

General

EXPLOSIVES AND BLASTING AGENTS INDUSTRIAL COMMISSION

Chapter Ind 5

PART I

GENERAL

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History: Chapter Ind 5 as it existed on February 28, 1965 was repealed, and a new chapter Ind 5 was created effective March 1, 1965.

Ind 5.01 Scope. (1) These rules apply to the storage, handling and transportation of explosives, but do not apply to the interstate transportation of explosives. This code shall not apply to the military, naval forces, federal agencies, state militia, police or fire department of any community provided they are acting within their official capacity and in the proper performance of their normal or emergency duties.

(2) Whenever the term "explosives" is used in this code, it shall be construed as including blasting agents, unless a conflicting rule is contained in Part III or a specific exemption is made.

(3) When explosive or explosive items are for the United States military forces, whether they are in the process of being manufactured, handled, shipped, stored, etc., the safety rules as established herein *SHALL NOT* apply. In these cases, the safety and security requirements, rules and other regulating specifications of the participating military branch shall apply.

Note: Applicable special rules may be issued by the industrial commission when deemed necessary.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.02 Construction of rules. Failure on part of superintendents, foremen, bosses, and other persons having control of any place of employment or of any employee and of any operations, to carry out any duty prescribed in these rules is violation of such rule by the employer.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.03 Definitions. (1) **AMMONIUM NITRATE.** A chemical compound represented by the formula NH_4NO_3 .

(2) **AN-FO.** An abbreviation for ammonium nitrate and fuel oil mixture.

(3) **APPROVED.** The term "approved" shall be held to mean approved by the industrial commission.

(4) **BARRICADE.** The term "barricade" when used in these rules shall be held to mean natural features of the ground, such as hills, timber of sufficient density that the surrounding exposures can not be seen when the trees are bare of leaves, or an "efficient artificial barricade" consisting of an artificial mound or properly revetted wall of earth of a minimum thickness of 3 feet at the top.

(5) **BLASTER.** The term "blaster" shall mean any person or persons holding a license issued by the industrial commission.

(6) **BLASTING.** The term "blasting" shall denote a method of loosening, moving or shattering masses of solid matter by use of explosive compounds.

(7) **BLASTING AGENT.** The term "blasting agent" shall denote any material or mixture consisting of a fuel and oxidizer intended for blasting, not otherwise classified as an explosive and in which none of the ingredients is classified as an explosive (provided that the material or mixture cannot be detonated by a No. 8 test blasting cap under the conditions specified for the cap sensitivity test).

(8) **BLASTING CAP.** The term "blasting cap" means a small metal tube or shell closed at one end, loaded with a detonating charge, whose minimum strength shall be equivalent to one gram of 80% mercury fulminate and 20% potassium chlorate mixture, used in detonating high explosives. One end of this tube shall be opened for the insertion of safety fuse.

(9) **BLASTING MAT.** The term "blasting mat" shall mean a heavy mat of woven rope, steel wire, or chain, or a mat improvised from timber, poles, brush or other materials, placed over loaded holes, tending to minimize the amount of rock and other debris that might be thrown into the air.

(10) **BUILDING.** The term "building" when used in the American Table of Distances shall mean and include only a building occupied in whole or in part as a habitation for human beings, or any church, schoolhouse, railroad station, airport terminal, mercantile building, garage, factory, or other building where people are accustomed to assemble, except operating buildings. (See Wis. Adm. Code section Ind 5.06 (6).)

(11) **CAP SENSITIVITY TEST.** The "cap sensitivity test" is a simple method of measuring the initiation sensitivity of a blasting agent. A one quart, cylindrical, cardboard carton of the type commonly used for bulk ice cream, is filled with the blasting agent to be tested and packed to the approximate shipping package density. A commercial No. 8 blasting cap is inserted into the center of the blasting agent through a hole in the top of the carton. The charge is then placed on soft ground in an isolated area with adequate protection for personnel and the blasting cap fired. If a crater is formed in the soft ground of sufficient size to indicate that any part of the blasting agent detonated, the material is cap-sensitive and must be treated as a high explosive.

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(12) **COMMUNITY.** The term "community" shall mean cities, villages, and built-up inhabited areas including any residence, motel or business and industrial establishments which may be in an unincorporated area.

(13) **CONVEY.** The term "convey" shall mean to bear or carry explosives from one place to another on the premises of the user of explosives.

(14) **DELAY ELECTRIC BLASTING CAP.** The term "delay electric blasting cap" means an electric blasting cap with a timing element interposed between the ignition head and the detonating compound.

(15) **DETONATOR.** The term "detonator" means any kind of blasting cap used for detonating a high explosive.

(16) **ELECTRIC BLASTING CAP.** The term "electric blasting cap" means a blasting cap with an ignition head inserted into and sealed in the open end with 2 projecting wires for electric firing.

(17) **EXPLOSIVE.** For the purpose of these rules, an "explosive" is defined as any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion, i.e., with substantially instantaneous release of both gas and heat, unless such compound, mixture or device is otherwise classified by the industrial commission of Wisconsin.

(18) **FOREMAN.** The term "foreman" when used in these rules shall mean a person who at any one time is charged with the immediate direction of the work.

(19) **HIGHWAY.** The term "highway" when used in these rules shall be held to mean and include any public street, public alley or public road.

(20) **MAGAZINE.** The term "magazine" means any building or other structure of approved construction used for the storage of explosives.

(21) **NITRO-CARBO-NITRATE.** A blasting agent that has been classified as a nitro-carbo-nitrate under interstate commerce commission regulations and which is packaged and shipped in compliance with these regulations.

(22) **PERSON.** The term "person" when used in these rules shall be held to mean and include a firm or body corporate as well as natural persons.

(23) **PRIMER.** The term "primer" when used in these rules shall mean a capped fuse, electric detonator, or any other detonating device inserted in or attached to a cartridge of explosive.

(24) **RAILROAD.** The term "railroad" when used in the American Table of Distances shall mean and include any steam, electric or other railroad tracks which carry passengers for hire.

(25) **SUPERINTENDENT.** The term "superintendent" when used in these rules shall mean the person having a general supervision of the work.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.04 Storage of explosives within communities. (1) No dynamite of more than 60% rated strength shall be kept or stored for sale in any building, storeroom, wareroom, or in or on any premises within the limits of any city, village, or community.

(2) Anyone storing explosives or detonators within any community shall notify the chief of the fire department of the place, extent and manner of such storage.

(3) Not more than a total quantity of 50 pounds of dynamite for sale or use shall be kept or stored in any building or on any premises of any city, village, or community. Such 50 pounds or less of such dynamite shall be kept and stored in a magazine made of fire-resistive materials or of wood covered with sheet iron and mounted on wheels or skids, and kept locked except when opened necessarily for use by authorized persons. Such magazine shall be plainly marked EXPLOSIVES, and located within a building, on the floor nearest the ground level, and within 10 feet from an outside entrance and 10 feet from any other magazine.

(4) Not more than a total quantity of 50 pounds of gunpowder and black powder may be kept or stored in any building or on any premises of any city, village, or community. Such powder shall be kept in closed metal canisters placed in a separate magazine constructed and located as described in subsection (2).

(5) Modern smokeless powder, generally classified as propellant powder or sometimes as flammable solids, and including double base powders, for ammunition loading shall be subject to the following regulations:

(a) A maximum of 300 pounds may be stored in original containers in a locked cabinet painted red and labeled SMOKELESS POWDER STORAGE in letters at least 4 inches high.

(b) The regular capacity of the magazine shall be painted on the outside.

(c) The location of the magazine shall be known to the local fire department.

(d) Ammunition primers shall not be stored in the same locked cabinet.

(e) No smoking shall be permitted and fire extinguisher requirements for commercial areas shall be complied with when shells are loaded in public areas. All spillage shall be swept up and destroyed.

(f) Public demonstrations of loading equipment and display containers shall use a substitute non-flammable material in place of the propellant powder.

(g) Quantities in excess of 300 pounds shall be kept in a magazine separated from inhabited buildings and highways in accordance with the following table:

| Quantity | Distance |
|-------------------------|----------|
| Up to 1,000 pounds..... | 50 feet |
| 5,000 pounds..... | 75 feet |
| 10,000 pounds..... | 100 feet |

Over 10,000 pounds shall be stored in explosives magazine in accordance with the American Table of Distances for Storage of Explosives.

(h) The magazine shall be fire and theft resistant, free of grit and rubbish. No smoking or open flames permitted.

(i) Interstate transportation of these propellant powders shall be according to I.C.C. regulations. All intrastate transportation of quantities over 300 pounds shall comply with the regulations for transporting explosives.

(6) Not more than 7,000 detonators may be kept or stored in any

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building or premises of any community. *In no case shall explosives and detonators be kept in the same magazine.*

(7) Detonators shall be kept or stored in a similar, but separate magazine at least 10 feet away from any other magazine.

(8) Blasting operations within a community may store up to a maximum of 24 hours explosives requirements, but where such 24 hours requirements exceeds 50 pounds, written permission shall be obtained in advance from the industrial commission and the explosives shall be stored in a magazine as described in Wis. Adm. Code section Ind 5.08.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.05 Storage outside the limits of cities and villages. All explosives in excess of the supply authorized to be stored in any building, storeroom, wareroom, or on any premises within the limits of any city, village, or community shall be kept or stored in specially constructed magazines located outside the limits of cities and villages according to the American Table of Distances. This rule shall not apply where the requirements of this table can be met within such limits.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.06 Location of magazines. (1) All magazines in which explosives are kept or stored shall be located at a distance from buildings, railroads and highways in conformity with the following American Table of Distances, unless otherwise authorized by the industrial commission.

(2) The American Table of Distances governing the keeping and storage of explosives is as follows:

AMERICAN TABLE OF DISTANCES

| EXPLOSIVES | | DISTANCES IN FEET (UNBARRICADED) | | | |
|----------------|--------------------|-------------------------------------|-----------------------|--------------------|----------------------------|
| Pounds Over | Pounds Not Over | Inhabited Buildings | Passenger Railways | Public Highways | Separation of Magazines |
| 2 | 5 | 140 | 60 | 60 | 12 |
| 5 | 10 | 180 | 70 | 70 | 16 |
| 10 | 20 | 220 | 90 | 90 | 20 |
| 20 | 30 | 250 | 100 | 100 | 22 |
| 30 | 40 | 280 | 110 | 110 | 24 |
| 40 | 50 | 300 | 120 | 120 | 28 |
| 50 | 75 | 340 | 140 | 140 | 30 |
| 75 | 100 | 380 | 150 | 150 | 32 |
| 100 | 125 | 400 | 160 | 160 | 36 |
| 125 | 150 | 430 | 170 | 170 | 38 |
| 150 | 200 | 470 | 190 | 190 | 42 |
| 200 | 250 | 510 | 210 | 210 | 46 |
| 250 | 300 | 540 | 220 | 220 | 48 |
| 300 | 400 | 590 | 240 | 240 | 54 |
| 400 | 500 | 640 | 260 | 260 | 58 |
| 500 | 600 | 680 | 270 | 270 | 62 |
| 600 | 700 | 710 | 290 | 290 | 64 |
| 700 | 800 | 750 | 300 | 300 | 66 |
| 800 | 900 | 780 | 310 | 310 | 70 |
| 900 | 1,000 | 800 | 320 | 320 | 72 |
| 1,000 | 1,200 | 850 | 340 | 330 | 78 |
| 1,200 | 1,400 | 900 | 360 | 340 | 82 |
| 1,400 | 1,600 | 940 | 380 | 350 | 86 |
| 1,600 | 1,800 | 980 | 390 | 360 | 88 |
| 1,800 | 2,000 | 1,010 | 410 | 370 | 90 |

AMERICAN TABLE OF DISTANCES—Continued

| EXPLOSIVES | | DISTANCES IN FEET (UNBARRICADED) | | | |
|----------------|--------------------|-------------------------------------|-----------------------|--------------------|----------------------------|
| Pounds Over | Pounds Not Over | Inhabited Buildings | Passenger Railways | Public Highways | Separation of Magazines |
| 2,000 | 2,500 | 1,090 | 440 | 380 | 98 |
| 2,500 | 3,000 | 1,160 | 470 | 390 | 104 |
| 3,000 | 4,000 | 1,270 | 510 | 420 | 116 |
| 4,000 | 5,000 | 1,370 | 550 | 450 | 122 |
| 5,000 | 6,000 | 1,460 | 590 | 470 | 130 |
| 6,000 | 7,000 | 1,570 | 620 | 490 | 136 |
| 7,000 | 8,000 | 1,600 | 640 | 500 | 144 |
| 8,000 | 9,000 | 1,670 | 670 | 510 | 150 |
| 9,000 | 10,000 | 1,730 | 690 | 520 | 156 |
| 10,000 | 12,000 | 1,750 | 740 | 540 | 164 |
| 12,000 | 14,000 | 1,770 | 780 | 550 | 174 |
| 14,000 | 16,000 | 1,800 | 810 | 560 | 180 |
| 16,000 | 18,000 | 1,880 | 840 | 570 | 188 |
| 18,000 | 20,000 | 1,950 | 870 | 580 | 196 |
| 20,000 | 25,000 | 2,110 | 940 | 630 | 210 |
| 25,000 | 30,000 | 2,260 | 1,000 | 680 | 224 |
| 30,000 | 35,000 | 2,410 | 1,050 | 720 | 238 |
| 35,000 | 40,000 | 2,550 | 1,100 | 760 | 248 |
| 40,000 | 45,000 | 2,680 | 1,140 | 800 | 258 |
| 45,000 | 50,000 | 2,800 | 1,180 | 840 | 270 |
| 50,000 | 55,000 | 2,920 | 1,220 | 880 | 280 |
| 55,000 | 60,000 | 3,030 | 1,260 | 910 | 290 |
| 60,000 | 65,000 | 3,130 | 1,290 | 940 | 300 |
| 65,000 | 70,000 | 3,220 | 1,320 | 970 | 310 |
| 70,000 | 75,000 | 3,310 | 1,350 | 1,000 | 320 |

