 Kentucky Requirements

The state of Kentucky requires all blasters who regularly use explosives to be licensed. There are no special requirements for surface coal mine blasters. Twenty-four months of working in a blasting operation under the immediate supervision of an experienced blaster is required for certification. Passing an examination that evaluates the examinee's practice of blasting operations and the storage, moving, handling, and detonation of explosives is also required.

No formal training is required to obtain the blaster's license, although a 30-hour course is available.

There are two classes of licenses: (1) "Kentucky Blaster's License" and (2) "Limited Kentucky Blaster's License". Persons holding the limited Kentucky blaster's license cannot conduct a blasting operation in which more than 5 lbs. or explosives are used in a single charge, unless they are supervised by a person holding a Kentucky blaster's license.

There is a $10.00 fee for the application for a license and a $5.00 fee for the license after the test is successfully passed.

Enforcement is by spot check by the Kentucky Department of Mines and Minerals.

3.13 Maryland Requirements

The state of Maryland requires the completion of a 40-hour training and qualification course to obtain a certification as a surface coal mine blaster.

The content of the course is directed toward blasting safety and techniques. The cost of the training course is $50.00. A minimum of one year of experience in the handling and using explosives is a prerequisite for certification. The experience is evaluated by the Maryland Bureau of Mines inspectors.

There is only one class of certification and this is valid until September 1, 1981. Renewal after that time is annual and is made by application and paying a $5.00 fee.

Enforcement is by inspection by the Maryland Bureau of Mines.

3.14 Missouri Requirements

The state of Missouri does not require certification of a surface coal mine blaster.

3.15 Montana Requirements

The state of Montana does not require certification of a surface coal mine blaster.

3.16 New Mexico Requirements

The state of New Mexico does not require certification of a surface coal mine blaster.

3.17 North Dakota Requirements

The state of North Dakota does not require certification of a surface coal mine blaster.

3.18 Ohio Requirements

The state of Ohio requires all surface coal mine blasters-in-charge to be certified. The certification requirements are six months of previous experience as a blaster and to pass a written examination administered by the Ohio Department of Natural Resources, Division of Reclamation.

There is only one class of certification and has no time limit. Enforcement is conducted by the Ohio Department of Natural Resources, Division of Reclamation.

3.19 Oklahoma Requirements

The state of Oklahoma requires all surface coal mine blasters to have previous blasting experience (proven from employer records) and pass a written examination to be certified. A 40-hour course is offered by the state but is not mandatory. The training course is well balanced and provides adequate classroom training in blasting safety and techniques.

There is only one class of license and only the blaster-in-charge is required to be certified. There is no time limit on the certification, unless revoked for violation of state or federal blaster regulations.

Enforcement is accomplished by a state inspection of the State Mining Board every 30 days or more frequently, if necessary.

3.20 Pennsylvania Requirements

The state of Pennsylvania requires all surface coal mine blasters to have previous blasting experience and pass a written examination to be certified. Each applicant for a blaster's license shall be accompanied by a signed, notarized statement from the applicant's employer or employers or other responsible persons certifying that the applicant has had at least one year of qualifying experinece as a "blaster learner" in the handling and use of explosives under the direction of a licensed blaster and that in the opinion of the employer or employers or such other persons, the applicant is qualified by experience and is physically and mentally fit to hold a blaster's license. The state offers, but does not require, a two-day training course with an examination administered on the third day. The examination covers both techniques and safety.

There is only one class of surface coal mining license for each blaster and they may supervise as many as six helpers.

Certification is good for one year and can be renewed by paying a fee of $3.50.

Enforcement is by spot check by the Bureau of Surface Mine Reclamation Division of Explosives.

3.21 Tennessee Requirements

The state of Tennessee does not require certification of surface coal mine blasters. However, the state of Tennessee does require each firm who uses explosives to obtain a "Registration Certificate" (not a license). All personnel who are employed by the firm and use explosives are listed on the

reverse side of the "Registration Certificate" and are issued identification cards.

The "Registration Certificate" must be renewed annually and the fee is $15.00 for the certificate and $2.00 for each employee identification card.

Enforcement is by field inspection conducted by the State Department of Insurance.

3.22 Texas Requirements

The state of Texas does not require certification of a surface coal mine blaster.

3.23 Virginia Requirements

The state of Virginia requires one year of experience as a blaster and completion of four hours of classroom training, which includes a written examination to be certified for a surface coal mine blaster. The classroom training has limited coverage in the short period of instruction time available.

There is only one class of license and all blasters must be certified. The fee is $10 and has an indefinite period of validity.

Enforcement is by spot check by the Virginia Board of Mine Examiners.

3.24 Washington Requirements

The state of Washington requires surface coal mine blasters to be certified. No examination is required. However, prior experience (certified by another state's license; public agency; corporation; or blasting school; or a resume of successful blasting experience, properly witnessed) is required.

There is only one class of surface coal mine blaster certification.

Certification is valid for one year and is renewed by paying the annual fee of $3.00.

Enforcement is by inspection of mines on a spot check basis by the state of Washington Department of Labor.

3.25 West Virginia Requirements

The state of West Virginia does not have any special requirements for surface coal mine blasters. All blsters are required to obtain a "Permit to Use". Details are described in Section 4.

3.26 Wyoming Requirements

The state of Wyoming requires all surface coal mine blasters to be certified. Six months of experience on the job is evaluated by the state mine inspector. A written or oral examination is administered. There is no fee and no time limit on the validity of the license. Enforcement is by inspection of the mines by the state mine inspectors.

4. SURFACE METAL-NONMETAL AND UNDERGROUND METAL-NONMETAL AND COAL MINES - FEDERAL AND STATE REGULATIONS

4.1 Introduction

To prevent repetition and cumbersome wording, the term "mines" will refer to surface metal-nonmetal and underground metal-nonmetal and coal mines in Section 4 of this report.

There are no federal regulations that require certification of blasters working in mines. States requiring certification of blasters are discussed on an individual basis.

Twenty-seven states require certification of blasters who work in mines. State requirements vary considerably from certification by registration to required instruction and examination.

Twenty-one states require the passing of an examination to be certified as a blaster. Only four states issue lifetime certification. The other states require certification renewal by paying a fee or re-registration or re-examination (Table 1).

4.2 Alabama Requirements

The state of Alabama does not require a mine blaster to be certified.

4.3 Alaska Requirements

The state of Alaska requires blasting experience (no time specified) and the passing of a written examination for certification which is valid for all types of blasting. The examination stresses safety and electrical initiation.

All who handle explosives are required to be certified blasters and there is only one class of license. Formal training is not required. The applicant must be 21 years of age.

A yearly $10 certification renewal fee is required.

Blasting regulations are enforced by spot check by the Department of Labor of the state of Alaska.

4.4 Arizona Requirements

The state of Arizona does not require the certification of individual blasters. The only blasting that is regulated is that which is done by contractors. By definition the term "contractor" is synonymous with the term "builder."

4.5 Arkansas Requirements

The state of Arkansas does not require a mine blaster to be certified.

4.6 California Requirements

The state of California requires one certified blaster working on each shift. The blaster must have three years of blasting experience and must pass a written and oral examination. A $15 fee is charged for mining and tunneling certification. No fee is charged for the other blaster classifications. The certificate has a time limit of five years and is renewable by re-examination and payment of a fee. Persons assisting a certified blaster between the ages of 18 and 21 must work under the direct supervision of the certified blaster.

There are five blaster classifications:

- Unlimited (all types of blasting)
- General above ground (all types of above ground blasting)
- General underground (all types of underground blasting)
- Demolition (building and other structures)
- Limited blasting and limited specialties.

Enforcement is accomplished by inspection by safety engineers of the California Division of Occupational Safety and Health Administration during safety surveys.

4.7 Colorado Requirements

The state of Colorado does not require a mine blaster to be certified.

4.8 Connecticut Requirements

The state of Connecticut requires blasting experience (no time specified) and the passing of a written examination. However, no examination is required if the applicant supplies three letter of competency. The applicant must be 21 years of age.

A fee of $25 is required for new applicants and is renewable by payment of a $10 fee. Connecticut recognizes licenses from adjacent states.

Enforcement is accomplished by spot check by the local fire marshal.

4.9 Delaware Requirements

The state of Delaware requires blasting experience (no time specified) and the passing of a written examination. The examination evaluates the blaster's knowledge and understanding of federal and state laws pertaining to storage and delivery. A certification fee of $10 is charged annually. Delaware is presently developing a new examination.