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AMERICAN TABLE OF DISTANCES—Continued

| EXPLOSIVES | | DISTANCES IN FEET (UNBARRICADED) | | | |
|----------------|----------------------------------|-------------------------------------|-----------------------|--------------------|----------------------------|
| Pounds Over | Pounds Not Over | Inhabited Buildings | Passenger Railways | Public Highways | Separation of Magazines |
| 75,000 | 80,000 | 3,390 | 1,380 | 1,020 | 330 |
| 80,000 | 85,000 | 3,460 | 1,410 | 1,040 | 340 |
| 85,000 | 90,000 | 3,520 | 1,440 | 1,060 | 350 |
| 90,000 | 95,000 | 3,580 | 1,460 | 1,080 | 360 |
| 95,000 | 100,000 | 3,630 | 1,490 | 1,090 | 370 |
| 100,000 | 110,000 | 3,670 | 1,540 | 1,100 | 390 |
| 110,000 | 120,000 | 3,710 | 1,580 | 1,110 | 410 |
| 120,000 | 130,000 | 3,750 | 1,620 | 1,120 | 430 |
| 130,000 | 140,000 | 3,780 | 1,670 | 1,130 | 450 |
| 140,000 | 150,000 | 3,800 | 1,700 | 1,140 | 470 |
| 150,000 | 160,000 | 3,870 | 1,740 | 1,160 | 490 |
| 160,000 | 170,000 | 3,930 | 1,780 | 1,180 | 510 |
| 170,000 | 180,000 | 3,980 | 1,810 | 1,200 | 530 |
| 180,000 | 190,000 | 4,020 | 1,840 | 1,210 | 550 |
| 190,000 | 200,000 | 4,060 | 1,870 | 1,220 | 570 |
| 200,000 | 210,000 | 4,155 | 1,910 | 1,240 | 590 |
| 210,000 | 213,000 | 4,200 | 1,960 | 1,270 | 630 |
| 230,000 | 250,000 | 4,310 | 2,020 | 1,300 | 670 |
| 250,000 | 275,000 | 4,430 | 2,080 | 1,340 | 720 |
| 275,000 | 300,000 | 4,550 | 2,150 | 1,380 | 770 |
| | Maximum Quantity Permitted | | | | |

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(a) *Maximum allowed.* No quantity in excess of 300,000 pounds, or in the case of blasting caps, no number in excess of 20,000,000 caps shall be kept or stored in any magazine in this state.

(b) *Blasting caps. Quantity equivalent to weight.* 1,000 caps shall be considered as equivalent to 1½ pounds of explosives for computing explosives content of detonators in a magazine.

(3) Magazines in which more than 50 pounds of explosives are kept and stored shall be detached from other structures.

(4) When 2 or more magazines are located on the same property, each magazine must comply with the minimum distances specified from inhabited buildings, railways, and highways, and in addition they shall be separated from each other by not less than the distances shown for "Separation of Magazines." The magazine with the greater quantity of explosives shall govern the separating distance, except that the quantity of explosives contained in cap magazines shall govern in regard to the spacing of said cap magazines from magazines containing other explosives. If any 2 or more magazines are separated from each other by less than the specified "Separation of Magazines" distances, then such 2 or more magazines, as a group, must be considered as one magazine, and the total quantity of explosives stored in such group, must be treated as if stored in a single magazine located on the site of any magazine of the group, and must comply with the minimum distances specified from other magazines, inhabited buildings, railways, and highways.

(5) Whenever a magazine is screened from buildings, railroads, highways, or other magazines, either by natural features of the ground, or by a barricade as described in Wis. Adm. Code section Ind 5.03 (4), of such height that any straight line drawn from the top of any side wall of the magazine to any part of the building to be protected will pass through such intervening natural or efficient artificial barricade, and any straight line drawn from the top of any side wall of the magazine, to any point 12 feet above the center of the railroad or highway to be protected, will pass through such intervening barricade, the applicable distances, as prescribed by the American Table of Distances in subsection (2) may be reduced one-half.

(6) Explosives magazines, except detonator magazines as provided in Wis. Adm. Code sections Ind 5.07(5) and (6), shall not be located nearer than 200 feet from regular operating places of any mine or quarry, or from any mine shaft, tunnel, or slope opening at the surface. *The American Table of Distances shall not apply at these places.*

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.07 Construction and maintenance of magazines. Storage of explosives. (1) Magazines for storing high explosives, except detonators, shall be constructed of brick, poured concrete, concrete block or hollow clay tile (walls not less than 6 inches thick) with openings filled with sand or screenings (less than ¾ inch), or of metal, lined with 4 inches of brick or hard wood. For magazines built of metal heavier than 14 gauge, the equivalent ratio of metal to the wood lining shall be ¼ inch of metal to one inch of wood. Wood frame construction may be used if the construction consists of walls 6 inches apart filled from sill to plate with sand and the structure completely surfaced on the outside with not less than 26 gauge metal or an

equivalent fire-resistive material, such as asbestos cement sheathing or shingles.

(2) "Igloo" type magazines are acceptable if constructed according to standards equivalent to those described in this section.

(3) The doors shall be constructed of 3/16 inch thick boiler plate lined with 3 layers of 7/8 inch hardwood, or if metal is less than 3/16 inch thick, lined with 4 layers of 7/8 inch hardwood or equivalent.

(4) A bullet-resistant ceiling consisting of a tray of sand 4 inches thick or equivalent, shall be provided at the level of the plate line if the dynamite can be shot into through the roof of the magazine. A 2-inch space shall be provided between the tray and the walls of the building for ventilation.

(5) No detonators shall be stored in any magazine containing other explosives. Buildings for storage of detonators and blasting supplies, or black powder magazines, shall be constructed of metal and lined, or of wood construction covered with metal or fire-resistive material. The door shall be similarly constructed and kept locked.

(6) A waterproof box of equivalent construction, or as described in Wis. Adm. Code section Ind 5.08, painted red and conspicuously marked EXPLOSIVES shall be considered as complying with this rule for storage of not more than 7,000 detonators. Such storage may be indoors. For more than 7,000 detonators use the American Table of Distances.

(7) All nails in the interior of the magazines shall be countersunk.

(8) Each magazine shall be ventilated and the vent openings shall be screened to prevent sparks of fire passing through them, except that magazines containing only black powder may be constructed without openings for ventilation. Ventilation openings shall be located at the top of the magazines and below the floor line, and a 2-inch opening shall be provided between the floor and the wall, except at the door, for complete air circulation. Where magazines do not have a ceiling, the vent opening shall be protected by a deflector.

(9) Magazine doors shall be kept closed and locked except when opened for transacting business.

(10) The ground around the magazines, within 25 feet in all directions, shall be kept free from rubbish, dead grass, shrubbery or other flammable materials.

(11) Signs with the words EXPLOSIVES—KEEP OFF legibly printed thereon in letters approximately 3 inches high, shall be posted and maintained at all times on the premises on which the magazines are located. Such signs shall be located so that a bullet fired directly at them will not strike any magazine.

(12) Magazines shall be kept clean and dry.

(13) Magazines shall be in charge of a person especially appointed for the purpose, who shall have in his possession the keys of the magazine and shall be responsible for the safe storage of explosives contained therein.

(14) Explosives shall not be handled near open lights, fire, flame, or sparks. Only a safety electric flashlight or safety electric lantern shall be used in a magazine if artificial light is needed. Smoking or carrying matches, lighters or other flame-producing devices shall not be permitted in a magazine.

(15) Fibre, rubber, or wooden tools shall be used to open explo-

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sives cases except that "slitters" may be used to open fibre-board cases. Cases shall be opened outside the magazine.

(16) No flammable, except wood wedges and fibre, rubber or wooden mallets, nor any sparking metal tools or implements, shall be kept or stored in any magazine containing explosives.

(17) Explosives shall be stored so that the oldest stock is readily accessible and can be used first.

Note: A continuous inventory should be kept in connection with all magazines.

Note: Complete plans for all types of magazines are available from the U. S. Bureau of Mines, explosives manufacturers, and the Institute of Makers of Explosives.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.08 Storage, daily supply. Where explosives in excess of immediate requirements are removed from a magazine and delivered in the vicinity of a blasting operation, they shall be kept in a stout, tight box constructed of nominal 2-inch plank, covered with not less than 26 gauge sheet metal or other fire-resistive material, and equipped with hinged lid, or in a small portable building similarly covered. Not more than 24 hours' supply of explosives shall at any time be kept or stored therein. If this daily supply exceeds 50 pounds, it shall be located not less than 200 feet from the work in progress and from buildings, railroads, and highways, except by written permission of the industrial commission. Except when necessarily opened for use by authorized persons, such box shall be locked. Each such box shall be painted red and be conspicuously marked EXPLOSIVES.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.09 Portable magazines. When work is of a temporary nature, the magazine shall be constructed in accordance with specifications in Wis. Adm. Code section Ind 5.07, except that 4 inches of sand or equivalent will be accepted if the capacity of such magazine is not more than 6,000 pounds. Such magazine shall be subject to all orders applying to permanent magazines, except that ventilation requirements shall be waived.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.10 Explosives unfit for use. (1) When it is necessary to destroy dynamite or detonators, it shall be done under competent supervision. Unnecessary delays shall be avoided.

Note: 1. See also Appendix B for the recommendations of the explosives manufacturer.

Note: 2. These explosives may be fresh material from containers which have been broken during transportation, usable material for which there is no further need on the job, or they may consist of material which has deteriorated or which has become unfit for use through some sort of damage. Frequently, deteriorated explosives are much more hazardous than those in good condition, and hence, require special care in handling and disposal.

(2) Empty cases, paper and sawdust from deteriorated explosives, and sweepings may be explosive, and shall be destroyed separately by burning. Such burning shall be conducted in a safe location where no damage or injury will result in the event of an explosion.

(3) In case magazine floors become stained with nitroglycerin they shall be scrubbed well with a stiff broom, hard brush, or mop, using

a solution freshly mixed in the proportion of 1½ quarts of water, 3½ quarts of denatured alcohol, one quart of acetone, and one pound of sodium sulfide (60% commercial). The liquid shall be used freely to decompose the nitroglycerin thoroughly. If the magazine floor is covered with ruberoid or any material impervious to nitroglycerin, this portion of the floor shall be thoroughly swept with dry sawdust and the sweepings taken to a safe distance from the magazine and destroyed by the method described in subsection (2).

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.11 Transportation of explosives. (1) These orders shall apply to the transportation of explosives in the state of Wisconsin in intrastate movements, as they are applicable.

(2) Motor trucks or vehicles *when transporting explosives*, shall be marked or placarded on both sides and the rear with the word EXPLOSIVES in letters not less than 6 inches high.

(3) Motor vehicles transporting explosives shall be handled in a safe and careful manner.

(4) Only careful, qualified men who have been selected and regularly designated by the employer shall drive, load, or unload a vehicle transporting explosives.

(5) No person shall be permitted to ride upon, drive, load, or unload a vehicle transporting explosives while smoking or under the influence of liquor.

(6) When transporting explosives, no metal tools, flammable or corrosive materials shall be carried in the same compartment with explosives.

(7) Only necessary stops shall be made by motor vehicles loaded with explosives. They shall stop at all railroad grade crossings. All scheduled rest stops or any emergency stops in any community shall be reported to the local fire chief who shall be consulted as to the safest parking location.

(8) The vehicle used for transporting explosives shall have a tight floor. If there is any exposed sparking metal on the inside of the body, it shall be covered or protected with non-sparking material so that the explosives containers will not come in contact with the exposed sparking metal. Trucks used for the transportation of explosives shall be clean and free from surplus oil and grease, shall have wiring completely insulated, fuel and exhaust lines free from leaks, and all necessary precautions shall be taken to prevent the truck from catching fire. A fire extinguisher having a total performance rating of 8-B in not more than 2 units shall be provided. The extinguishers shall be of a UL approved type and shall be properly maintained. In open trucks servicing any job with explosives, a tarpaulin shall be used to cover explosives and the sides of the body shall be high enough to prevent cases from falling off.

Note: Fire extinguisher ratings will be found on the extinguisher on the label containing the Underwriters' Laboratories approval.

(9) Detonators may be transported in the same motor vehicle with high explosives only as follows: The detonators shall be packed in authorized I.C.C. specification outside shipping containers, or in prescribed inside I.C.C. packages in an outside box made of one inch lumber lined with padding material not less than ½ inch thick, or a

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box made of not less than 12 gauge sheet metal lined with plywood or other similar material not less than $\frac{3}{8}$ inch thick so that no metal is exposed on the inside. Hinged covers and fastening devices are required on boxes. These boxes shall be loaded in the motor vehicle so that the contents of the box will be immediately accessible for removal in case of fire.

(10) Dynamite shall be transported or conveyed in original outside boxes. Broken cases shall be placed in boxes as described above or in a Daily Supply Box.

Note: A "full cover" type paper carton is considered equivalent to the original box when the cover is replaced and taped.

(11) Detonators and dynamite being transported and conveyed in service trucks shall be kept in separate compartments and in approved containers.

(12) Explosives may be transported on any truck or any semi-trailer attached to a tractor. Under no conditions shall explosives be transported in any "full" trailer, or any form of "pole" trailer.

(13) Cases of explosives shall not be dropped, slid, or otherwise roughly handled.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.12 Blasters license. (1) No person shall be permitted to prepare explosive charges or conduct blasting operations, and no employer shall employ any person for such purposes unless such person is 21 years of age and holds a valid blasters license issued by the industrial commission after a determination of fitness by examination.

(2) Persons authorized to prepare explosive charges or conduct blasting operations shall comply with all provisions of the explosives code, and shall use every reasonable precaution to insure the safety of the workmen and general public. They shall not delegate the work of preparing explosive charges or conducting blasting operations to a person who does not hold a blasters license, except under their direct supervision. A person not holding a blasters license may act only as a helper.

(3) The blasters license may be revoked or suspended by the industrial commission in cases of violations of safety practices.

(4) These licensing requirements shall not apply to laboratory, transportation and manufacturing personnel.

(5) The blaster shall not engage in blasting operations other than those indicated by his classification and license.

(6) Blasters certificates which are valid on March 1, 1965 shall become invalid in one year unless application for a blasters license is filed with the industrial commission and an examination is written and passed when scheduled. Arrangements for examination will be made as soon as practicable.

(7) After the initial registration of the blasters license, applications for renewal shall be made every 4 years. Examinations will be arranged as required.

(8) Explosives shall be purchased only by persons holding a valid blasting license or authorized agents of concerns employing licensed blasters.

(a) This rule shall not apply to the purchase of shell loading components.

(9) CLASSIFICATION OF BLASTERS.

(a) V. 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) IV. Precision blasting, excavating and/or demolition.

1. Requirements: Four weeks of blasting experience in builtup 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) III. 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) II. 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) I. 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.

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- o. Limited to a time, type of blasting, or a place.
- p. Miscellaneous.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.13 Detonators, primers, fuse and detonating cord. (1) Only a crimper shall be used for attaching fuse to blasting caps. The employer shall furnish and keep in accessible places, ready for use, crimpers in good repair. Capped fuses shall be made up only as required.

(2) No fuses shall be capped with blasting caps in any magazine, or where blastholes are being loaded, but approved benches shall be provided at a safe distance from such storage place where all fuse ends shall be trimmed immediately before capping.

(3) All cap and fuse and electric primers shall be made as recommended by the manufacturer. Primers consisting of less than one cartridge shall be made by inserting the cap in the end of the cartridge. They shall be made at the site just prior to loading in borehole.

Note: The manufacturer's recommendations are found on "case inserts" in every case of explosives.

(4) Safety fuse and related ignition devices shall be stored in a cool dry place, away from oils and grease in a locked cabinet or in a detonator magazine.

(5) Detonating cord shall be stored in an approved explosives magazine.

Note: See the safety recommendations in the appendix.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.14 Use of explosives. (1) Explosives shall be handled in a careful manner as described in this section.

(2) There shall be one blaster in charge of blasting in each section of any operation. He shall enforce these orders and directions and personally supervise the fixing of all charges and all other blasting operations and shall use every precaution to insure safety.

(3) Explosives shall be conveyed in original shipping containers, in approved covered wooden boxes, in containers, or sacks provided for that purpose.

(4) Detonators shall be conveyed separately from other explosives in approved containers. The carrying container for capped fuses shall be of rigid construction and provided with a hinged cover. If containers are of metal, a lining of felt, or similar material, shall be provided. Explosives stacked near the blast hole shall not exceed the amount required for the shot. After priming materials are laid out to form the blast pattern, the area shall be guarded against approach of vehicles and unauthorized persons. The area shall not be left unattended until the shot is fired or all materials are covered, shorted, and made safe until blasting time. Every reasonable attempt shall be made to fire the blast on the same day.

(5) After loading is completed, all surplus explosives and supplies shall be returned at once to the daily supply magazine as specified in Wis. Adm. Code section Ind 5.08, observing the rules used for distribution. When explosives have been brought to the blast site in compliance with the regulations for transportation of explosives, any re-

maintaining materials may be stored for the day under the same conditions and returned to the permanent magazine at the end of the day.

(6) Before loading any blast holes, they shall be checked with a tamping pole and other equivalent devices to make sure they are in proper condition, and the proper size and temperature for the loading of explosives.

(7) There shall be no smoking, open flames, sparks, or use of matches or lighters within 100 feet of place where explosive charges are being prepared.

(8) All tamping poles and dollies shall be constructed of wood, except that non-sparking metal spikes may be used where necessary to load rough holes and that non-sparking metal connectors may be used for extending the length of tamping poles.

(9) Explosives shall be tamped only lightly. Excessive ramming shall be avoided. The primer shall not be tamped.

(10) A blast hole shall not be loaded adjacent to a hole being drilled.

(11) All blast holes shall be stemmed to the collar wherever practicable. Otherwise, they shall be stemmed sufficiently to minimize possibility of injury to personnel from flying materials.

(12) Before drilling is started on any shift, all remaining holes shall be examined for unexploded charges and if any are found, these shall be handled by or under the supervision of a competent and experienced person.

(13) Blast holes shall not be started in partial holes (bootlegs) remaining from a previous blast.

(14) Damaged and contaminated explosive cases, wooden and fibre-board, and all liners and packing material shall be destroyed by burning weekly at a distance of not less than 200 feet from magazines, dwellings and other structures. All persons shall retire to a place of safety as soon as the pile is ignited.

Note: A blaster's log should be kept which records as much loading, spacing, depth, rock, and powder information as possible.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.15 Firing blasts with cap and fuse. (1) The use of any fuse having a nominal burning rate of less than one foot in 40 seconds is prohibited.

(2) The minimum length of fuse to be used for a single shot shall be 30 inches. When 5 or more shots are to be lighted by one person, the minimum length shall be 48 inches and 2 capped "warning" fuses shall be used for each blast. They should be 24 inches long. "Warners" shall be placed so personnel will not be injured by flying fragments.

(3) At least 2 men shall be present at each location where cap and fuse blasting is done.

(4) Lighting of fuse before placing primer in position in the drill hole is prohibited.

(5) The use of cap and fuse for firing mud cap charges is prohibited unless charges are separated sufficiently to prevent one charge from dislodging other shots in the vicinity.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.16 Firing blasts with electricity. (1) Due precautions shall be taken to prevent accidental discharge of electric blasting caps from

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current induced by radar, radio transmitter, lightning, adjacent power lines, dust storms, or other sources of extraneous electricity. Such precautions shall include:

(a) The suspension of all blasting operations where electric-fired caps are used and removal of persons from the blasting area during the approach and progress of an electric (thunder) storm.

(b) The posting of signs warning against the use of mobile radio transmitters on all roads within 350 feet of the blasting operations.

(c) Compliance with the 1955 recommendations of the Institute of Makers of Explosives with regard to blasting in the vicinity of radio transmitters or power lines. (See subsection (18).)

Note: Additional recommendations and information are in Appendix C.

(2) Before adopting any system of electrical firing, the blaster shall conduct a thorough survey for possible extraneous currents and if 0.15 volts or more are detected, such extraneous voltage shall be eliminated before any holes are loaded. Periodic recheck surveys shall also be made.

Note: Alternate instruments or techniques that produce equivalent results will be acceptable.

(3) Only electric blasting caps shall be used for blast initiation in cities, villages, and inhabited areas, or on highways, or adjacent to highways open to traffic, *except where sources of extraneous electricity make such use dangerous.*

(4) In shaft, tunnel, or caisson blasting, only electrical firing shall be used *except as modified in subsections (3) and (18)* and the metallic exterior of electrical equipment shall be grounded with a resistance to ground of not more than one ohm.

(5) Whenever blasting is being conducted in the vicinity of gas, electric, water, fire alarm, telephone, telegraph, and steam utilities, such utilities shall be notified.

(6) Precautions shall be taken to prevent blasting lines from being thrown into contact with a power line.

(7) Before loading an electrical blast, all portable or temporary electric circuits within 100 feet shall be disconnected.

* (8) Before stemming holes, the caps shall be tested for circuit continuity with a blasting galvanometer equipped with silver chloride cell. In case a cap wire is broken, a new primer shall be inserted. The leg wires shall be kept short-circuited until they are connected into the blast circuit.

* (9) All circuits shall be tested with a blasting galvanometer before firing.

* (10) All electric caps fired in a single blast shall be of the same general type and made by the same manufacturer in order to reduce the possibility of failure to fire.

* (11) Where electric haulage is used, all rail bonds shall be properly maintained and all rails and pipe lines shall be cross-bonded and grounded.

* (12) The entire firing circuit shall be insulated and no electrical ground shall be permitted. All parts of the blasting circuit shall be protected from accidental contact with power lines, pipe lines, or other sources of extraneous current.

* (13) All connections shall be made from the bore hole back to the source of firing current, and the leading wire shall remain shorted and not be connected to the blasting machine or other source of current until the charge is to be fired.

* (14) Blasts connected in single series or parallel series may be fired by power lines or blasting machines as recommended by the manufacturer. Blasts connected in parallel shall be fired only with a power line or a special blasting machine designed for the purpose and only with an adequate supply of available current. "Series in parallel" combinations shall not be used in the same blast unless carefully balanced electrically.

* (15) Blasting machines shall be tested periodically to insure their ability to develop their rated capacity. If defective, they shall not be used.

* (16) Only well insulated copper leading wire, 14 gauge or larger, and approved by the industrial commission shall be used. When firing with a blasting machine the leading wires shall be kept disconnected and short-circuited, except when firing the blast.

* (17) (a) When firing with a power circuit, a firing switch shall always be used. This switch shall be locked in the "open" or "off" position at all times except when firing a blast. It shall be so designed that the firing lines are short-circuited when the switch is in the "off" position.

(b) The box shall be kept locked except when blasting and no person shall have access to it except the blaster.

(c) On the power side of the switch, a 5 foot lightning gap shall be provided which shall be closed by a "jumper" immediately prior to the time of firing.

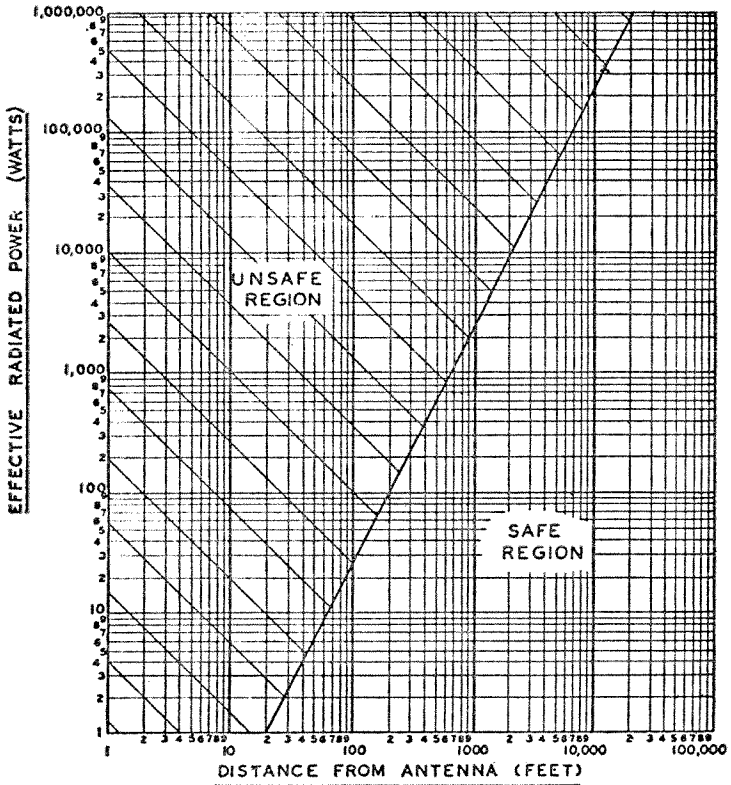
(d) No electric firing shall be done with a power line voltage of less than 110 volts nor more than 480 volts.

* *Note:* Rules preceded by an asterisk apply also to underground mines. See subsection (19).

(18) (a) Electric blasting caps shall not be stored or transported in the vicinity of an operating radio transmitter unless they are in their original package or coiled as specified by the manufacturer. If not in their original package, they shall be kept in a special metal-covered container as described in Wis. Adm. Code section Ind 5.11(9).

(b) Electric blasting caps shall not be used or handled in the vicinity of a known operating radio transmitter within the following distances:

FIGURE I
RECOMMENDED DISTANCE FROM AMPLITUDE-MODULATED
(AM) BROADCASTING TRANSMITTERS FOR SAFE
ELECTRIC BLASTING OPERATIONS



(c) All known mobile transmitters, or those under control of operator of plant, within blasting area shall be shut off.

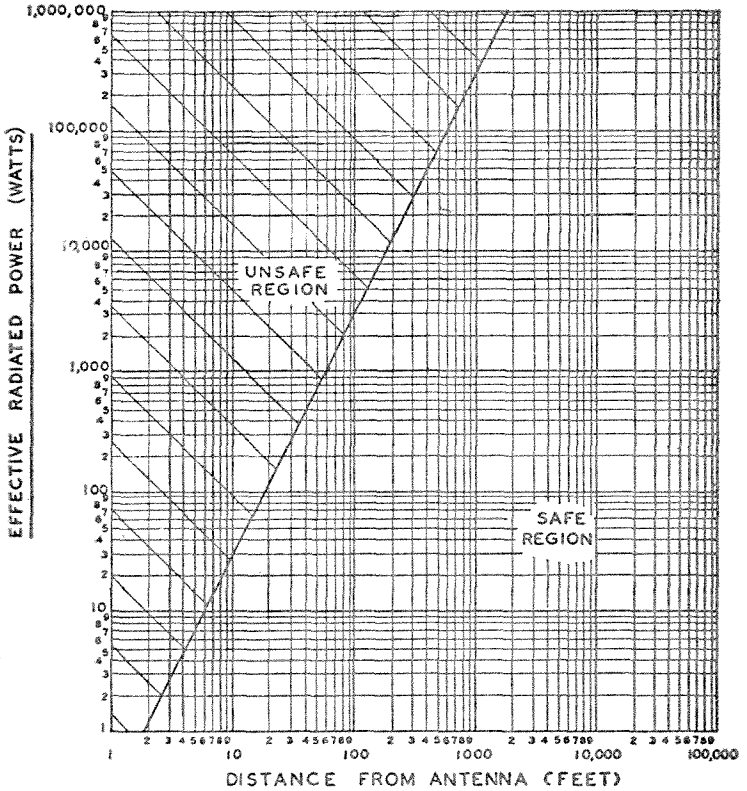
(d) If for any reason, a mobile or permanent transmitter can not be shut off, the following test shall be made to determine if a hazard exists. A #48 radio pilot lamp shall be inserted into the blasting circuit in place of the electric detonator. *If any glow is observed in the lamp, electrical firing shall not be used and the blast shall be primed with cap and fuse or detonating fuse.*

(19) Subsections (8), (9), (10), (11), (12), (13), (14), (15), (16) and (17) apply also to underground mines.