Enforcement is conducted through the State Fire Marshal's office which issues site permits. This application process requires the names of the individuals doing the blasting.

4.10 Florida Requirements

The state of Florida requires blasting experience (no time specified) and the passing of a written examination. The examination evaluates the blaster's knowledge and understanding of state and federal laws pertaining to storage and delivery of explosives. An applicant must be 18 years of age.

A blaster's permit is required for each drilling rig. The permit fee is $25 and can be renewed each year by payment of $25.

There is no known enforcement of these requirements.

4.11 Georgia Requirements

The state of Georgia does not require a mine blaster to be certified.

4.12 Hawaii Requirements

The state of Hawaii requires blasting experience (no time specified) and the passing of a written examination for certification. The examination is oriented toward storage and security.

There is no fee for certification and renewal is accomplished through application.

Enforcement is accomplished by requiring that a blasting license be shown before purchasing explosives.

4.13 Idaho Requirements

The state of Idaho does not require a mine blaster to be certified.

4.14 Illinois Requirements

The state of Illinois requires that a person conducting an operation or activity involving the storage and possession of explosives must obtain a certificate of compliance. A blaster's license is required only if the blaster works at a mine for which no storage license is held. The applicant for a blasters license must be 21 years of age and must successfully pass an examination consisting of 30 questions relating to transportation, storage and safety. A certification fee of $5 is charged for new applicants. There is no time limit.

There is no known enforcement of these requirements.

4.15 Indiana Requirements

The state of Indiana does not require a mine blaster to be certified.

4.16 Iowa Requirements

The state of Iowa requires blasting experience (no time specified) and a $60 fee for certification which is renewable annually. An applicant must be 21 years of age.

Enforcement of these requirements is carried out by spot check by the local fire marshal, sheriff or police.

4.17 Kansas Requirements

The state of Kansas does not require a mine blaster to be certified.

4.18 Kentucky Requirements

The state of Kentucky requires all blasters who regularly use explosives to be licensed. Twenty-four months of working in a blasting operation under the immediate supervision of an experienced blaster is required for certification. Passing an examination that evaluates the examinee's practice of blasting

operations and the storage, moving, handling and detonation of explosives is also required.

No formal training is required to obtain the blaster's license, although a 30-hour course is available.

There are two classes of licenses: (1) "Kentucky Blaster's License" and (2) "Limited Kentucky Blaster's License." Persons holding the limited Kentucky blaster's license cannot conduct a blasting operation in which more than 5 pounds of explosives are used in a single charge, unless they are supervised by a person holding a Kentucky blaster's license.

There is a $10.00 fee for the application for a license and a $5.00 fee for the license after the examination is successfully passed.

Enforcement is by inspection by the Division of Explosives and Blasting, Department of Mines and Minerals.

4.19 Louisiana Requirements

The state of Louisiana requires that all blasters be certified. To become certified an applicant must be 21 years old and not have been convicted of a felony. The certification is valid for one year. The annual fee is $10.00 and must be renewed each year.

Enforcement is carried out by spot check by state police.

4.20 Maine Requirements

The state of Maine does not require a mine blaster to be certified.

4.21 Maryland Requirements

The state of Maryland does not require a mine blaster to be certified.

4.22 Massachusetts Requirements

The state of Massachusetts requires blasting experience (no time specified) and the passing of an oral examination for certification which is valid for two years. The oral exam evaluates the applicant's knowledge of safe practice, transportation, storage, electrical firing and the handling of misfires.

The applicant must be 21 years of age for a license and must be endorsed by a licensed blaster who has knowledge of the applicant's ability. A certification fee of $20 is required for new applicants and for renewal.

Blaster's licenses are issued under the following seven categories:

- Quarry blasting
- Tunnel blasting
- Marine blasting
- Research and development blasting
- Black powder blasting
- Seismograph blasting
- Other

Enforcement of these requirements is by spot check by local police and fire chiefs.

4.23 Michigian Requirements

The state of Michigan requires all blasters to be certified. No prior experience or training is required.

The applicant must be at least 18 years old. Application is made on prescribed forms and indicates personal information as well as an indication of the intended use of the explosives.

The certification fee is $1.00. Renewal is by paying the $1.00 fee.

Enforcement is by local authorities.

4.24 Minnesota Requirements

The state of Minnesota does not require a mine blaster to be licensed. The only requirement pertaining to explosives is that any person in possession of explosives must be 18 years of age and possess a blasting permit valid for one year. The permit is issued free.

Enforcement is by local authorities.

4.25 Mississippi Requirements

The state of Mississippi does not require a mine blaster to be certified.

4.26 Missouri Requirements

The state of Missouri does not require a mine blaster to be certified.

4.27 Montana Requirements

The state of Montana does not require a mine blaster to be certified.

4.28 Nebraska Requirements

The state of Nebraska requires blasting experience (no time specified) and the passing of a written examination to be certified as an explosives "user." The applicant must be a high school graduate and be at least 20 years old.

Annual renewal of the certification is required and is accomplished by re-examination and paying a $5.00 fee.

Enforcement is accomplished by the State Fire Marshal.

4.29 Nevada Requirements

The state of Nevada does not require a mine blaster to be certified.

4.30 New Hampshire Requirements

The state of New Hampshire requires at least one blaster to have a certificate of competency and be physically present at all times while explosives are being used. The certificate of competency must be obtained in addition to a "user's license." The certificate of competency is issued to an individual, while a "user's license" can be issued to an individual or to a firm.

There is no fee for the certificate of competency and is valid for four years.

The applicant for the certificate of competency must be 18 years old and pass a written examination. The applicant must also have the recommendation of two current holders of the certificate of competency who certify to the applicant's ability to conduct blasting operations.

Blasting regulations are enforced by the State Police inspectors.

4.31 New Jersey Requirements

The state of New Jersey requires blasting experience and the passing of a written examination. Certification is valid for one year and is renewed by payment of the fee. Certification is issued in the following eleven classifications:

- Type A (All types)--fee $100
- Type B1 (Quarry, surface mines, no limit)--fee $50
- Type B2 (Quarry, secondary blasting)--$25
- Type C (Underground mines)--$25
- Type D (Tunnels and shaft construction)--$50
- Type E1 (General construction)--$50
- Type E2 (Trench and foundation blasting)--$25
- Type E3 (General construction limited to 50 pounds per blast)--$25
- Type F (Demolition)--$50
- Type G (Agriculture)--$10
- Type N (Special)--$25

An applicant must be 21 years of age. A different examination is given for each classification. These examinations evaluate the knowledge of explosives and blasting techniques. Safety, electrical firing, vibration control, handling of misfires, control of fly rock, as well as state laws, are stressed.

All surface mines are required to report approximate size and time of each blast to the Department of Labor and Industries Mine Safety Section 24 hours before blasting.

These requirements and those for blaster certification are enforced by four inspectors who inspect mines on a daily basis. Every mine is visited several times a year and every violation or complaint is followed up by an inspector within three to four weeks. Penalties for infractions vary from warnings to fines of several hundred dollars.

4.32 New Mexico Requirements

The state of New Mexico does not require a mine blaster to be certified.

4.33 New York Requirements

The state of New York requires that all mine blasters be certified. An applicant for certification must have three years of blasting experience under the supervision of a certified blaster and be at least 21 years of age. He must have completed Grammar school. The fee is $30. The certificate is valid for three years and is renewable by payment of a fee and re-examination.

There are three classifications of blaster's license:

Class A - Supervise and perform the preparation for detonating any blast.

Class B - Supervise and perform the preparation for detonating any above ground blast.

Class C - Supervise and perform the preparation for detonating any underground blast.

The examination stresses safe handling, storage and electrical detonation.

Requirements are enforced by spot check by inspectors of the New York State Department of Labor, Division of Safety and Health.

4.34 North Carolina Requirements

The state of North Carolina does not require a mine blaster to be certified.

4.35 North Dakota Requirements

The state of North Dakota does not require a mine blaster to be certified.

4.36 Ohio Requirements

The state of Ohio requires blasting experience (no time specified) and the passing of a written examination for lifetime certification. The examination covers blasting technique.

There are no reported enforcement procedures.

4.37 Oklahoma Requirements

The state of Oklahoma requires blasting experience (no time specified) and the passing of a written examination for certification which is valid indefinitely.

There are two classifications--blaster and explosive handler.