Note: Additional recommendations and information are in Appendix C.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

FIGURE 2
RECOMMENDED DISTANCE FROM VHF TELEVISION
(CHANNELS 2 TO 13), AND BOTH MOBILE AND BROADCASTING
FREQUENCY-MODULATION (FM) TRANSMITTERS FOR
SAFE ELECTRIC BLASTING OPERATIONS



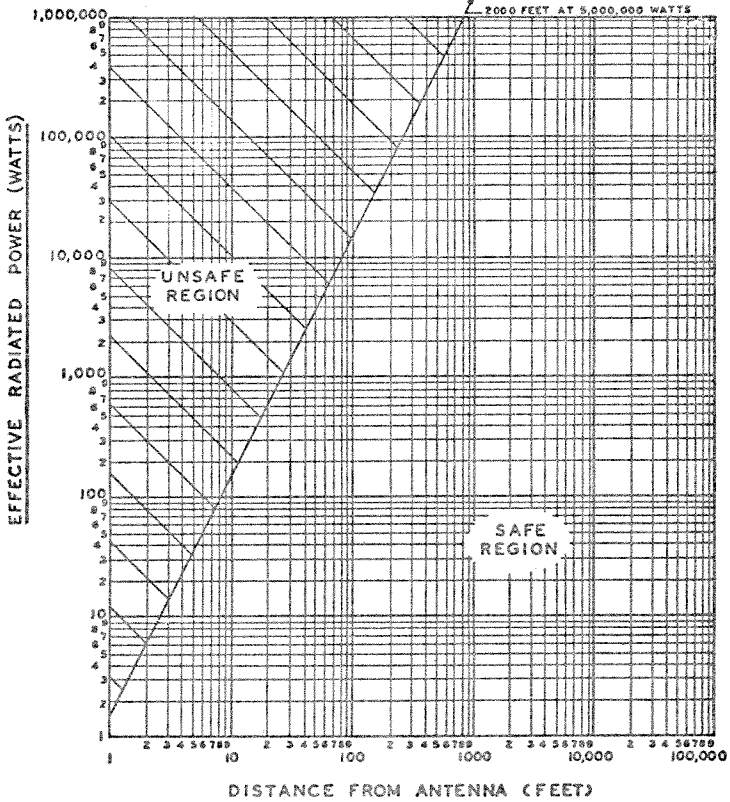
Ind 5.17 Firing blasts; general. (1) SURFACE BLASTING OUT OF DOORS.

(a) Before any blast shall be fired, a prearranged, audible warning signal shall be sounded and all persons required to retire to a shelter house designed for the purpose or equivalent, but in no case shall the persons be less than 300 feet away when the blast is fired, except as provided in subsection (3)(c).

(b) If shelters are not available, persons shall retire to a safe distance. In no case shall this distance be less than 500 feet. In any case, the required distance shall be paced or measured.

(c) All access roads or travelways shall be guarded before the warning signal is given and all personnel shall remain in place of safety until "all clear" signal has been authorized by the blaster in charge. Where highways or buildings are located within the danger zone, employees shall be sent in each direction to warn the public

FIGURE 3
RECOMMENDED DISTANCE FROM UHF TELEVISION
(CHANNELS 14 TO 83) TRANSMITTERS FOR SAFE
ELECTRIC BLASTING OPERATIONS



when shots are to be fired. The persons giving the warning shall proceed not less than 500 feet from the blast and warning shall be accomplished by waving a red flag. A sign with the words STOP—BLASTING printed in letters approximately 3 inches high, shall be used in addition to the flag.

(d) STOP—BLASTING signs and flags shall be used only for duration of the blast and until danger from flying material and misfires is past.

(2) TUNNEL BLASTING. (a) All persons shall retire from tunnel and shaft or to a distance of 1,500 feet from the face of a tunnel being blasted unless protective offsets are provided. During shaft sinking operations, the provisions of subsection (1) apply.

(b) Whenever blasting is being done in a tunnel, at points likely

to break through to where other men are at work, the foreman or person in charge shall, before any holes are loaded, give warning of danger to all persons who may be working where the blasts may break through, and he shall not allow any holes to be changed until a warning is acknowledged and men are removed.

(c) In shaft, tunnel, or caisson blasting, only electrical firing shall be used *except as modified in sections Ind 5.16(3) and (18)* and the metallic exterior of electrical equipment shall be grounded with a resistance to ground of not more than one ohm. (Same as Ind 5.16(4).)

(d) Explosives used in tunneling shall be Fume class 1. Fume class 1 explosives produce less than 0.16 cubic feet of poisonous gases per (1¼ x 8") cartridge when detonated in the Bichel Gauge. The user shall post evidence in a conspicuous place showing compliance with this order.

Note: Refer to Dusts, Fumes, Vapors and Gases, Ch. Ind. 20.

(e) Explosives shall not be lowered into any tunnel on the same conveyance with detonators or primers.

(f) While explosives are being taken through air locks, no men other than the lock tender and the carrier shall be permitted in the lock.

(g) Explosives shall not be left or placed near electric wires.

(h) Where electric haulage is used, all rail bonds shall be properly maintained and all rails and pipe lines shall be cross-bonded and grounded. (Same as Ind 5.16(11).)

(i) Before explosives or detonators are delivered to a tunnel face, all power current shall be cut off within 50 feet of the face. All illumination shall be by battery lamps or floodlights only.

(j) In a tunnel or shaft in connection with community construction projects no blast hole shall be loaded until a round of holes is completely drilled.

(3) SPECIAL BLASTING OPERATIONS. (a) When chambering blast holes at the bottom, persons shall retire not less than 75 feet from the collar of the hole at right angles to its axis and away from any ledge of rock.

(b) When blasting in a building, the charge shall be properly placed and covered if necessary to prevent damage to persons or property. Passageways shall be guarded manually or by visual or audible signal. Warnings shall be sounded and persons shall retire to a sheltered place. Guards shall not be required to use flags or signs.

(c) When using explosives under mats or for shooting wells and post holes, it shall be the duty of the blaster to make certain that all persons are under cover or beyond danger from flying material.

(d) Overburden or backfill material may be substituted for part or all of the blasting mat requirements if in the judgment of the blaster,

1. The material will not be thrown into the air excessively.

2. The shot has been designed to minimize the displacement of the blasted material.

3. Shots of this type shall be designed and initiated by a Class V blaster.

Note: Attempt shall be made to use only fine uniform material.

(4) BLASTING IN COMMUNITIES. When blasting operations are con-

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ducted in cities, villages, and inhabited areas shots shall be screened with blasting mats to hold or catch flying material. Shots shall be spaced, located and charged with explosives in a manner as to minimize the danger of flying material. Permission for the use of explosives is subject to the approval of the proper local authorities.

(a) *Exception:* Blasting operations may be conducted in existing quarries and other locations without the use of blasting mats, provided buildings, thoroughfares and persons are not subject to the danger of flying material.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.18 Precautions after blast. (1) When multiple cap and fuse shots are fired, the blaster shall determine the length of the waiting period before any person is permitted in the blast area. In any case, when a misfire is known or suspected, no person shall enter the area for at least 30 minutes.

(2) Before resuming operations, the blaster shall examine the area for misfired shots, unexploded or burning dynamite. In case burning dynamite is observed, no attempt shall be made to extinguish it but persons shall retire to a safe place and remain there at least 60 minutes.

(3) When it is possible to refire a misfired hole safely, it shall be disposed of by refiring. If this can not be done, an attempt shall be made to insert a new primer after removing the stemming with a jet of water or air. A conductive rubber or copper pipe shall be used for this purpose.

(4) The handling of misfires shall be attempted only by blasters thoroughly experienced with this work.

Note: Whenever such a blaster is not available, the manufacturers shall be contacted for further advice.

Note: Additional precautions to be taken for the safe storage and use of explosives are provided in the Appendix.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

PART II

UNDERGROUND MINES

Ind 5.40 General. The handling, transportation and storage of explosives above ground in connection with underground mining shall comply with Wis. Adm. Code sections Ind 5.01 and Ind 5.18 in Part I of this code. Any of these provisions that conflict with Wis. Adm. Code sections Ind 5.40 and Ind 5.48 shall not apply to underground mining.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.41 Underground storage of explosives. (1) Magazines for the underground storage of more than one day's supply of explosives shall be located at least 200 feet from any work shaft or connecting winze or raise. When only one day's supply is to be stored, this distance may be reduced to 100 feet. Detonator magazines shall be located 50 feet from any shaft, winze, or raise and 25 feet away from any explosive storage magazine. Such magazines shall not be adjacent to any power circuit other than lighting circuits, nor shall they be located so that accidental explosion of their contents may cut off the escape of persons working underground.

(2) All underground magazines shall be so located and so protected as to prevent accidental impact from vehicles or falling objects.

(3) Sufficient explosives may be stored within a mine to meet the estimated requirements of such mine for 14 days.

(4) All unused explosives shall be returned to the approved storage place immediately following charging of the holes.

(5) Underground magazines shall be located in separate rooms or drifts in which no person other than powder men are employed. Drift magazines shall be completed by a 2 inch plank wall (and door) covered with sheet metal or equivalent fire-resistive material, or of masonry construction with a metal door lined with wood. The drift opening shall be completely closed. Nails used in the interior of this wall shall be countersunk.

(6) Magazines in open stopes shall be constructed with wooden walls 2 inches thick covered with sheet metal or equivalent.

(7) Box-type magazines shall be a tight box constructed of nominal 2 inch plank or equivalent with a hinged cover.

(8) Detonator storage underground shall be in drift-type or box-type magazines or a cabinet of sound construction. When the box is located in the capping house, the storage shall be limited to 3,000 detonators.

(9) All underground magazines shall be plainly marked **EXPLOSIVES**.

(10) Detonators and dynamite shall not be stored in the same magazine.

(11) Magazines shall be kept clean and dry and empty containers and packing shall be removed from the mine at least once a week.

(12) No flammables, except wood wedges and fibre, rubber or wooden mallets, nor any sparking metal tools or implements, shall be kept or stored in any magazine containing explosives.

(13) Magazines shall be lighted from the outside, or by portable-safety storage battery lamps, or by permanent interior lights provided with explosion-proof fixtures. Open flame lamps, matches, lighters, and flame-producing devices shall not be carried into any ex-

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plosives magazine. No smoking shall be permitted while handling explosives.

(15) Fibre, rubber, or wooden tools shall be used to open explosives cases, except that "slitters" may be used to open fibreboard cases. Cases shall be opened outside the magazine.

(15) Explosives shall be stored so that the oldest stock is readily accessible and can be used first.

(16) When underground magazines are accessible through unlocked slope or tunnel entrances they shall be locked.

Note: Complete plans for all types of magazines are available from the U.S. Bureau of Mines, explosives manufacturers, and the Institute of Makers of Explosives.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.42 Explosives unfit for use. The requirements as set forth in section Ind 5.10 of this code shall also apply to underground mines.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.43 Blasters license for supervisory staff. All general foremen and shift foremen shall qualify as blasters. They shall instruct the miners in the provisions of these rules and in the use and handling of explosives.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.44 Detonators, primers, fuse and detonating cord. (1) Only a crimper shall be used for attaching fuse to blasting caps. The employer shall furnish and keep in accessible places, ready for use, crimpers in good repair. Capped fuses shall be made up only as required.

(2) No fuses shall be capped with blasting caps in any magazine but approved benches shall be provided at a safe distance from such storage place where all fuses shall be capped. All fuse ends shall be trimmed immediately before capping.

(3) All cap and fuse and electric primers shall be made as recommended by the manufacturer. Primers consisting of less than one cartridge may be made by inserting the cap in the end of the cartridge. They shall be made up at the face just prior to loading into the borehole, except that the primers for stoping in wet areas, sinking, or drifting may be made up in the central capping house immediately before use in the quantity needed for any one blast and carried to the face in a substantial covered wooden box.

Note: The manufacturer's recommendations are found on "case inserts" in every case of explosives.

(4) Safety fuse and related ignition devices shall be stored in a cool dry place, away from oils and grease in a locked cabinet or in a detonator magazine.

(5) Detonating cord shall be stored in an approved explosives magazine.

Note: See all of the recommendations in the appendix.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.45 Use of explosives underground. (1) Explosives of Fume Class 1 shall be used in blasting underground. Underground atmospheres to which men are subjected shall conform to the requirements

of Wis. Adm. Code section Ind 3.20(2)(b) of the general rules on mines.

(2) Explosives shall be conveyed in original shipping containers, in approved covered wooden boxes, in containers or in sacks provided for that purpose.

(3) Detonators shall be conveyed separate from other explosives in approved containers provided for that purpose. The carrying container for capped fuses shall be of rigid construction and provided with hinged cover. If containers are of metal, a lining of felt, or similar material, shall be provided.

(4) Explosives and detonators shall not be placed where they may be struck by vehicles or subject to contact with live wires.

(5) No explosives shall be transported on underground locomotives, but they may be transported in a mine car, or in a truck, if carried in their original shipping containers or in a container as described in subsections (2) and (3) above. No one but the train crew, driver, or powder man shall be allowed to ride on a train or truck carrying explosives. One empty car with insulated couplings or an insulated bar shall be interposed between the locomotive and the powder car.

(6) In *sinking* a shaft or winze, no other material shall be carried on any cage, skip or bucket on which dynamite and detonators are handled and only those members of the crew needed for blasting may travel with such explosives or remain on the bottom while explosives are being lowered. Explosives shall be handled only in their original shipping packages or in approved containers as described in subsections (2) and (3).

(7) When lowering explosives for storage in underground magazines or transferring explosives from level to level, no person other than the attendants shall ride, nor shall any other material be handled in any cage or conveyance which is loaded with explosives. Dynamite and detonators shall not be lowered or hoisted together on any conveyance. A miner or powder man may carry 50 pounds of dynamite and capped fuses, or less, in approved containers when conveying explosives.

(8) Before loading any blast holes, they shall be checked with a tamping pole and other equivalent devices to make sure they are in proper condition and proper size and temperature for the loading of explosives.

(9) There shall be no smoking, open flames, sparks, or use of matches or lighters within 100 feet of place where explosive charges are being prepared with the exception of carbide lamps where this is the type of illumination used in *mines*.

(10) All tamping poles and dollies shall be constructed of wood with no exposed metal parts, except that non-sparking metal spikes may be used where necessary to load rough holes and that non-sparking metal connectors may be used for extending the length of tamping poles.

(11) Explosives shall be tamped only lightly. Excessive ramming shall be avoided. The primer shall not be tamped.

(12) While drilling in large underground rounds of blast holes, no hole shall be loaded which is not separated from a hole being drilled, by at least one empty hole and at least 6 feet of distance. In each case in which this practice is applied it shall be with the express knowledge of the person in charge of the mine, and he shall insure

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that in each particular instance of the practice, all aspects of the operation are carried out in a careful and workmanlike manner.

(13) All blast holes shall be stemmed to the collar wherever practicable. Otherwise, they shall be stemmed sufficiently to minimize possibility of injury to personnel from flying materials.

(14) Before drilling is started on any shift, all remaining holes shall be examined for unexploded charges or cartridges, and if any are found, these shall be handled by or under the supervision of a competent and experienced person.

(15) Blast holes shall not be started in partial holes (bootlegs) remaining from a previous blast.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.46 Firing blasts underground with cap and fuse. (1) The use of any fuse having a nominal burning rate of less than one foot in 40 seconds is prohibited.

(2) A minimum fuse length for all blasts except boulder blasts shall be 7 feet. In boulder blasting where single shots are fired, the minimum fuse length shall be 30 inches. Where 5 or more boulder blasts are shot at one time, the minimum fuse length shall be 48 inches.

(3) No man shall "spit" more than 15 fuses in a round of shots except when using a water-resistant or waterproof ignitacord.

(4) Where a carbide lamp or similar lighter is used in spitting fuses, a second light shall be kept burning as a safety measure, and such extra light shall be placed a safe distance from the blast.

(5) At least 2 men shall be present at each location where cap and fuse blasting is done.

(6) Lighting of fuse before placing primer in position is prohibited.

(7) The use of cap and fuse for firing mud cap charges is prohibited unless charges are separated sufficiently to prevent one charge from dislodging other shots in the vicinity.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.47 Firing blasts electrically underground. (1) Electric detonators shall not be handled within 100 feet of a portable radio transmitter.

(2) Only electric or delay electric blasting caps shall be used in the following operations:

(a) In sinking shafts or winzes or driving raises over 50 feet high, except that in such raises ignitacord may be used in conjunction with cap and fuse firing.

Note: Electrical ignition of ignitacord increases the safety factor.

(b) In cutting shaft stations.

(c) In drifts, crosscuts, storage pockets and pump sumps where there is not enough protection for the men from flying rock or concussion.

(3) In addition to the provisions of Wis. Adm. Code section Ind 5.47, the provisions of section Ind 5.16(8) through (17) shall also apply to underground mining.

Ind 5.48 Firing blasts underground, general. (1) Persons about to fire shots shall cause warning to be given in every direction and all entrances to the place or places where shots are to be fired shall be manned or barricaded.

(2) Employees shall not be permitted to retire to a dead-end drift or crosscut in selecting shelter from fly rock and blasting gases.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Ind 5.49 Precautions after underground blasting. (1) When multiple cap and fuse shots are fired, the blaster shall determine the length of waiting period before any person is permitted in the blast area. In any case, when a misfire is known or suspected, no person shall enter the area for at least 30 minutes.

(2) Before resuming operations, the miner shall examine the area for misfired shots, unexploded or burning dynamite. In case burning dynamite is observed, no attempt shall be made to extinguish it but persons shall retire to a safe place and remain there at least 60 minutes and until the mine captain or foreman has determined that it is safe to return to the working place.

(3) When it is possible to refire a misfired hole safely, it shall be disposed of in this manner. If this cannot be done, an attempt shall be made to insert a new primer after removing the stemming with a jet of water or air. A rubber or copper pipe shall be used for this purpose.

(4) The handling of misfires shall be attempted only by miners thoroughly experienced with this work.

Note: Additional precautions to be taken for the safe storage and use of explosives are provided in the Appendix.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

PART III
BLASTING AGENTS
BULK MIXING PLANTS

Ind 5.60 Blasting agents. (1) Location of mixing plant. Plants for mixing ammonium nitrate with fuel oil and/or other carbonaceous materials shall be isolated from inhabited buildings, passenger railroads, and public highways in accordance with the American Table of Distances for explosives. The quantity of materials used in this determination shall be the maximum amount which will be in the mix building and the immediate area thereof at any one time and will include the sum total of the following materials:

- (a) Finished product.
- (b) Materials in process.
- (c) Raw ammonium nitrate awaiting processing.

(2) FUEL STORAGE. Fuel oil and/or other carbonaceous fuels shall be stored in a separate building or in an outside tank to minimize possible contact between molten ammonium nitrate and fuel in case of fire. A shut-off valve shall be installed in the fuel line at the fuel tank.

(3) SEPARATION OF MIXING PLANT AND STORAGE BUILDINGS. The location of the permanent storage area for blasting agents with respect to the mixing plant shall be in accordance with magazine separation distances of the American Table of Distances.

(4) LOCATION OF OPERATING STOCKS. The layout of the mixing plant shall be such that there is physical separation between the daily operating stocks of raw ammonium nitrate, the finished mixed blasting agents, and the mixing and packaging operations.

(5) MIXED BUILDING. The mixing building shall be of non-combustible construction; however, buildings made of corrugated metal sheeting over wood studs and framing are acceptable. It should have one or more natural-draft vents, equipped with spark-arresting screens.

(6) MIXING BUILDING FLOOR. The floor of the mixing building shall be of concrete or of other approved non-absorbent material. A wash-down house and drain shall be provided; however, any pipe-connected drains shall be provided with an effective closure and this closure shall be in place at all times except during wash down.

(7) BUILDING HEAT. Heat for the mixing building shall be provided from a source outside the building. However, space heaters that do not depend on a combustion process within the heating unit may be used if they are properly installed and maintained and are located no closer than 30 inches from raw materials and finished product. Such space heaters must conform to the requirements of the most recent Wisconsin State Electrical Code for installation in a hazardous area.

(8) ELECTRICAL EQUIPMENT. All electrical switches, motors, controls, lights, etc., located in the mixing building or in the blasting agent storage building shall conform to the requirements of the Wisconsin State Electrical Code for installation in a hazardous area; otherwise, they must be located outside the building.

(9) MIXING EQUIPMENT. The design of the mixer shall minimize the possibility of frictional heating, compaction, and especially confine-

ment. All other surfaces must be accessible for easy cleaning. The frame of the mixer and all other permanently located handling equipment shall be electrically bonded together and connected to an effective electrical ground. Mixing and packaging equipment shall be constructed of materials which are compatible with ammonium nitrate and with fuel being used in the blasting agent mix. Zinc and galvanized metals shall not be used because of their tendency to promote and accelerate decomposition of ammonium nitrate. Copper shall not be used because of corrosion problems in the presence of ammonium nitrate.

(10) **WATER-DELUGE SYSTEMS.** An automatic water-deluge system is required to protect mixing and packaging areas in the mixing building.

(11) **HOUSEKEEPING.** The mixing and packaging equipment and areas shall be cleaned and maintained properly to prevent accumulation of raw ingredients and finished product. The floors shall be washed down and the entire working area dusted or washed down. Discarded empty ammonium nitrate bags must be disposed of daily in a safe manner, such as burning in an isolated location. The area surrounding the mixing and packaging building shall be kept free of rubbish, dry grass, weeds or other combustible material for not less than 25 feet in all directions.

(12) **SMOKING AND OPEN FLAMES.** Smoking, smoking materials, or open flames shall not be permitted in or near the mixing and packaging building. Signs to this effect shall be posted and the rule shall be rigidly enforced.

(13) **REPAIRS AND ALTERATIONS.** Welding and cutting with cutting torches shall not be permitted in the mixing or storage buildings while any blasting agent or ammonium nitrate is in the building. The building and area shall be cleaned or washed free of all ammonium nitrate and blasting agent before any welding or gas cutting operations are started. Where feasible, equipment should be removed from the building for repairs or alterations.

(14) **PERSONNEL LIMITATIONS.** A limit shall be established on the number of personnel who may be in the mix building at any one time, and this limitation shall be posted and enforced.

(15) **PRODUCT LIMITATIONS.** No more than one day's production of blasting agent shall be permitted in the mixing and packaging building at any one time.

(16) **LABELING.** All cartridges, bags or other containers of blasting agents shall be labeled to indicate their contents. Ammonium nitrate bags must not be re-used as containers for blasting agents unless they are positively relabeled accordingly.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

COMPOSITION

Ind 5.61 Liquid fuels. (1) **LIQUID FUELS.** No liquid fuel shall be used in the blasting agent mix which has a flashpoint lower than of No. 2 Diesel fuel (125 degrees Fahrenheit). More volatile fuels such as gasoline, kerosene, or No. 1 Diesel fuel, are not acceptable because they offer no significant advantage in blasting and do tend to increase the possibility of a vapor explosion and fire. Crude oil and crankcase drainings shall not be used because they may contain low flashpoint constituents or gritty particles which could increase the sensitivity of

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the blasting agent. Specifications of the liquid fuel shall be posted for interested parties' observation.

(2) **MIX PROPORTIONS.** The fuel oil content of the blasting agent shall be approximately 5.7% by weight. This proportion shall be maintained within a reasonable production tolerance. If other carbonaceous fuels are used, an oxygen-balanced proportion shall be maintained. If solid fuels are used, they shall be chosen and handled so as to minimize the possibility of dust explosions.

(3) **CAP SENSITIVE INGREDIENTS.** If any cap sensitive ingredients are used or added to the blasting agent mix or package, such as detonating fuse, dynamite, etc., then the entire mix or package shall be considered as a high explosive and must be handled as such.

(4) **EXPERIMENTAL MIXES. MANUFACTURING.** Unusual compositions or combinations of ingredients shall not be attempted except under the supervision of personnel competent by education and experience to evaluate the possibility of new hazards and unless the operation is equipped to determine the sensitivity of the resultant product. Metal dusts (such as aluminum powder), sulfur, perchlorates, and explosive substances (such as nitroglycerine, TNT, and other high explosives) shall not be used to sensitize ammonium nitrate unless the strict standards of explosive plant operations* can be and are met. Nitrites and chlorates shall not be used in blasting agent formulations. High explosives manufacturing operations shall be conducted in accordance with methods approved by the Industrial Commission.*

**Note:* Manufacturing procedures recommended by IME are generally acceptable.

(5) **CAP SENSITIVITY.** The cap sensitivity of the mix shall be checked at regular intervals as described in section Ind 5.03(11). If any change is made in mixing proportions, character of ingredients, or mixing procedure, another cap sensitivity test shall be made immediately.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

STORAGE OF BLASTING AGENTS

Ind 5.62 Storage. (1) **BUILDINGS.** Buildings which are one-story, without a basement and of fire-resistant construction shall be used. The storage building must be kept clean, dry, and free of debris and empty containers. Combustible materials (including flammable liquids), corrosive acids, chlorates, nitrites, or similar materials shall not be stored in the same building with blasting agents.

Note: It is permissible to use standard explosives magazines for storage of blasting agents.

(2) **VAN STORAGE.** Semi-trailer or trucks used for highway or on-site transportation of blasting agents are satisfactory for temporary storage. Vans must be kept in condition for highway use. Parked vans shall be substantially blocked before they are unhitched from the trailers. Vans containing ammonium nitrate must be kept locked when unattended.

(3) **LOCATION OF STORAGE BUILDINGS AND VANS.** Buildings for permanent storage and trailers for temporary storage of blasting agents must be located in accordance with the American Table of Distances.

(4) **GENERAL HOUSEKEEPING.** The blasting agent storage building shall be ventilated, kept locked when unattended, and posted with

warning signs, DANGEROUS MATERIALS—KEEP OFF or EXPLOSIVES—KEEP OFF. The surrounding area shall be kept free of rubbish, dry grass, weeds, and any other materials of a combustible nature for a distance of at least 25 feet in all directions. Broken bags or cartridges shall be cleared up promptly and removed from the area. Blasting agents in bags or cartridges shall be stacked to provide air circulation and easy access by authorized personnel. (This does not apply to van storage.)

(5) **SMOKING AND OPEN FLAMES.** Smoking, smoking articles, and open flame are prohibited in or near the blasting agent storage buildings or vans. Signs to this effect shall be posted and the rule shall be enforced.