Enforcement of requirements is ensured by State Mining Board inspections every 30 days.

4.38 Oregon Requirements

The state of Oregon does not require a mine blaster to be certified.

4.39 Pennsylvania Requirements

The state of Pennsylvania requires blasting experience (no time specified), the passing of a written examination and payment of a $5 fee for certification which is valid for one year. An applicant must be 21 years of age. The renewal fee is $3.50.

There are six license classifications:

- General
- Trench Construction
- Seismic and Pole Line
- Surface Mining
- Black Powder
- Steel Mill and Salamander Blasting

Certification is conducted by the Commonwealth of Pennsylvania, Department of Environmental Resources, Bureau of Surface Mine Reclamation, Division of Explosives. A two-day course is offered but is not mandatory. The examination includes safe handling, storage, electrical connections and handling of misfires.

Enforcement of these requirements is by spot check and is conducted by the Department of Environmental Resources, Bureau of Surface Mine Reclamation, Division of Explosives.

4.40 Puerto Rico Requirements

The Commonwealth of Puerto Rico does not require prior experience or the passing of an examination for blaster certification. A license is required, however, and can be obtained by anyone 18 years of age or older by registering and paying a $5 certification fee. Certification is valid for one year and can be renewed thereafter by payment of a fee.

4.41 Rhode Island Requirements

The state of Rhode Island requires previous blasting experience be substantiated by submitting letters from previous employers. A written examination concentrates on safe procedures.

The certification fee is $10.00. Annual renewal is required and is accomplished by application and paying the $10.00 fee. The applicant must be at least 21 years old.

There are three classifications of certification:

1. General blasting
2. Marine blasting
3. Research and Development blasting

4.42 South Carolina Requirements

The state of South Carolina does not require a mine blaster to be certified.

4.43 South Dakota Requirements

The state of South Dakota does not require a mine blaster to be certified.

4.44 Tennessee Requirements

The state of Tennessee requires all firms that use explosives to register and include the names of their employees who will be using explosives. The individual receives a certificate of registration.

The registration fee is $15.00. The certificate of registration for each employer is $2.00 per employee. Annual renewal is required by paying the appropriate fee.

Enforcement is by field inspection and is conducted by the State Department of Insurance.

4.45 Texas Requirements

The state of Texas does not require a mine blaster to be certified.

4.46 Utah Requirements

The state of Utah requires that blasters in all gassy coal mines be certified. To become certified, a blaster must complete 40 hours of on-the-job underground training conducted by his employer.

A written and oral examination is administrated by the College of Eastern Utah or by the Utah State Industrial Commission. The certification examination is referred to as a "shot fire" test. After successfully passing the examination, the applicant must pay a $3 certification fee.

Certification in Utah is indefinite unless the blaster changes jobs for a lengthy period of time.

Enforcement of these requirements is conducted by the Utah State Industrial Commission during periodic mine inspections.

4.47 Vermont Requirements

The state of Vermont requires that a blaster be of the age of majority. A $2 certification fee for a Vermont resident is charged and the nonresident fee is $4. No blasting experience is required. Certification is renewable annually by payment of a fee.

Blasting regulations are enforced by spot check by the Department of Public Safety.

4.48 Virginia Requirements

The state of Virginia requires certification of all blasters in all surface mines. An application must be submitted along with a notarized statement from the employer to verify one year of blasting experience.

The Board of Mine Examiners conducts four one-hour classes prior to administering the examination for surface mine blasters and all coal and mineral mines. The subjects covered are blasting practices, blasting controls, transportation and storage of explosives, and Virginia rules and regulations. After successfully completing the examination a blaster's certification is issued with payment of a $10 fee. Board certification does not expire and is valid until revoked by the Board for violation.

Blasting regulations are enforced by the Virginia Division of Mines and Quarries.

4.49 Washington Requirements

The state of Washington requires that all blasters have blasting experience (no time specified) and be 21 years old. A one year certificate is issued after payment of a $3 fee. Renewal is accomplished by payment of a fee thereafter. The state of Washington issues the following types of blaster's license:

Code 0 - unlimited

Code 1 - agriculture

Code 2 - general construction

Code 3 - mining underground

Code 4 - quarrying and mining

Code 5 - logging and general use

Code 6 - transmission systems

Code 7 - seismographic systems

Code 8 - well drilling

Code 9 - industrial ordnance

Code 10 - explosive disposal

Code 11 - avalanche control

Code 12 - underwater demolition.

There are three user grades:

Code 1 - 10 years' experience

Code 2 - 6 to 9 years' experience

Code 3 - 2 to 5 years' experience.

Enforcement is by inspection of mines on a spot check basis by the State of Washington, Department of Labor.

4.50 West Virginia Requirements

The state of West Virginia requires that all blasters have blasting experience (no time specified) and be 21 years old. A blaster's permit is issued for the following types of blasting:

Class A unlimited - all types of blasting.

Class B general above ground - all phases of blasting operations in quarries, open pit mines, above ground construction.

Class C general underground - all phases of blasting operations in underground mines, shafts, tunnels, and drifts.

Class D demolition - all phases of blasting on demolition projects.

Class E seismic prospecting - all phases of blasting on seismic prospecting.

Class F agriculture - all phases of blasting in agriculture but limited to not more than 50 pounds per blast.

Class G special - special blasting as described on the permit.

Application to the State Fire Marshal must be accompanied by a statement from the blaster's employer that the blaster has not been convicted of a crime punishable by imprisonment exceeding one year, that the blaster is not a fugitive from justice, that the blaster is not addicted to dangerous drugs, that the blaster has no mental defects, and further that his employer feels the blaster has had adequate experience and training in the use of explosive materials.

A blaster's permit is valid for one year and is renewable every year thereafter by application.

The West Virginia Department of Mines requires that all underground coal mine blasters successfully pass a "shot fire" examination which consists of 90 multiple choice safety-oriented questions.

Enforcement is by the State Fire Marshall's office.

4.51 Wisconsin Requirements

The state of Wisconsin requires previous blasting experience as stated under the types of certification which follows.

The applicant must be 21 years of age. The examination fee is $10.00 and the certification fee is $20.00 for four years. Renewal is by re-examination and payment of a fee. Each applicant must have the recommendation of the sheriff as to character. The certification examination is written and oral.

Classification of Blasters

(a) Unlimited.

1. Requirements: For unrestricted blasting. Special qualifications and blasting experience, including blasting in communities. Training with or under a representative of an explosives manufacturer. Knowledge of safety codes and practices.

(b) Precision blasting, excavating and/or demolition.

1. Requirements: Four weeks of blasting experience in built-up areas doing specialty blasting. Knowledge of the explosives code, supervising, inspecting or completing a course of study.

2. Activities:

a. Trenches in communities.
b. Excavating and/or well drilling in communities.
c. Low structure-demolition in communities. (Minus 15 feet.)
d. Underwater (excavating) (demolition).
e. Miscellaneous.

(c) Quarry-open pit and/or road blasting.

1. Requirements: Four weeks of blasting experience. Knowledge of the explosives code. Drilling and acting as a helper. Supervising, inspecting or completing a course of study.

2. Activities:

a. Quarry.
b. O.P. Mining.
c. Boulders (on surface).
d. Road grades.
e. Ditch grades.

(d) Underground mining and/or tunneling.

1. Requirements: Four weeks of blasting, supervision, demonstrating, inspecting. Completion of a course of study.

2. Activities:

a. U. G. Mining.
b. Tunnels.
c. Shaft sinking; raising.
d. Drifting
e. Bombing chutes.
f. Boulders (underground).

(e) Limited and miscellaneous.

1. Requirements: Two weeks of blasting, drilling, acting as helper, or completion of a course of study.

2. Activities:

a. Stumps.
b. Boulders.
c. Ice--frost.
d. Concrete.
e. Fertilizer piles. (Not ammonium nitrate.)
f. Pole setting (in muck).
g. Ditches (including Propagating shots).
h. Well drilling.
i. Beaver dams; pot holes
j. Pole holes (rock).
k. Instructor; inspector.
l. Student helper.
m. Black powder (blasting).
n. Seismic.

Enforcement is by inspection by state mine deputies, sheriff and local police.

4.52 Wyoming Requirements

The state of Wyoming requires all mine blasters to be certified. Six months of experience on the job is evaluated by the state mine inspector. A written or oral examination is administered. There is no fee and no time limit on the validity of the license. Enforcement is by inspection of the mines by the state mine inspectors.