(6) **PROLONGED STORAGE.** Prolonged storage of ammonium nitrate-fuel oil blasting agents shall be avoided unless it is demonstrated that the properties of the mix and/or package will effectively prevent segregation and evaporation of the oil.

(7) **COMBINED STORAGE.** Blasting agents may be stored with explosives only in a properly constructed explosive magazine. The aggregated weight of all stored materials, including explosives, blasting agents, and ammonium nitrate must be used to determine conformance with the American Table of Distances.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

TRANSPORTATION OF BLASTING AGENTS

Ind 5.63 General requirements. (1) **MINIMUM.** The regulations of the Wisconsin Explosives Code, the Wisconsin Motor Vehicle Department, and the Federal Interstate Commerce Commission covering the transportation of blasting agents over public highways shall be considered as minimum requirements. Vehicles transporting blasting agents shall display EXPLOSIVES or DANGEROUS signs.

(2) **VEHICLES AND DRIVERS.** Vehicles used to transport blasting agents on public highways shall be in safe operating condition and shall be driven by a competent driver with a driver's license valid for the type of vehicle being driven. Drivers shall be familiar with all applicable federal, state and local regulations and codes.

(3) **MOBILE MIXING EQUIPMENT.** Mobile processing equipment shall not be used for mixing of blasting agents while on public highways or other public thoroughfares or while in populated areas.

(4) **SMOKING AND OPEN FLAMES.** No person shall smoke, carry matches or other flame producing devices, or firearms while in or near a motor vehicle transporting blasting agents.

(5) **COMBINED SHIPMENTS WITH OTHER MATERIALS.** Acids or other corrosive liquids shall not be transported in the same vehicle with blasting agents. If high-explosives are transported in the same vehicle with blasting agents, the combined weight shall be considered as high-explosives and handled as such.

(6) **PASSENGER VEHICLES.** Explosives or blasting agents shall not be transported in any public vehicle carrying passengers for hire.

(7) **FIRES AND FIRE EXTINGUISHERS.** All trucks transporting blasting agents shall carry fire extinguishers having a total performance rating of 8-B in not more than 2 units. The extinguishers shall be of U.L. approved type and shall be properly maintained. These extinguishers are effective against ordinary truck fires but are not

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effective against fires directly involving the blasting agent. Only copious quantities of water are effective in combating fires in blasting agents. Fires directly involving blasting agents should be fought only in the incipient stage and if efforts to control such a fire appear futile, the area should be evacuated as rapidly as possible.

Note: Fire extinguisher ratings will be found on the extinguisher on the label containing the Underwriters' Laboratories approval.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

BLASTING OPERATIONS—GENERAL

Ind 5.64 Smoking and open flames. (1) **GENERAL.** Smoking, smoking materials, and open flames shall not be permitted in the vicinity of any explosive loading or handling operations.

(2) **MISFIRES.** When misfires occur with ammonium nitrate used as a blasting agent, they shall be treated and handled with the same respect shown to misfires occurring with dynamite. When there is a reason to believe a misfire has occurred, no one shall return to the blasting area for a reasonable period of time. All personnel shall make sure it is free of visible reddish-brown fumes which indicate toxic concentrations of nitrogen dioxide gas. (See Wis. Adm. Code section Ind 5.18 (1).)

Note: 1. Safety aspects. Although blasting agents are generally less sensitive to accidental initiation than other explosives, they are still an explosive and should be handled with the care and respect due such products. It should be remembered that in use they are virtually always combined with a cap sensitive explosive and the entire charge should be accorded the respect due the most sensitive element.

Note: 2. Priming. Primers of adequate size and properties should be used to insure against misfires and incomplete detonations. Failure to use adequate priming results not only in poor performance but also can cause copious quantities of toxic gases to be generated when the charge is fired.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

BLASTING OPERATIONS—ABOVEGROUND

Ind 5.65 Blasting (1) **MIXING AT THE BOREHOLE COLLAR.** For vertical boreholes, mixing blasting agents by pouring oil onto the raw ammonium nitrate (outside the borehole) is acceptable; provided, the proper proportions of fuel oil and ammonium nitrate are used and a soaking period is allowed before the mixture is poured into the borehole.

(2) **MIXING AND DELIVERING TRUCKS.** Trucks designed to mix blasting agents at the blasting site and/or deliver the mixed material directly into the borehole are acceptable provided:

(a) They meet the requirements for transporting such blasting agents. (Wis. Adm. Code section Ind 5.63.)

(b) Produce a mix of the proper proportions and consistency.

(c) Do not subject the mixture to excessive pressures before it is released into the borehole.

(3) **FUMES.** Before re-entering the blast area, the blaster shall make certain it is completely free of visible reddish-brown fumes which indicate toxic concentrations of nitrogen dioxide gas.

(4) **PNEUMATIC LOADING.** If pneumatic loading of blasting agents is used aboveground, the pertinent rules that are listed under Wis. Adm. Code section Ind 5.66 shall apply.

(5) **HOT BOREHOLES.** Boreholes heated from drilling or "springing" shall not be loaded until they have cooled to less than 150 degrees Fahrenheit.

Note: Mixing in the borehole. Attempting to mix blasting agents in the borehole by pouring oil onto ammonium nitrate previously loaded in the hole is not recommended. Such a procedure has proven inefficient and is apt to cause misfires and toxic fumes.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

UNDERGROUND MINES

Ind 5.66 Mix composition (1) FUMES. Blasting agents intended for use underground shall be carefully compounded in an oxygen-balanced mixture to minimize the possibility of producing toxic fumes. A positive mixing method shall be employed to assure consistent uniform composition. Mixing shall be done at a surface location.

(2) **LOADING BOREHOLES.** When loading blasting agents in underground use, care shall be used to assure the cross section of the borehole is completely filled and that a continuous column, free of voids and impurities is obtained.

(3) **PNEUMATIC LOADING.** The possibility that pneumatic loading devices may generate static electricity in sufficient amounts to cause premature detonation of the priming charge must be recognized. Before pneumatic loading is employed at any operation, thorough tests using adequate equipment shall be made to evaluate this hazard.

(4) **PNEUMATIC LOADING EQUIPMENT.** All elements of pneumatic loading devices shall be electrically bonded together and grounded to dissipate any static charges which might be generated during loading operations. Water lines, air lines, rails or permanent electrical grounding system for other equipment *shall not* be used to ground pneumatic loading equipment. Metal equipment in intimate contact with wet or damp earth will be acceptable.

Note: It is recommended that pneumatic pressure vessels be tested hydrostatically on a periodic basis to one and one half times the operating pressure.

Reference: Wisconsin Boiler and Unfired Pressure Vessel Code

(5) **PNEUMATIC LOADING HOSE.** The hose or tube used in the pneumatic loading system to convey the blasting agent from the hopper into the borehole shall be of the semi-conductive type, with a total resistance low enough to dissipate any charge of static electricity which might be generated and high enough to limit any flow of stray current to a safe level. In general, the resistance of such hose should be not *less* than 5,000 ohms per foot nor *more* than 3,000,000 ohms for the entire length. Periodic checks should be made of the hose to assure that the resistance does not change in usage to a value outside the safe operating limits.

(6) **BOREHOLE SLEEVES AND LINERS.** Plastic or other non-conductive sleeves or liners shall not be used in boreholes being loaded pneumatically unless a positive grounding method is used inside the liner.

(7) **PROTECTION FROM WATER.** Because water decreases the sensitivity of blasting agents and increases the output of toxic fumes on detonation, every reasonable precaution shall be taken to protect blasting agents from water both during storage and in use. Before loading boreholes containing water with blasting agents, the water

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shall be thoroughly removed. If water continues to flow into the hole, a water resistant explosive or blasting agent shall be used rather than a blasting agent.

(8) HEALTH HAZARDS OF AMMONIUM NITRATE AND FUEL OIL OR OTHER BLASTING AGENTS. The possibility of irritating effects from ammonium nitrate, fuel oil or other blasting agent sources should be recognized and corrective action taken where a need is indicated.

(9) FUMES. Following blasting, such place shall not be reentered until the concentration of toxic gases is reduced to a safe level.

History: Cr. Register, February, 1965, No. 110, eff. 3-1-65.

Appendix A

SAFETY RECOMMENDATIONS

These "Do's" and "Don'ts" are from the latest revision adopted by the Institute of Makers of Explosives, September 30, 1955. These rules can also be found on "Case Inserts" in every case of explosives.

1. Don't permit metal, except approved metal truck bodies, to contact cases of explosives. Metal, flammable, or corrosive substances should not be transported with explosives.

2. Don't allow smoking or unauthorized or unnecessary persons in the vehicle.

3. DO load and unload explosives carefully.

4. DO see that other explosives are separated from blasting caps and/or electric blasting caps where it is permitted to transport them in the same vehicle.

5. Don't store blasting caps, electric blasting caps, or primers in the same box, container, or magazine with other explosives.

6. Don't store explosives, fuse, or fuse lighters in a wet or damp place, or near oil, gasoline, cleaning solutions or solvents, or near radiators, steam pipes, stoves, or other sources of heat.

7. Don't store any sparking metal, or sparking metal tools in an explosives magazine.

8. Don't smoke or have matches, open lights, or other fire or flame in or near an explosives magazine.

9. Don't shoot into explosives or allow the discharge of firearms in the vicinity of an explosives magazine.

10. DO consult the manufacturer if nitroglycerin from deteriorated explosives has leaked onto the floor of a magazine. The floor should be desensitized by washing thoroughly with an agent approved for that purpose.

11. Don't use sparking metal tools to open kegs or wooden cases of explosives. Metallic slitters may be used for opening fiberboard cases, provided that the metallic slitter does not come in contact with the metallic fasteners of the case.

12. Don't carry explosives in the pockets of your clothing or elsewhere on your person.

13. Don't make up primers in a magazine, or near excessive quantities of explosives, or in excess of immediate needs.

14. Don't insert anything but fuse in the open end of a blasting cap.

15. Don't strike, tamper with, or attempt to remove or investigate the contents of a blasting cap or an electric blasting cap, or try to pull the wires out of an electric blasting cap.

16. Don't allow children or unauthorized or unnecessary persons to be present where explosives are being handled or used.

17. Don't handle, use, or be near explosives during the approach or progress of any electrical storm. All persons should retire to a place of safety.

18. Don't use explosives or blasting equipment that are obviously deteriorated or damaged.

19. Don't attempt to reclaim or use fuse, blasting caps, electric blasting caps, or any other explosives that have been water soaked, even if they have dried out. Consult the manufacturer.

20. DO carefully examine the face or rock before drilling to determine the possible presence of unfired explosives. Never drill into explosives.

21. DO check the bore hole carefully with a wooden tamping pole or measuring tape to determine its condition before loading.

22. Don't stack surplus explosives near working areas during loading.

23. DO cut from the spool the line of detonating fuse extending into a bore hole before loading the remainder of the charge.

24. Don't load a bore hole with explosives after springing (enlarging the hole with explosives) or upon completion of drilling without making certain that it is cool and that it does not contain any hot metal, or burning or smoldering material. Temperatures in excess of 150° F. are dangerous.

25. Don't spring a bore hole near another hole loaded with explosives.

26. Don't force cartridges or any explosives into a bore hole or past any obstruction in a bore hole.

27. Don't force a blasting cap or an electric blasting cap into dynamite. Insert the cap into a hole made with a punch designed for the purpose.

28. Don't slit, drop, deform, or abuse the primer.

29. Don't connect blasting caps, or electric blasting caps to detonating fuse except by methods recommended by the manufacturer.

30. Don't tamp dynamite that has been removed from the cartridge.

31. Don't tamp with metallic devices of any kind. Use wood tamping tools with no exposed metal parts except non-sparking metal connectors for jointed poles. Avoid violent tamping. Never tamp the primer.

32. DO confine the explosives in the bore hole with sand, earth, clay, or other suitable incombustible stemming material.

33. Don't kink or injure fuse, or electric blasting cap wires, when tamping.

34. Don't uncoil the wires or use electric blasting caps during dust storms or near any other source of large charges of static electricity.

35. Don't uncoil the wires or use electric blasting caps in the vicinity of radio-frequency transmitters except at safe distances.

36. DO keep the firing circuit completely insulated from the ground or other conductors such as bare wires, rails, pipes, or other paths of stray currents.

37. Don't have electric wires or cables of any kind near electric blasting caps or other explosives except at the time and for the purpose of firing the blast.

38. DO test all electric blasting caps, either singly or when connected in a circuit, using only a blasting galvanometer specifically designed for the purpose.

39. Don't use in the same circuit either electric blasting caps made by more than one manufacturer, or electric blasting caps of different style or function even if made by the same manufacturer, unless such use is approved by the manufacturer.

40. Don't attempt to fire a circuit of electric blasting caps with less than the minimum current specified by the manufacturer.

41. DO be sure that all wire ends to be connected are bright and clean.

42. DO keep the electric cap wires or leading wires short-circuited until ready to fire.

43. DO handle fuse carefully to avoid damaging the covering. In cold weather warm slightly before using to avoid cracking the waterproofing.

44. Don't use short fuse. Never use less than 30 inches. Know the burning speed of the fuse and make sure you have time to reach a place of safety.

45. Don't cut fuse until you are ready to insert it into a blasting cap. Cut off an inch or two to insure a dry end. Cut fuse squarely across with a clean sharp blade. Seat the fuse lightly against the cap charge and avoid twisting after it is in place.

46. Don't crimp blasting caps by any means except a cap crimper designed for the purpose. Make certain that the cap is securely crimped to the fuse.

47. DO light fuse with a fuse lighter designed for the purpose. If a match is used the fuse should be slit at the end and the match head held in the slit against the powder core. Then scratch the match head with an abrasive surface to light the fuse.

48. Don't light fuse until sufficient stemming has been placed over the explosive to prevent sparks or flying match heads from coming into contact with the explosive.

49. Don't hold explosives in the hands when lighting fuse.

50. Don't fire a blast without a positive signal from the one in charge, who has made certain that all surplus explosives are in a safe place, all persons and vehicles are at a safe distance or under sufficient cover, and that adequate warning has been given.

51. Don't return to the area of any blast until the smoke and fumes from the blast have been dissipated.

52. Don't attempt to investigate a misfire too soon. Follow recognized rules and regulations, or if no rules or regulations are in effect, wait at least one hour.

53. Don't drill, bore, or pick out a charge of explosives that has misfired. Misfires should be handled only by or under the direction of a competent and experienced person.

54. Don't abandon any explosives.

55. DO dispose of or destroy explosives in strict accordance with approved methods. Consult the manufacturer or follow the Institute of Makers of Explosives pamphlet on destroying explosives.

56. Don't leave explosives, empty cartridges, boxes, liners, or other materials used in the packing of explosives lying around where children or unauthorized persons or livestock can get at them.

57. Don't allow any wood, paper, or fiber materials employed in packing explosives to be burned in a stove, fireplace, or other confined space, or to be used for any purpose. Such materials should be destroyed by burning at an isolated location out of doors and no person should be nearer than 100 feet after the burning has started.

LITERATURE ON EXPLOSIVES

All explosive manufacturers have pamphlets or handbooks available for distribution to users of explosives giving very complete information on the proper use and storage of explosives. A particularly informative pamphlet is one entitled, "Safety in the Handling and Use of Explosives," issued by the Institute of Makers of Explosives, 250 East 43rd Street, New York 17, N.Y.

Appendix B

RECOMMENDATIONS FOR DESTROYING EXPLOSIVES

These recommendations are from Pamphlet No. 21 adopted by the Institute of Makers of Explosives, September 30, 1955.

It is often necessary to destroy explosives. These explosives may be fresh material from containers which have been broken during transportation, usable material for which there is no further need on a job, or they may consist of material which has deteriorated or which has become unfit for use through some sort of damage. Frequently deteriorated explosives are much more hazardous than those in good condition and, hence, require special care in handling and disposal. The methods recommended for destroying various explosive products are given in the following paragraphs. If large quantities of explosives must be destroyed, if experienced or competent men are not available for the work, or if there is any question about the safety of the undertaking, then the handling and destruction of the explosives should be deferred until a representative of the United States Bureau of Mines or of an explosives manufacturer has been consulted.

Warning. The preferred method of destroying dynamite and detonating fuse is by burning. It must be assumed that there is always a possibility of an explosion when either of these two materials is being burned, although it is a remote one in the case of detonating fuse. Consequently, it is important that a place be chosen for burning which is far enough away from any dwelling, railroad, highway, or other place where people may assemble, to eliminate the possibility of injury to persons, or damage to property, should an explosion occur.

Every precaution must be taken when destroying explosives or blasting supplies to make certain that only one type is destroyed at a time. Dynamite, black powder, detonating fuse and safety fuse must be examined carefully to make certain that no detonators of any kind are included. Any attempt to burn these materials when caps of any description are included will almost certainly result in an explosion.

The American Table of Distances, prepared by the Institute of Makers of Explosives, specifies the quantity of explosives that may be stored safely at various distances from inhabited buildings, passenger railways, and public highways. The 2 to 100 pound portion of the American Table of Distances (as revised and approved September 30, 1955) dealing with the separation of unbarricaded explosives storage buildings from inhabited buildings follows:

| Explosives (Pounds) | Distances (Feet) | Explosives (Pounds) | Distances (Feet) |
|------------------------|---------------------|------------------------|---------------------|
| 2- 5..... | 140 | 30- 40..... | 280 |
| 5-10..... | 180 | 40- 50..... | 300 |
| 10-20..... | 220 | 50- 75..... | 340 |
| 20-30..... | 250 | 75-100..... | 380 |

Explosives should be burned at a distance *not less* than those specified in the table for the quantity involved. These *minimum* distances will protect persons against everything but the missile hazard; to guard against it, they should stand near suitable cover that is available for immediate use in case missiles develop. The *minimum* distances will also protect buildings against major structural damage. Obviously, if it is practicable to do so, the burning should be carried out at distances so great that there is *no* chance of either missile injury or minor damage to buildings. If the burning is near magazines, their doors should be closed.

Dynamite. When properly stored and cared for, dynamite will remain in good condition for long periods, in many cases years, but it will deteriorate rapidly if improperly treated. Dynamite which shows obvious signs of deterioration, such as hardness, discoloration, excessive softness, or leakiness, should be destroyed. If the leakiness has proceeded to the extent of saturating the sawdust in the bottoms of the cases, or of staining the cases, the dynamite should not be touched except under the supervision of a representative of the United States Bureau of Mines or of an explosives manufacturer. In addition, dynamite may become unfit for use through some damage, such as wetting, and should be destroyed.

Small amounts of dynamite can be destroyed by exploding them in a safe place, but this is not usually practical where larger quantities are involved. The most satisfactory method of destroying dynamite is by burning, which can be done safely providing certain precautions are taken. It is advisable to limit the amount of dynamite burned at any one time to not more than 100 pounds, and local conditions may make it necessary to reduce this quantity materially.

When burning large quantities of explosives, it is often necessary to burn more than one pile at a time. This is safe provided that: (1) the distance from any dwelling, railroad, highway, etc., is *not less* than that specified in the table, (2) any persons involved are also at the *minimum* safe distance as specified in the table, and are near suitable cover in case of missiles, before the first pile starts to burn, and (3) the piles are separated far enough so that there is no chance of propagation. The latter, which means that the detonation of one pile causes the sympathetic detonation of other piles, can be avoided by spacing the piles *at least* 25 feet apart. This distance covers all quantities up to 100 pounds.

Situations occasionally arise in which the quantity of explosives to be destroyed is so large that it would be impractical to limit the amount to be burned at one time to 100 pounds. In such cases, consult an explosives manufacturer before proceeding.

Dynamite should never be burned in cases or deep piles. The cases should be opened with wooden mallets and wedges, using special care in this operation if there are any signs of leakiness. The cartridges should be removed, slit, and spread over the ground, preferably with a mat of loose paper or excelsior underneath them. In no case should the layer of dynamite exceed two or three inches in thickness. Some dynamites are difficult to ignite, hence it is necessary to have combustible fuel beneath the cartridges. If the dynamite is wet, it may be necessary to pour a little kerosene or diesel fuel oil over it. The pile should be ignited by a small pilot fire of paper, wood shavings, or other kindling material arranged so that the fire will have to burn several feet before it reaches any explosive material. This will allow

the operator ample time to reach a place of safety before there is any possibility of an explosion. It is also recommended that the kindling be arranged so that it can be ignited on the down wind end. After lighting the pilot fire, all persons should retire immediately to a safe place until the dynamite has completely burned.

When more than 100 pounds of dynamite must be destroyed, a new space should be selected for each lot, as it is not safe to place dynamite on the hot ground of the preceding burning. As soon as all dynamite has been destroyed, the ground where the material was burned should be plowed. The residue from burning dynamite contains salts which may be eaten by cattle with serious results.

In case magazine floors become stained with nitroglycerin, they should be scrubbed well with a stiff broom, hard brush, or mop, using a freshly mixed solution composed of 1½ quarts of water, 3½ quarts of denatured alcohol, 1 quart of acetone, and 1 pound of sodium sulfide (60% commercial). The liquid should be used freely to decompose the nitroglycerin thoroughly. If the magazine floor is covered with ruberoid or any material impervious to nitroglycerin, this portion of the floor should be thoroughly swept with dry sawdust and the sweepings taken to a safe distance from the magazine and destroyed *in the same manner as dynamite*.

Dynamite boxes and packing materials. All empty dynamite boxes, box liners and sawdust, and empty bags or cartridges, should be carefully collected and destroyed. This is in part because they constitute a potential hazard, and in part because livestock may eat the paper products with possibly fatal results.

Burning is also the most satisfactory means for destroying dynamite boxes and packing materials. An explosion may take place during the burning, however, either because a little loose dynamite is still present or because the materials have absorbed some of the liquid explosive. Thus the burning must be carried out in the open, and in a location such that neither injury nor damage will result in the event of an explosion. All persons involved should proceed to a safe place, at least 100 feet away, immediately after the fire is started.

Waste materials accumulated in loading a shot should preferably be burned after the shot has been made. If they are burned before the shot, the burning should never be carried out either (1) in the shot area, or (2) before the holes have been stemmed.

Detonating fuse. The preferred method of destroying detonating fuse is by burning. It should not be burned on the spool, but should be strung out in parallel lines one-half inch or more apart on top of paper or dry straw.

Black powder. This is best destroyed by pouring the powder into a river or large body of water. Pellet Powder should be removed from its wrapper to insure quick destruction. State Stream Pollution laws should be consulted before this method is used.

Detonators. Blasting caps, electric blasting caps, and delay electric blasting caps which have so deteriorated from age or improper storage that they are unfit for use should be destroyed. These devices should also be destroyed if they have ever been under water, as for example, during a flood, regardless of whether they have been subsequently dried out. In some cases the shells of caps which have been wet and then dried will show signs of corrosion. Such caps may be very dangerous to handle, and it is recommended that they not be

disturbed until a representative of the manufacturer has had an opportunity to pass on them.

The method most generally used for destroying detonators is to explode them with dynamite under some confinement as described below. Detonators should not be thrown into small lakes or bodies of water, such as rivers, creeks, ponds, wells, or water-filled abandoned quarries.

If possible it is advisable to explode ordinary (fuse) blasting caps in the original containers. Otherwise they should be placed in a small box or bag. A hole should be dug in the ground, preferably in dry sand, at least a foot deep. The container is placed in the bottom of the hole and primed with about one-half pound of dynamite and a good electric blasting cap or ordinary cap and fuse. The caps and the primed cartridge should be carefully covered with paper and then dry sand or fine dirt and fired from a safe distance. It is recommended that never more than 100 caps be fired at one time and that the ground around the shots be thoroughly examined after the shot to make certain that no unexploded caps remain. The same hole should not be used for successive shots unless the entire inside surface of the hole feels cool to the touch.

To destroy electric blasting caps or delay electric blasting caps it is necessary first to cut the wires off about one inch from the top of the cap, preferably with a pair of tin snips. No attempt should be made to cut wires from more than one cap at a time. Not more than 100 caps should be placed in a box or paper bag, primed with about one-half pound of dynamite and a good electric blasting cap, buried under paper and sand or dirt, and exploded as described above. It is desirable, especially in the case of delay electric blasting caps, to bundle them together so that the business ends are close together. Of course, the same precautions mentioned in the preceding paragraph should be observed.

Electric squibs and delay electric squibs. These devices should be destroyed by the same procedure as that used for electric blasting caps.

Safety fuse. This material may be disposed of very satisfactorily by burning in a bonfire.

All other materials. The destruction of explosives and blasting supplies not included above should be referred to the manufacturer.

Alternate methods. Manufacturers are familiar with and frequently employ means of destroying explosives and blasting supplies other than by the methods above described, and such other methods may be employed, but only under the direction of the manufacturer.

Appendix C

RADIO FREQUENCY ENERGY—A POTENTIAL HAZARD IN THE USE AND TRANSPORTATION OF ELECTRIC BLASTING CAPS

Note: These recommendations are from Pamphlet No. 20 adopted by the Institute of Makers of Explosives.

Introduction. When they are in operation, all transmitters of radio and the related radio-frequency (RF) services such as television and radar create a field of electrical energy in the air surrounding their antennas. It has been found that, under exceptional circumstances, electric blasting caps may pick up enough of this energy to cause them to explode.

Magnitude of the RF energy hazard. From a practical standpoint, the possibility of a premature explosion due to RF energy is extremely remote. This has been demonstrated by numerous tests on representative transmitting equipment, and it is confirmed by many years of experience. The annual consumption of electric blasting caps is well over 100 million, and they are used in every section of the country. Yet there have been only two authenticated cases of a cap being accidentally fired by radio. Both of these were caused by amplitude-modulated (AM) transmitters operating in the low frequency range (540–1600 kilocycles) with horizontal antennas.

All types of RF energy receivers are harmless. There is also no danger from transmitters in the case of explosives that are not directly actuated by electricity. Examples of these explosives are fuse-type blasting caps, the detonating fuses such as "Primacord," and dynamite.

How RF energy can fire an electric blasting cap. The wires on an electric blasting cap, or in an electric blasting circuit, can act as an antenna. If the configuration of the wires is just right, and if the radio transmitter is close enough, this antenna may pick up enough current to cause detonation.

A peculiar feature of radio-frequency current is the fact that the actual current varies at different points along an antenna, and is at a maximum at certain points and zero at others, varying continuously in between. If the electric blasting cap wires are acting as an antenna, therefore, the greatest danger exists when the cap is located at a point where the induced current is at a maximum.

Conditions required for maximum current pickup. For the radio frequencies used in AM radio broadcasting, navigational aids, and mobile transmitters, the hazard is greatest when (1) the cap is in the center of a straight length of wire equal to one-half the radio wave length*, or a multiple thereof, or (2) the cap is at the grounded end of a straight length of wire equal to one-quarter the radio wave length or an odd (3, 5, etc.) multiple thereof. At these frequencies, the maximum current pickup is obtained when the wires are (1) parallel to a horizontal transmitting antenna or pointed toward a vertical antenna and in its zone of maximum radiation, and (2) raised a few feet above the ground.

For the high radio frequencies used in frequency-modulation (FM) and television broadcasting, the hazard is greatest when the cap is at the grounded end of a straight length of wire which is (1) equal in

length to several radio wave lengths* and (2) directed at the transmitter antenna.