5. INDUSTRIES NEED FOR BLASTING PERSONNEL

Very few blasters are capable of conducting all of the various types of blasting that is required by industry. For instance, the surface coal mining industry uses contour, strip, auger, mountain top removal, box cut, open pit and area mining methods. Each type of mining requires different techniques and a blaster trained in one method does not necessarily understand the techniques of other methods. A blaster trained and experienced in nonelectric initiation blasting is not qualified to conduct electrical blasting unless he is knowledgeable of the special electrical problems they may encounter.

Industry's need for the varoius types of blasting will be discussed in this section.

5.1 Introduction

The various needs for different types of blasters were determined by a survey of the entire industry by personnel of the Explosives Products Division of E.I. du Pont de Nemours & Co. (Inc.) during routine contacts with all members of the industry.

The opinion of various mining and trade organizations for the training needs for blasters was solicited by letters sent directly to these organizations. Few responses were received and those that were answered will be presented later on in this section.

Published data on the number of mines, personnel, production and methods of mining is at least two years in back of the current year. In order to provide current information, the available data was updated to December 1979 with information obtained from the industry survey.

5.2 Surface Coal Mines

5.2.1 Large Mines

There are approximately 161 surface coal mines that produce 500,000 tons or more of coal each year. Because of their size, these mines employ the more productive methods of stripping. The large mines can economically employ full blasting crews that permit training of new personnel without adversely effecting production rates. The typical blasting crew consists of a superintendent, two mining engineers, four blasters, sixteen laborers, one foreman and one blaster in training. The duties of the blasters are usually limited to loading the explosives, connecting the initiation system and initiating the blast. Layout and design of the blast,

selection of the type of explosives and initiating delay system is the responsibility of the superintendent or the mining engineers.

Since there is sufficient time available to properly train the crew members in their respective responsibility the members of the crews are capable of working without full supervision seventy-five percent of the time.

Using the average number of five blasters at each of the 161 mines, we obtain a total count of 805 blasters needed for this size of operation.

The industrial survey conducted by Du Pont showed that the superintendent was responsible for the complete blasting operation. The superintendent and engineering or safety department were responsible for the blast design and selection of the type of explosives used. The engineering or safety department was responsible for training and safety concerning the blasting procedures. The blaster was responsible for the loading and initiation of the explosives. This information is shown in Table 4.

5.2.2 Medium-Sized Mines

There are approximately 400 surface coal mines that produce between 100,000 and 499,000 tons of coal per year. This size mine is also large enough to have complete blasting crews. A typical crew may consist of a superintendent, a mining engineer, four blasters, three laborers and one foreman. The responsibilities of each of the crew members is well defined and each member has had sufficient training so that each can perform their assignment competently and without supervision seventy-five percent of the time. Using the average of four blasters at each of the 400 mines we need 1600 blasters for this size operation. In this size of mine, we begin to see the direct influence of the owners in the operations. In some locations the blaster has some responsibility for blast designs and all the responsibility for loading and shooting. (Table 5).

5.2.3 Small Mines

There are approximately 3330 surface coal mines that produce less than 100,000 tons of coal each year. This size mine has a limited blasting crew and usually only one blaster. Therefore, any training must be accomplished off-shift since the blaster is needed for production. The blasting crew usually consists of a superintendent, foreman, blaster and two laborers. In these smaller mines, the responsibility of the blaster increases. Since these blasters do not receive the training that blasters from

TABLE 4. - Surface coal mines producing 500,000 tons or more per year: blasting personnel responsibility, percent of total

	Blasting Operation	Blast Design	Type Explosive Used	Blasting Safety	Blaster Training	Blast Loading & Firing
Superintendent	60	65	50			
Drill & Blast Superintendent	40	10				
Engineering or Safety Department		25	50	100	100	
Blaster						100

TABLE 5. - Surface coal mines producing 100,000 - 499,000 tons per year: blasting personnel responsibility, percent of total

	Blasting Operation	Blast Design	Type Explosive Used	Blasting Safety	Blaster Training	Blast Loading & Firing
Superintendent	75	37	83			
Drill & Blast Superintendent	8	26				
Foreman	15	25	10			
Engineering or Safety Department		2		100	100	
Owner	2		3.5			
Purchasing Agent			3.5			
Blaster		10				100

larger mines get, the smaller mine blaster requires supervision sixty-seven percent of the time. We would need 3,300 blasters for these small mines. (Table 6)

5.2.4 Mining Organizations

Many of the mining or trade assocations that were contacted by letter declined to express an opinion on the certification and training needs for blasters. One of these organizations referred the request to individual members of their organization for comments.

5.2.4.1 Bituminous Coal Operators Association Inc. (BCOA)

The BCOA requested their member companies to comments on the need for certification and training of blasters. The comments were consolidated by BCOA.

The composite opinions of the members state that the blaster is responsible for transporting explosives to and from the magazine, loading the explosives, connecting the initiation system, clearing the blasting area and initiating the blast. The selection of the type and amount of explosives must be approved by line supervision.

5.2.4.1.2 Need for Improvements in Blasting Safety

The BCOA report states that there is a need for improving blasting safety and efficiency. The surface blaster should be knowledgable of the cost and efficiency of blasting products utilized. The surface blaster should know how to control noise and vibration. The surface blaster should exhibit good safety procedures so that they can guide and instruct their personnel in how to safely work with explosives.

5.2.4.1.3 Environmental Problems

The BCOA summary stated that environmental problems that affect the land, water or air are a growing concern to all. Any contamination of the land, water or air should be of concern to the surface blaster.

TABLE 6. - Surface coal mines producing less than 100,000 tons per year: blasting personnel responsibility, percent of total

	Blasting Operation	Blast Design	Type Explosive Used	Blasting Safety	Blaster Training	Blast Loading & Firing
Superintendent	100	70	100	100	100	
Foreman		10				
Blaster		20				100

5.2.4.1.4 Certification Requirements

Some BCOA members stated that those certification requirements that are presently in existance are adequate. In those states that do not require certification, the members feel that a blasting apprentice should work for two years with a qualified blaster, before being examined for certification. The members feel that the existing training is primarily concentrated on state and federal laws with no instruction on safety, techniques or economics.

Some members stated that if the certified blaster, and not the operator, were held accountable for regulation infractions then certification would be more meaningful.

One member of the BCOA proposed that mine management should be responsible for blaster training and as such would institute procedures that would comply with state, federal and local regulations.

Other members of the BCOA want to establish their own safety procedures based on regulations and manufacturers recommendations.

One group of BCOA members suggested that the explosives manufacturers should supply the training material and inform mine operators of needed safety procedures so that they could develop their own training programs.

In reviewing the certification requirements that were proposed by BCOA members, the only common information is that all feel some type of training for surface blasters is needed. There were diverse approaches that were suggested to accomplish the training.

5.2.4.2 Institute Makers of Explosives

The Institute Makers of Explosives (I.M.E.) suggests the following for blaster training and certification:

- All blasters should be thoroughly trained in the basic fundamentals of safety and health associated with the use of explosives.

- Blasters should be trained to perform properly and safely the tasks associated with explosives as they are used at their specific location of work.

- A means of certification should be provided by the proper authorities to insure accomplishment of the above items.

- There should be periodic certification renewal to insure continued competence.

5.2.5 Classes of Blasters Required

Each method of mining requires different blasting techniques and unless a blaster has experience with the various methods he will not be able to perform his assignment safely and economically. For example, using a surface detonating cord initiation system requires techniques that are quite different than a down the hole detonating cord initiation system. Blasting in a stripping operation is entirely different than contour mining blasting. Therefore, the classes of blasters will be determined by the type of operation that is employed. A list of the more common types of mining are contour, strip, auger, mountaintop removal, box cut, open pit and area mining.

5.2.6 Job Description of Blasting Personnel

Job descriptions vary considerably from company to company and according to the type of operation. An example of a job description follows:

Title - Primary blaster

Primary Function - Loads explosives and detonates charges

Tools and Equipment - Blasting machine, loading poles, galvanometer and shovels.

Materials - Blasting agents, detonating cord, electrical blasting caps

Supervision - Amount of explosives and how loaded

Direction Exercised - Direct the work procedures of assigned helpers

Working Procedure

- Examine and measure the depth of boreholes
- Load prescribed amount of explosives in each hole
- Connect detonating cord or electrical blasting cap
- Insure that connections are made to provide the proper delay sequence
- Measure electric circuit resistance or check detonating cord circuit
- Clear blasting area
- Initiate the blast under supervision of blaster-in-charge
- Inspect post-blast area
- Give all-clear signal

5.2.7 Responsibility and Authority Given to Blasting Personnel

Responsibilities are divided into the following six categories:

- Overall responsibility for the entire blasting operation
- Blast design
- Type and quantity of explosives
- Blasting safety
- Blaster training
- Explosives loading and initiation

The blaster inspects the blasted area after each shot to determine whether all explosives have detonated; reports daily inventory of explosives to foreman; maintains cleanliness of equipment; and directs clean-up of working area.

5.2.8 Need to Improve Safety and Efficiency

The need to improve safety in surface coal mine blasting is clearly pointed out in a paper by Richard W. Watson (Research Supervisor, Explosives, Pittsburgh Mining and Safety Research Center, Pittsburgh, Pennsylvania) and Julius Roth (Consultant, Management Science Associates, Los Altos, California) entitled, "A Review of Blasting Accidents in Surface Mining," presented at the Fourth Conference on Explosives Engineers. The paper indicated that blasting accident trends in surface mines for the years 1973, 1974, 1975 and 1976 decreased in quarries and in surface metal mines and increased in the coal stripping industry. In 1976 the coal stripping industry reported 21 injury-producing, blasting related accidents while the stone quarry industry reported seven and surface metal mines reported none.

5.2.9 Environmental Problems

Blasting is considered to cause environmental concern to all of the 161 mines producing 500,000 tons per year or more. Forty percent of these mines have smoke and fume problems; 60 percent have noise problems; 60 percent feel they have vibration problems; and 40 percent are concerned with fly rock. Approximately 60 percent of these mines have operations near a public facility requiring special precautions such as seismographic reading, public notice of blasting and highway guarding.

5.3 Underground Coal Mines

5.3.1 Introduction

Coal produced in underground mine operations in the United States accounts for 40 percent of the coal produced. This coal is produced in 2,292 underground coal mines in 13 states. Listed below are the eight states that require a blaster to be certified:

Illinois	Pennsylvania
Kentucky	Utah
Maryland	Virginia
Ohio	West Virginia

These eight states produce 96 percent of the underground coal produced in the United States. Five states, Alabama, Arkansas, Colorado, Indiana and Tennessee do not require certification for underground coal blasters. The remaining eight require the passing of a test commonly known in the underground coal mining industry as a "shot firer" test.

Management of several leading coal mining companies estimate that one in every 25 employees is a certified shot firer. This figure compares favorably with one area in West Virginia where a known 2,697 shot firers work in 112 mines. Therefore, the nation's 917 coal mines that do not use mechanical means of excavating coal would require 22,008 certified shot firers.

Assuming that a mine using continuous miners would employ half as many shot firers, the 1,375 mines that mechanically produce coal would require 16,508 certified shot firers for an industry total of 38,516. This is a highly conservative estimate and could be twice that number since in small mines personnel are very flexible in that they are called upon to do various jobs.

5.3.2 Classes of Blasting Required

The classes of blasting required in underground coal mines are blasting undercut coal, blasting solid coal, and blasting rock falls.

5.3.3 Job Description of Blasting Personnel

A formal job description for blasters in underground coal mines is practically nonexistent. All underground coal blasters are referred to as shot firers. One company, however, did report the following job description:

> Underground shot firers must be state certified. They take explosives and detonators from underground magazines and transport them to work sites. This is normally shooting bottom or top rock strata, rock falls, overcasts and conveyor belt heading holes.
>
> The shot firer ensures that holes (top or bottom) are properly located, that the explosives are loaded in the holes, stems the holes with incombustible material, makes the necessary gas tests, warns all persons in the area and does the blasting.

The person assisting in loading may not be supervised 100 percent of the time. Therefore, the loader should demonstrate that he knows how and why he must handle explosives safely.

5.3.4 Responsibility and Authority Given to Blasting Personnel

Responsibility and authority given to blasting personnel in underground coal mines vary a great deal. The use of explosives is limited to producing coal, rock shooting, cleanup of large falls, shooting overcasts or extending roof clearance for belt headings. In some mines using short or long wall mechanical miners, solid shooting of small areas is done to facilitate a tail entry of the machine. This infrequent type of blasting is handled by the section foreman and several of his men, the roof bolting crew or the continuous miner crew. When a large fall occurs or a large overcast is shot, some mines provide a rock shooting crew to stay with the job until it is complete. In most cases, each crew has a foreman and at least one member of the crew certified as a shot firer (as required by various states). Normally, the entire crew participates in loading and wiring the shot. The certified man normally checks the circuit for continuity, clears the area, and initiates the blast. Few problems occur in this type of blasting other than insuring that proper materials are available.

Loading and connecting the wires of the blasting caps are performed by the shot firer. The shot firer also is responsible to insure that all personnel have retired to a safe location and then fires the round.

Not all shot firers are certified. At many mines, the mine superintendent or foreman is the certified shot firer. In general, a successful mine has a very experienced blaster who does the loading and shooting with one or two helpers.

If a large number of cuts are shot on a shift, the shot firer is responsible for helping with and seeing that the drilling is correctly placed. It is the shot firer's responsibility to see that the round is properly loaded, the area is cleared, and fire the blast with the proper blasting machine.

Overall responsibility for the blasting operation is that of the mine superintendent.

Selection of the type of explosive used, blasting safety, and blasting training is divided almost equally among the superintendent and/or the foreman in all underground coal mines.

Responsibility for blast design belongs to the superintendent in approximately 50 percent of the mines and to the blaster in the other 50 percent.

Responsibility for loading the shot belongs to the blaster in 100 percent of the mines.

5.3.5 Special Problems Encountered in Underground Coal Mines

Underground coal mines are classified as "gassy" and as such only permissable explosives, electric blasting caps and blasting accessories approved for this use are allowed. Electrical connections are critical and must conform to the regulations.

Blasting machines that are limited in deliverable energy and cut off the current in a specified time are necessary to prevent explosions in the gassy mines.

Other problems are the overloading of explosives and use of insufficient amount of stemming.

Clay stemming is one material used and often gets hard or is not kept in sufficient inventory. Water stemming bags are used in many locations. Tamping the clay dummy is the most physical aspect of loading the shot and, as a result, only a small amount of clay stemming is used or the clay is only moderately tamped.

In general, the stemming used in small mines does not meet state and federal requirements.

Other problems are the loading of wet or water filled holes, blasting in weak strata areas or blasting from a solid face.

5.3.6 Need to Improve Safety and Efficiency

The results of the industry survey that was conducted as part of this contract showed that blasting accidents were still occurring.

Improper drilling was observed, and this can cause fly rock and initiation of coal dust or mine gases. Overloading is a waste of money and may cause mine explosions, fly rock and damage support columns.

Only instruments or accessories that have been approved for use in gassy mines should be employed.

When delay caps are used they are sometimes fired out of sequence because they are loaded in the wrong holes. Delay periods are sometimes skipped because insufficient numbers of the required periods are delivered to the face.

Proper electrical wiring of the blasting caps and lead wire is necessary to prevent misfires.

Many accidents occur because of improper clearing of the area of personnel and failing to retreat to a safe place to initiate the blast.

5.3.7 Licensing Requirements

Blasters should be certified by showing expertise through oral or written examination in the following fields:

- Understanding why an explosive is classified permissible.
- Permissible blasting procedures.
- Physical properties of explosive used.
- Understanding of characteristics of sensitivity.
- Delay shooting methods, solid shooting and undercut shooting.
- Primer makeup and primer placement.
- Electrical wiring of shot.
- Testing of circuitry and complete understanding of the galvanometer, including what it measures and how to calculate resistance.
- Shot guarding and signal system.
- Blasting machine use.
- Electric circuit maintenance.
- Storage and transportation methods.

5.4 Underground Mining (Metal-Nonmetal)

5.4.1 Introduction

Underground mining (metal or nonmetal) is conducted in 38 states. Seventeen, or 45 percent, of these states require that a blaster be licensed. Twelve, or 29 percent, require that a blaster pass an examination. The 171 underground nonmetal mines in the United States employ at least 2,907 blasters. The number of blasters per mine varies from as few as two in some limestone and salt mines to 30 or more in larger mines. The 680 underground metal mines employ 31,430 blasters.