Effect of transmitter type. Commercial amplitude-modulated (AM) transmitters are potentially the most dangerous. This is because they combine high power, low frequencies, and in some cases horizontal antennas. The latter are objectionable because most blasting circuits are also horizontal, and low frequencies induce more current than high frequencies.

Frequency-modulated (FM) radio and TV transmitters are very unlikely to create a hazardous situation. Although their power is often high, they employ high frequencies with a flat, radiation pattern, and their antennas are located on top of very high towers.

Mobile radio must be rated as a potential hazard because, although its power is low, it can be brought directly into the blasting area. Actually, however, there is little chance that mobile radio could cause a premature explosion. In addition to its low power, the favorable factors are vertical antennas and high frequencies.

There is also little possibility that other sources of RF energy such as amateur radio, microwave relay, Loran, etc., will ever constitute a practical problem. They are all characterized by one or more of the following: (1) location in areas where blasting is unlikely, (2) low power, (3) very high frequency, and (4) restricted radiation patterns. In the vicinity of high-power radar, or "over-the-horizon" or forward scatter antennas, however, electric blasting should not be conducted within the beam because of the extremely high effective radiated power resulting from the high-gain antennas used with this equipment.

The tables on pages 11 and 12 give the pertinent data with respect to most types of RF transmitters. Rated power of the transmitting stations is normally the "effective radiated power" in its zone of maximum radiation.

Recommended minimum distances from radio-frequency transmitters. Radio-frequency energy decreases as the square of the distance from the transmitter antenna and the square of the transmitter frequency. Thus it is obvious that there must be some minimum distance beyond which it is safe to conduct electric blasting operations, even under the worst of conditions. The minimum distances recommended by the Institute of Makers of Explosives are indicated in Tables 1, 2, and 3 and the graphs of Figures 1, 2, and 3 respectively. Whereas the tables are useful for quick reference, the graphs make it easy to interpolate distances for intermediate powers not shown in the tables. Distance measurements should be taken either from the foot of the antenna tower or, if there are more than one, from the foot of the nearest tower.

Determining the extent of radio-frequency hazards. If electric blasting is to be used near a transmitter and either (1) the conditions are not covered by the tables and graphs or (2) a field survey of the hazards is desired, the following comments may be helpful:

(1) The minimum firing current of commercial electric blasting caps now manufactured in this country is about 0.25 ampere. It is strongly recommended, however, that nonelectric initiation be used if a current testing device shows more than 0.06 ampere.

(2) The most satisfactory testing device is a thermomilliammeter, which is useful at radio frequencies as high as 500 megacycles. If one

* The radio wave length in feet is approximately 1,000,000 divided by the frequency in kilocycles or 1,000 divided by the frequency in megacycles.

is not available, however, an incandescent lamp which lights up brightly at 0.06 ampere may be substituted. The No. 48 pilot lamp meets this requirement at the present time.

(3) In surveying a blasting area for radio hazards, it is obvious that conditions should deliberately be made as hazardous as they ever conceivably could be. In the vicinity of low frequency transmitters, therefore, the dummy circuit should (1) consist of a straight piece of wire of exactly half the radio wave length* with the test device in the center of the wire and (2) be held several feet off the ground on stakes or other insulated support (not held up by hand), parallel to a horizontal transmitter and in its zone of maximum radiation and as close to the antenna as blasting would ever be done. In the case of vertical antennas the tests should be made in a similar way except that one end of the wire, which is parallel to the ground, should be pointed at the antenna tower and the other end in a direction away from the antenna. For television and FM broadcasting transmitters, (1) the dummy circuit should consist of a straight piece of wire at least five lengths long with the test device connected between one end of the wire and a good ground, and (2) the other end of the wire should be "aimed" at the antenna. (By way of detail, the ground may consist of a metal stake driven into the ground to which one side of the test device is attached. The "antenna" wire should be attached to the other side of the device and pointed diagonally upward toward the transmitting antenna which is on top of the tower.) As has been stated previously, electric blasting is not recommended if the test device indicates a current of 0.06 ampere or more.

The presence of a microwave radar beam can most readily be detected by means of a 2-watt neon glow lamp, such as the present NE-34 or NE-36. The Institute of Makers of Explosives have not found it possible to detonate commercial electric blasting caps by means of radar; nevertheless, it is advisable to keep them out of a radar beam.

Transportation. All available evidence indicates that radio is not a hazard in the transportation of electric blasting caps so long as they are in their original containers. This is because the wires are then coiled or folded in a manner which provides highly effective protection against current induction. Furthermore, almost all truck bodies and freight cars are made of metal and this virtually eliminates the penetration of RF energy.

If vehicles equipped with radio transmitters are used in transporting electric blasting caps to or from a job, it is recommended that (1) they be carried in a closed metal box, and (2) the transmitter be turned off when the caps are either being put into or taken out of the box. To protect against shock and friction, the metal box should be lined with a soft material such as wood or sponge rubber.

The statements in this pamphlet apply solely to commercial electric blasting caps manufactured in the United States. They do not apply to military electric firing devices. They are based on our own research and that of others and are believed to be accurate. However, no guarantee of their applicability is made because we cannot cover every possible application nor anticipate every variation encountered in the use of electric blasting caps.

* Due to end effects, the wave length is sometimes slightly less than the figure obtained in dividing 1,000,000 by the frequency in kilocycles, or 1,000 by the frequency in megacycles. It is good practice, therefore, to start with the calculated wire length and then cut off short lengths from each end until the maximum current is reached.

TABLE I
RECOMMENDED TABLE OF DISTANCES FOR AM TRANSMITTERS
(See Also Figure 1)

| Transmitter Power (Watts) | Minimum Distance (Feet) |
|------------------------------|----------------------------|
| 5-25 | 100 |
| 25-50 | 150 |
| 50-100 | 220 |
| 100-250 | 350 |
| 250-500 | 450 |
| 500-1,000 | 650 |
| 1,000-2,500 | 1,000 |
| 2,500-5,000 | 1,500 |
| 5,000-10,000 | 2,200 |
| 10,000-25,000 | 3,500 |
| 25,000-50,000 | 5,000 |
| 50,000-100,000 | 7,000 |

TABLE II
RECOMMENDED TABLE OF DISTANCES FOR VHF TV, FM BROADCASTING AND FM MOBILE TRANSMITTERS
(See Also Figure 2)

A. VHF Television and FM Broadcasting

| Transmitter Power (Watts) | Minimum Distance (Feet) |
|------------------------------|----------------------------|
| 1-10 | 5 |
| 10-100 | 20 |
| 100-1,000 | 60 |
| 1,000-10,000 | 200 |
| 10,000-100,000 | 600 |
| 100,000-1,000,000 | 2,000 |

B. FM Mobile Transmitters

| Transmitter Power (Watts) | Minimum Distance (Feet) |
|------------------------------|----------------------------|
| 1-10 | 5 |
| 10-30 | 10 |
| 30-60 | 15 |
| 60-250 | 30 |
| 250-600 | 45 |

RECOMMENDED TABLE OF DISTANCES FOR UHF TELEVISION

TABLE III
TRANSMITTERS
(See also Figure 3)

| Transmitter Power (Watts) | Minimum Distance (Feet) |
|------------------------------|----------------------------|
| 1-10 | 2.5 |
| 10-100 | 8 |
| 100-1,000 | 25 |
| 1,000-10,000 | 80 |
| 10,000-100,000 | 250 |
| 100,000-1,000,000 | 800 |
| 1,000,000-5,000,000 | 2,000 |

RADIO TRANSMITTING STATIONS
Partial List

| Type | Frequency (Megacycles) | Wavelength (Feet) | Maximum Transmitter Power (Watts) |
|--|-----------------------------|----------------------|--|
| Commercial | | | |
| Standard Broadcast (AM)..... | 0.54-1.6 (540-1,600 Kc.) | 1820-615 | 50,000* |
| Frequency Modulation (FM)..... | 88-108 | 11.2-9.1 | 550,000* |
| Television (Channels 2 to 5)..... | 54-88 | 18.2-11.2 | 100,000* |
| Television (Channels 6 to 13)..... | 174-216 | 5.6-4.5 | 316,000* |
| Television (Channels 14 to 83)..... | 470-880 | 2.1-1.1 | 5,000,000* |
| Amateur | | | |
| 160-Meter Band..... | 1.8-2.0 | 545-480 | 1,000 |
| 80-Meter Band..... | 3.5-4.0 | 280-248 | 1,000 |
| 40-Meter Band..... | 7.0-7.3 | 140-135 | 1,000 |
| 20-Meter Band..... | 14.0-14.4 | 70.0-68.2 | 1,000 |
| 15-Meter Band..... | 21.10-21.25 | 46.3-46.0 | 1,000 |
| Citizens' Band..... | 26.96-27.23 | 36.6-36.0 | 5 |
| 10-Meter Band..... | 28.0-29.7 | 35.1-33.0 | 1,000 |
| 6-Meter Band..... | 50.0-54.0 | 19.7-18.2 | 1,000 |
| 2-Meter Band..... | 144-148 | 6.8-6.65 | 1,000 |
| 1 $\frac{1}{2}$ -Meter Band..... | 220-225 | 4.46-4.36 | 1,000 |
| (Also others scattered in the range 420 to 30,000 megacycles.) | | | |
| Two-Way Communications | | | |
| HF Range Central Station..... | 25-50 | 36-18 | 500 |
| Mobile Unit..... | 25-50 | 36-18 | 100 |
| VHF Range Central Station..... | 148-174 | 6.3-5.3 | 600 |
| Mobile Unit..... | 148-174 | 6.3-5.3 | 50 |
| LF Range (Aviation)..... | 0.2-0.4 | 5000-25000 | 2,000 |
| HF Range (Aviation)..... | 4-23 | 250-44 | 50,000 |
| VHF Range (Aviation)..... | 118.0-135.9 | 8.5-7.4 | 50 |
| UHF Range (Aviation)..... | 225-500 | 4.4-2.0 | 100 |
| Radio Telegraph..... | 6-23 | 167-44 | 50,000 |
| Microwave Relay..... | 2000-12,000 | 0.5-0.08 | 50 |
| Navigational Aids | | | |
| Radio Range Beacon ("A"- "N")..... | 0.200-0.415 | 5000-2400 | 600 |
| Loran..... | 1.8-2.0 | 545-490 | 1,000,000 peak; 3,000 avg. |
| VOR-ILS (Aviation)..... | 108-118 | 9.0-8.3 | 200 |
| Shoran..... | 290-320 | 4.7-3.1 | 25,000 peak; 1,000 avg. |
| Long Range Radar (Non-Military)..... | 1300-1350 | 0.77-0.74 | 1,000,000 peak; 100,000 avg. |
| 10-CM. Radar (Non-Military)..... | 2700-2900 | 0.37-0.34 | 750,000 peak; 1,000 avg. |
| 3-CM. Radar..... | 10,000 | 0.10 | |

*Maximum effective radiated power (ERP).

Appendix D

RECOMMENDATIONS FOR STORAGE OF AMMONIUM NITRATE

1. **General precautions.** Ammonium Nitrate, either in bulk or in bags, should be stored so it is easily accessible and away from electrical wires, steam pipes, radiators, explosives, organic materials, acids and any easily oxidized materials including oils, grease, solvents, etc.

2. **Storage buildings.** Storage buildings for Ammonium Nitrate should be constructed of noncombustible or fire-resistant materials. Corrugated metal roofing and siding over wood studding is considered satisfactory. The buildings shall be dry, well ventilated, and equipped with spark-arresting screens over the ventilators.

3. **Storage building floors.** The storage building floor should be of noncombustible material, concrete or an approved substitute, and all open drains shall be effectively plugged to prevent molten Ammonium Nitrate flowing into such drains in case of a fire. Any cracks appearing in floor are to be repaired immediately.

4. **Storage of bags.** Bags of Ammonium Nitrate should not be stacked closer than 30 inches to building walls or in piles of more than 20 feet in width. Aisles between piles of bags should be not less than 30 inches wide, and should be placed to provide easy access and ample ventilation. Bags should not be closer than 36 inches from the eaves of the roof or from the supporting or spreader beams.

5. **Storage building location.** The following shall be considered in choosing an Ammonium Nitrate storage building location for temporary or permanent storage:

- (a) Maximum amount of intended storage.
- (b) Congestion of area, including highway and rail traffic and public buildings.
- (c) Availability of fire fighting facilities.
- (d) State and local regulations.
- (e) Toxic-fume hazards in event of fire.

6. **Smoking and open flames.** Smoking, smoking materials and open flames are prohibited in or near Ammonium Nitrate storage areas. Signs to this effect should be posted and the rule should be enforced.

7. **Loosening of caked ammonium nitrate.** Under *no* circumstances shall caked Ammonium Nitrate either in bags or in bulk be loosened by blasting with explosives.

8. **General housekeeping.** The Ammonium Nitrate storage area should be kept clean and maintained in good housekeeping order. Ammonium Nitrate from broken bags should be cleaned up promptly and rebagged or removed from the premises.

9. **Storage with blasting agents.** If Ammonium Nitrate is stored in the same building with blasting agents, the combined quantity of both materials shall be considered as blasting agent and the location of the storage building must then conform to American Table of Distances with respect to inhabited buildings, passenger railroads and public highways.

10. **Storage with explosives.** Ammonium Nitrate may be stored with explosives only in a properly constructed explosive magazine. The

aggregated weight of all stored materials including explosives, blasting agents, and Ammonium Nitrate must then be used in conformance with the American Table of Distances.

11. **Bulk storage.** Bulk storage of Ammonium Nitrate may be in mobile or stationary trucks, vans, tanks, railroad cars or similar conveyances or containers.

Note: Other rules pertaining to ammonium nitrate can be found in the Manual Sheet A-10 published by the Manufacturing Chemists Association, Inc., 1825 Connecticut Avenue, N.W., Washington, D.C. Price 50 cents.