5.4.2 Classes of Blasting

The classes of blasting in underground mining are varied. Blasting of drift or heading rounds is used to drive access tunnels, levels, drifts, or crosscuts into and through the ore body. Blasting of raise rounds in vertical or steeply inclined passages driven upward to connect levels, develop stopes and provide access into ore body areas.

Shaft and winze rounds are blasted to develop passageways to a lower level. Shafts are normally sunk from the surface.

Stope blasting is a step-like excavating method to mine inclined deposits in layers. Long hole rings and fans are small diameter holes drilled radially outward from an access drift, in a plane parallel to an open stope. Bench blasting is an underground method that is similar to that used in vertical blasthole shooting in open pit quarries or mines.

Chute or grizzly blasting is secondary blasting used to break large boulders that become blocked in chutes or grizzlies.

5.4.3 Job Description of Blasting Personnel

As in most other mining industries, there seems to be no formal job description for blasters. Personnel involved in blasting operations in underground metal mines are:

- Mine superintendent
- Foreman
- Blaster
- Engineer
- Mine manager

Personnel involved in underground nonmetal mines are:

- Mine superintendent
- Foreman
- Blaster
- Engineer
- Safety department
- Mine manager

5.4.4 Responsibility and Authority Given to Blasting Personnel

The responsibility and authority given to blasting personnel vary considerably as they do in other types of mining. The overall responsibility for various phases of the blasting operation are about the same for the mine superintendent in underground metal mines as for underground nonmetal mines. However, the blaster's responsibility increases and the foreman's responsibility decreases in metal mines.

In underground mines, especially metal mines, drilling and blasting are usually conducted on a contract basis where production is most important. Although there is some decrease in this practice, it is widely used. Consequently, the blaster quickly learns how to drill a pattern and how to delay the holes. (Tables 7 and 8)

5.4.5 Special Problems Encountered in Blasting

Unlike most other phases of the mining industry, the underground mine blaster is not the lowest paid, and, in fact, carries some prestige. Thus, turnover is not as frequent and presents less of a problem.

The main problem in underground blasting is usually carelessness and lack of supervision. A great amount of time and money is spent in drilling a round. Once the round is loaded and ready to fire, the schedule is rushed to complete the job. Thus, loading and connecting the initiating system are carried on in less than ideal conditions. The main problems in underground blasting are:

- Poor maintenance of electrical firing line.
- Poor maintenance and careless treatment of blasting machines.
- Poor maintenance and handling of galvanometer.
- Poor electrical connections.
- Disregard of misfires.
- Lack of understanding of stray currents and their source.
- Lack of knowledge on how to connect the initiation systems, either nonelectric or electric.

TABLE 7. - Underground metal mines: blasting personnel responsibility, percent of total

	Blasting Operation	Blast Design	Type Explosive Used	Blasting Safety	Blaster Training	Blast Loading & Firing
Superintendent	50	24	60	24	28	
Foreman	29	10	2	6	8	
Blaster	17	52	12	16	6	100
Engineering Department	2	14	6	52	58	
Mine Manager	2		12	2		
Purchasing Agent			8			

TABLE 8. - Underground nonmetal mines: blasting personnel responsibility, percent of total

	Blasting Operation	Blast Design	Type Explosive Used	Blasting Safety	Blaster Training	Blast Loading & Firing
Superintendent	53	53	47	30	24	
Foreman	47	30	12	24	30	
Blaster						100
Engineering Department		17	17			
Safety Department				46	46	
Mine Manager			24			

5.4.6 Need to Improve Safety and Efficiency

There is a need to improve safety and efficiency in blasting in underground mines. Injury-producing, blasting-oriented accidents are grouped as metal and nonmetal, surface and underground by The Health Safety Analysis Center in Denver, Colorado.

Forty-four percent of the total accidents from fly rock can probably be discounted from underground mining where the shooting is done between shifts. However, accidents from premature detonation, digging explosives, misfires, suffocation, and fumes and loss of hearing are possible underground incidents.

5.4.7 Licensing Requirements

Each phase of the blasting routine is highly dependent upon the other. The type of explosive used can dictate what drill pattern is to be used in order to obtain the proper loading conditions. The blaster must be a person who approves of the various phases of the blasting operation and must be present during loading in the event that the loading needs to be changed.

5.5 Surface Quarry and Open Pit Nonmetal Mining

5.5.1 Introduction

Quarry and/or open pit nonmetal mining is conducted in all states and accounts for 14 percent of the total explosives used in the United States. There are 4,152 crushed stone quarries and 1,331 open pit mines that require the expertise of 15,352 blasters. (The term "open pit mine" refers to an operation mining a mineral that must be extracted from a known formation.) After the mineral is removed the remaining material is waste. This contrasts with quarries where all material mined is usually consumed as an end product. Quarries and open pit mines are mined in the same manner and the term is used interchangeably.

5.5.2 Mining Organizations

5.5.2.1 National Limestone Institute

The National Limestone Institute members reported two types of blasting:

- Primary blasting of productions shots.
- Secondary blasting of boulders.

Very few members have any type of job description and training is generally done on the job under the direction of an experienced blaster. Blasters with formal training are usually supervisory personnel who attended some type of training sponsored by explosives manufacturers.

The member companies reported that the overall responsibility of a blaster is to load the shot, laying out the pattern prescribed by the superintendent and loading the holes with the amount and kind of explosives as directed by foremen and superintendents.

One member whose quarry operation is located in a state requiring certification felt that the certification program ensured a high level of competency in all facets of his operation and stated that he was quite satisfied with the program for it provided a safe and manageable means of blasting.

5.5.2.2 National Crushed Stone Association

The National Crushed Stone Association has taken a closer look at blaster training and certification. The inquiring committee initiated efforts to develop a blaster's handbook and gave consideration to industry sponsored certification.

After considerable discussion, the group concluded training and certification should be handled and administered by a public authority since a question of liability might arise from an industry-sponsored program.

5.5.3 Job Descriptions of Blasting Personnel

Very few companies have a formal job description for blasting personnel -- "dynamite person" and "explosive person" is the description used by many. Many companies do not have a job description for blasting personnel because they consider the blaster as a foreman.

5.5.4 Responsibility and Authority of Blasting Personnel

The responsibilities of blasters and the makeup of the blasting team vary with each quarry. Unlike surface coal and metal mining, the composition of the blasting organization does not necessarily correspond with the size of the quarry nor the number of shots fired. Some large

operations do not utilize engineering for blast designs since their shot geometry does not change; but, most quarries that drill large diameter holes require that the shot be designed by the engineer. The person with overall responsibility varies to such an extent that a typical blasting team for certain size quarries cannot be named. Table 9 illustrates the percentage of quarries, regardless of size, that specify responsibilities for blasting operations. Not shown on the table is that the only responsibility given 100 percent to the blaster is shot loading and initiation system connection. Otherwise, the blaster has very little responsibility.

In over 90 percent of all quarries, regardless of size, the foreman is responsible for solving loading problems, initiating the blast, handling misfires, cancelling loading operations because of hazardous conditions, and setting the time for the blast. It is interesting to note from the table that many surface mines give more responsibility to their explosives supplier than they do to their blaster.

5.5.5 Special Problems Encountered in Blasting

Blasting problems are similar to those of surface coal mining:

- Few, if any, companies require formal blaster training. Most blasters learn on the job.
- Some large multi-quarry operations meet for blasting seminars to study handling of misfires, the use of electric instruments, delay patterns, sequential timing, and planning techniques. Emphasis is placed mainly on loading the blast hole. Little emphasis is placed on blast design since this is usually the duty of engineers or superintendents.
- Loading crews are usually personnel with limited experience and are untrained in handling explosives.
- Vibration and noise are the main problems of quarries.
- Geological causes of fly rock and weak burdens or seams are misunderstood by the blaster.
- Few blasters have an understanding of explosive engineering and they rely, therefore, upon experience alone for blast design.

TABLE 9. - Crushed stone quarries and nonmetal mines: blasting personnel responsibility, percent of total

	Blasting Operation	Blast Design	Type Explosive Used	Blasting Safety	Blaster Training	Blast Loading & Firing
Superintendent	58	57	53	52	55	
Foreman	17	13	16	19	17	
Blaster	8	10	11.5	7.5	8.7	100
Safety Department				3	1.7	
Plant Manager	4	5	6	3	3	
Engineering Department	3	3	3	3	3	
Owner	2	2	1.5	2	1.7	
Supplier	8	10	9	10.5	9.7	

- Special problems encountered in this type of blasting are loading wet and mud filled holes, partially blocked holes, weak burdens, excessive burdens, and misfires.

5.5.6 Need to Improve Safety and Efficiency

The need to improve safety is evident from figures published by the Health Safety Analysis Center in Denver, Colorado. From 1975 through 1977 there were 108 blasting-associated accidents in metal and nonmetal surface and underground mines. There were 11 types of blasting-associated accidents:

- Premature detonation
- Tamping accidents
- Misfire or digging explosives
- Breakthrough pillar or rib
- Shotgun blasts
- Fly rock
- Suffocation by fumes
- Cap or detonator accidents
- Transportation and handling
- Insufficient warning
- "All other"

Forty-four percent of these accidents were a result of fly rock.

In a paper written by Richard W. Watson (Research Supervisor, Explosives, Pittsburgh Mining and Safety Research Center, Pittsburgh, Pennsylvania) and Julius Roth (Consulting Management Mining Associates, Los Altos, California), entitled "A Review of Blasting Accidents in Surface Mining," and presented at the Fourth Conference of Explosives and Blasting Technique in New Orleans, Louisiana, sponsored by the Society of Explosive Engineers, it was shown that although the number of accidents in surface nonmetal quarries was only one-third as great as that in coal stripping, it was still much greater than the number of accidents in surface metal mines.

5.5.7 Environmental Problems Associated with Blasting

Environmental problems associated with the use of explosives have been increasing as more explosives are being used and more people are involved with the suburban sprawl. Another factor is that people are more willing to complalin when their comfort is being disturbed. Mines and quarries that just a few years ago were isolated from communities now find themselves surrounded by residential, commercial and industrial developments. Our highway systems also have expanded and the rights of way invade the blasting areas.

Some of the strains placed on the public are blast effect, real or imagined, dust from the operations, truck traffic and the continuous noise of drilling or crushing. Sometimes the noxious fumes from blasting can be carried into the inhabited areas.

Explosives consumers, manufacturers and the regulatory agencies all have been conscious of the environmental impact and have devoted time and money to understanding and improving the adverse efforts of blasting. Much has been learned about noise and vibration and by the proper use of modern techniques and delay systems will undoubtedly reduce the disturbance of the environment.

Noise is the main portion of the blast wave that is produced by unconfirmed explosives or by the indirect action of confining material subjection to the explosive loading. Depending on many factors such as atmospheric conditions, loading techniques, distance from the blasting site and type of mining being conducted, the air blast can cause damage to people and property.

Ground vibrations can cause damage to structures or to underground water. Contamination of underground water may occur by altering the natural flow, and thus redirect the stream into an area where contamination can occur. By the use of sesmic instruments, the ground vibration can be controlled with the proper use of explosives and delay patterns.

5.6 Surface Metal Mining

5.6.1 Introduction

There are 2,186 blasters employed by 279 metal mines which produce an excess of 88 percent of the total metal mined in the United States. These figures account for approximately 11 percent of total explosives consumption.

Approximately 19 percent of the 450 million pounds of explosives used in metal mining was used in states requiring certification of blasters.

By dividing the mines into three size catagories we see that in the small operations producing less that 1000 tons of blasted material or less per day (approximately 250 linear feet of borehole) the blasting crew would consist of a foreman and two blasters. The medium sized mines producing up to 50,000 tons per day (approximately 1250 linear feet of borehole) would require a blasting crew of one foreman and three blasters. The larger operations which require approximately 25,000 linear feet of borehole would require a blasting crew of two engineers, 1 blasting foreman, 5 blasters and 17 crew members.

5.6.2 Mining Organizations

The Interstate Mining Concept, an affiliation of 14 states, had an executive committee meeting in April of 1979 and unanimously passed a resolution urging no surface mining law for noncoal mines. Resolutions to the White House, Congress, and all 50 state governors will be distributed.

5.6.3 Classes of Blasting Required

The classes of blasting required in this industry are:

- Stripping of the waste material over the primary ore body.
- Primary blasting to produce the material.
- Secondary blasting.

5.6.4 Job Description

Very few companies have a formal job description for blasting personnel. We were unable to obtain a copy of a job description. However, the blaster's job can be described according to size of the operation. In large operations, the duties of the blaster are limited to loading the explosives according to plans issued by the engineering department. The initiation system is connected according to the blasting plan. Shot guarding and initiation of the blast are the responsibility of the blaster. In medium size operations in addition to the above the duties of the blaster may include blast design. In small operations the blaster is responsible for the entire blasting operation.

5.6.5 Responsibility and Authority Given to Blasting Personnel

The responsibility and authority given to blasting personnel in surface metal mines are similar to those in surface nonmetal mines, and are distributed among the superintendent, the foreman, engineer, blaster, safety department, and mine manager.

The overall responsibility of blasting personnel in surface metal mines producing up to 50,000 tons per day of ore and waste is shown in Table 10 as Percent of the Mines. Again, 100 percent of the mines give the blaster responsibility for explosives loading. Only 4 percent give the blaster responsibility for blast design.

In larger surface metal mines producing an excess of 50,000 tons per day, the blasting programs are complex and thorough and many people participate in the blasting program and responsibility. Blast patterns, energy requirements, hole diameter, burdens, spacing, and explosive ratios are all discussed at the three levels of responsibility: production, engineering and management. Most operations have drill and blast foremen with responsibility in hole diameters and loading of explosives. The engineering department is usually responsible for the explosive distribution calculations. Plant technical services are responsible for blast delay pattern design but the ultimate blasting responsibility is that of the mine superintendent and/or the general manager.

5.6.6 Special Problems Encountered in Blasting

Since the larger companies are required to produce large quantities of material the size of the blasts can involve 200,000 lbs. or more of explosives in a single blast. This requires very careful loading of delay design to prevent noise and vibration. With large shots, dust can be a problem and must be controlled. Care must be exercised to prevent damage to underground streams. Vibration can be of great concern in the large blasts and must be controlled and monitored. Fumes from the blast must be recognized as a potential problem.

In addition to the above the smaller size operations have the problem of people constantly moving closer to their operations and thus the above problems are intensified.

The geology of the material being produced is extremely important and can influence both safety and efficiency.

TABLE 10. - Surface metal mines: blasting responsibility as percent of total mines producing up to 50 million tons per year

	Blasting Operation	Blast Design	Type Explosive Used	Blasting Safety	Blaster Training	Blast Loading & Firing
Superintendent	70	50	71	50	51	
Foreman	20	30	1	8	16	
Engineer	10	16	8	25	25	
Blaster		4	5	4		100
Safety Department			10	13	8	
Mine Engineer			5			

5.6.7 Need to Improve Safety and Efficiency

The surface metal mining industry has had fewer injury-producing accidents related to blasting than other surface mines. From 1973-1976 the number of injury-producing accidents from blasting operations in surface metal mines averaged about one-quarter of that of surface quarries and nonmetal mines and approximately one-fifth of that of coal stripping operations. Although blasting-oriented accidents reported to the Health Safety Analysis Center in Denver, Colorado, do not separate metal and nonmetal mines, accidents were reported in the following categories:

- Premature detonation
- Misfires from digging into explosives
- Fly rock
- Fumes
- Transportation and handling
- Insufficient warning and shot guarding system
- "All other"

It is interesting to note that surface metal mines reported no injury-producing, blasting-oriented accidents in 1976.

5.6.8 Environmental Problems

Environmental problems associated with blasting in this industry are:

- Fly rock
- Smoke and dust
- Vibrations and air blast

Problems encountered in blasting operations are the same as those described for surface coal mines. Problems encountered in smaller surface metal mines (those producing less than 50,000 tons per day) are not unlike those encountered in other surface blasting operations.

5.6.9 Licensing Requirements

Recommended licensing requirements for blasters in the surface mining industry.

Blasters in any surface mining industry should be given an examination to demonstrate expertise in the following:

- Types of explosives used and under what conditions.
- Properties and characteristics of the explosives which will be used.
- Initiation systems used.
- Testing electrical systems with galvano- meter including what it measures and how to calculate the resistance.
- Also need something on nonelectrical systems.
- Types of primers used and what primers are needed for various types of explosives.
- The greatest possible emphasis should be placed on blast design and should include the following:

  a. calculations of powder factor

  b. crest and toe burdens

  c. backbreak and backshatter

  d. delayed patterns

  e. burden/spacing calculations

  f. cutoffs, causes and prevention

6. TYPES OF TRAINING

6.1 Introduction

Presently, the Office of Surface Mining is proposing regulations that will provide training and certification programs for blasters and blasting crew members. The Mine Safety and Health Administration requires hazard recognition training related to blasting and work task assignments for untrained blasters.

Several states are reviewing present blasting certification requirements in anticipation of updating their existing regulations.

These regulatory agencies activities have caused many new blaster training programs to appear on the market. The new type of traning varies from simple slides with a sentence or two of description to a complete blaster training seminar. Some of the seminars are put together and presented by people who have had no experience in blasting. Others consist of laboratory data and reference material from textbooks.

6.2 Academic Training Levels

As stated, a large number of operations do not require formal training. Therefore, most blasters receive their training on the job. This training is usually at grammar school level with the exception of several seminars that teach blasting theory or use laboratory data.

6.3 Methods of Instruction

There are four basic methods of instruction used:

- Slide and tape
- Modified program instruction
- Lectures supplemented with slides and motion pictures
- Hands-on demonstration

6.3.1 Slide and Tape Presentations

The majority of these training sessions are to familiarize the student with one facet of blasting training. The material is usually presented with the goal of being understood by grammar school level students and consists of slides giving the visual presentation and the oral description by either tape or a written manuscript.

This is an effective method of teaching one subject at a time. However, if the intent is to train a blaster piecemeal, the time span between sessions is usually too long for good subject matter retention.

6.3.2 Modified Programmed Instruction

Validated programmed instruction that is self-taught and self-paced is one of the most effective methods of training a large number of people. Slides and motion picture are used to supplement the written material. There are no well written and validated blasting courses available and they must be prepared by someone who is experienced in this type of training.

6.3.3 Lectures Supplemented with Slides and Motion Pictures

Lecture material is the most flexible and easiest to revise or update. At the same time, an effective lecturer who has a good experience background can tailor the material to any level necessary to reach the audience. Properly trained lectures must be used to avoid variation in content and requires frequent updating of the art.

6.3.4 Hands-on Demonstration

Hands-on demonstration is very effective. However, with a hazardous subject such as blasting, the number of people that can be safely trained is limited. The range of knowledge necessary to adequately train a blaster is so wide and varied that hands-on training does not appear feasible for a large number of blasters.

6.4 Training Cost

No-cost training is provided in some states. However, commercial training varies from $4-21 per hour, thereby making it difficult to find a base where one method can be compared to another.

6.5 Source of Training

Most states that provide training use a community college near the center of the mining activity, while commercial training courses are usually held at hotels or motels throughout the United States.

The Appendix is a list and brief description of the blaster training courses that are available. Every attempt was made to make this as complete as possible.

6.6 Background of Course Attendees

Blasting seminar and training course attendees are usually blasters, members of blasting crews, blasting foremen, mine superintendents, mine owners, insurance inspectors, MSHA inspectors, OSHA inspectors, OSM inspectors, members of various federal agencies that conduct or supervise blasting operations, and members of the armed forces.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

Based on the results of this survey and the information developed the following may be concluded:

- Regulations for blasters performing the same type of work are necessary.
- Certification should encompass responsibility, safety, job skills, knowledge, protection of the environment, and specified job capabilities depending upon the type of blasting performed.
- Certification procedures must be validated.
- Enforcement methods and procedures will require consolidation of federal and state requirements on a state-by-state basis.
- Age requirements for blasters must be determined.
- Class of license can best be defined by federal fundamental blaster requirements which will be supplemented by individual state requirements depending upon the type of blasting to be performed.
- Length and type of previous experience for each type of blaster should be determined by validation.
- Renewal procedures for certification must be determined through validation studies.
- Training of the blasters-in-charge and blasting helpers must encompass knowledge of types of explosives, safe handling and storage, methods of accidental or intentional initiation of explosives, electric and nonelectric initiation, measurement procedures, calculation of amount and location of charges, fly rock control, noise and vibration, shot guarding, and local, state and federal regulations.
- Most blasters are needed on the job; therefore, travel for training is practically nonexistent. Training must be available close to the job site. This will require development of flexible types of training and provide material for the blaster's future reference.
- Instructors for training explosive users must have practical blasting experience as well as the ability to conduct training courses.

7.2 Recommendations

Based on the information developed by this survey and the above conclusions, the following recommendations are made:

- Validate blasting requirements for certification for each type of blasting conducted.

- Define training requirements and content of flexible training systems that will encompass all types of blasting for certification.

- The appropriate federal agencies should provide validated and uniform certification requirements for each type of blasting operation.

- The various mining organization should become more involved with industry recommendations, job descriptions, certification requirements, certification renewal procedures and methods of enforcement. Safety and production goals should be established. The authority and responsibility of blasting personnel should be defined. Environmental standards for protection of land, water and air should be established.

- Until federal or state certification procedures have been established, an interim certification should be supplied by the operator.

- Blasting personnel should be better trained so that more responsbility and authority can be vested with them and infractions of regulations can be made the blaster's responsibility.

- Establish blasting certification trainers requirements based on practical experience and ability to instruct personnel.

- Establish minimum age requirements and amount of on-the-job experience needed for certification of blasting personnel.

- Establish three levels of certification:

  (1) Blaster-in-Charge. The individual assigned by the operator for the blasting responsibility defined by a job description.

  (2) Blaster. The individual learning the art of blasting by requiring the on-the-job experience under the supervision of the blaster in charge.

(3) Blasters Helpers. The individual who carries out work assignments made by the blaster-in-charge and under his supervision.

APPENDIX

Surface Mining Reclamation Commission of Alabama

Forty hours of classroom lecture, laboratory demonstration, field work for certification of surface coal mine blasters. The course is held at Walker State Technical College, Sumiton, Alabama 35148. The fee is $100 which covers tuition, course materials, meals and a calculator.

Community College of Allegheny and Garrett Counties in Maryland

Forty-five-hour program of instruction for certification of surface coal mine blasters. Total cost - $50.

The Southwest Virginia Community College at Richmond, Virginia

Twenty-four-hour course for certification as a blaster. Total cost - $17.

The Commonwealth of Kentucky, Department of Mines and Minerals at Laffoon Street, Madisonville, Kentucky 42431

Fifty-hour course for blaster certification. Total cost - $10 to $25.

Pikeville College in Pikeville, Kentucky

One-day seminar on blasting. No charge.

Indiana Vocational Technical College, P.O. Box 760, Terre Haute, Indiana 47802

Sixteen-hour blasting seminar. Cost - No charge to $100 per day.

Oklahoma Mine Training Institute, a Project of Southeastern Oklahoma State University, Oklahoma State Department of Mines, Krebs, Oklahoma

Forty-hour course for surface and underground blasters. No charge.

Ohio Laborers Training and Upgrading Trust Fund Conducted at Belmont Technical College, Millwood Training Site, Route #1, Howard, Ohio

Forty-hour blasting seminar. No charge.

Illinois Laborer and Contractors - A Union Supported Seminar Conducted at Mount Spring, Illinois

Forty-hour seminar for certification. No charge.

Vermont Construction Training Council, P.O. Box 750, Montpelier, Vermont 05602

Twelve-hour seminar. No charge.

Remark Construction Training Council, Burlington, Vermont

Eighteen-hour seminar. No charge.

Bob DeWire & Associates, Inc., Dover, Ohio

Twenty-four-hour seminar for blaster certification. No stated price.

Don Harris & Associates, 225 Bellham Way, Hayward, California 94541

Sixteen-hour workshop. No stated price.

Precision Blasting Service, 6990 Summers Road, P.O. Box 189, Montville, Ohio 44064

Twenty-four-hour seminar. Tuition - $395.

Safety Consulting Service, Merchants National Bank Building, Topeka, Kansas 66612

Blasting seminar. No stated price.

Kellogg Corporation, 5601 South Broadway, Suite 400, Littleton, Colorado 80121

Three-day blasting seminar. Tuition - $300.

E. I. du Pont de Nemours & Co. (Inc.), Applied Technology Division, Clayton Building, Concord Plaza, Wilmington, Delaware 19810

Twenty-two-hour blasting and explosives training. Tuition - $395.

Twenty-two-hour surface blasting. Tuition - $460.

West Virginia Mining Extension Service, Morgantown, West Virginia

Slide and tape program. Cost - $90.

Explosives Training Manual, ABA Publishing Company, 406 West 32nd Street, Wilmington, Delaware 19802
$10 Each