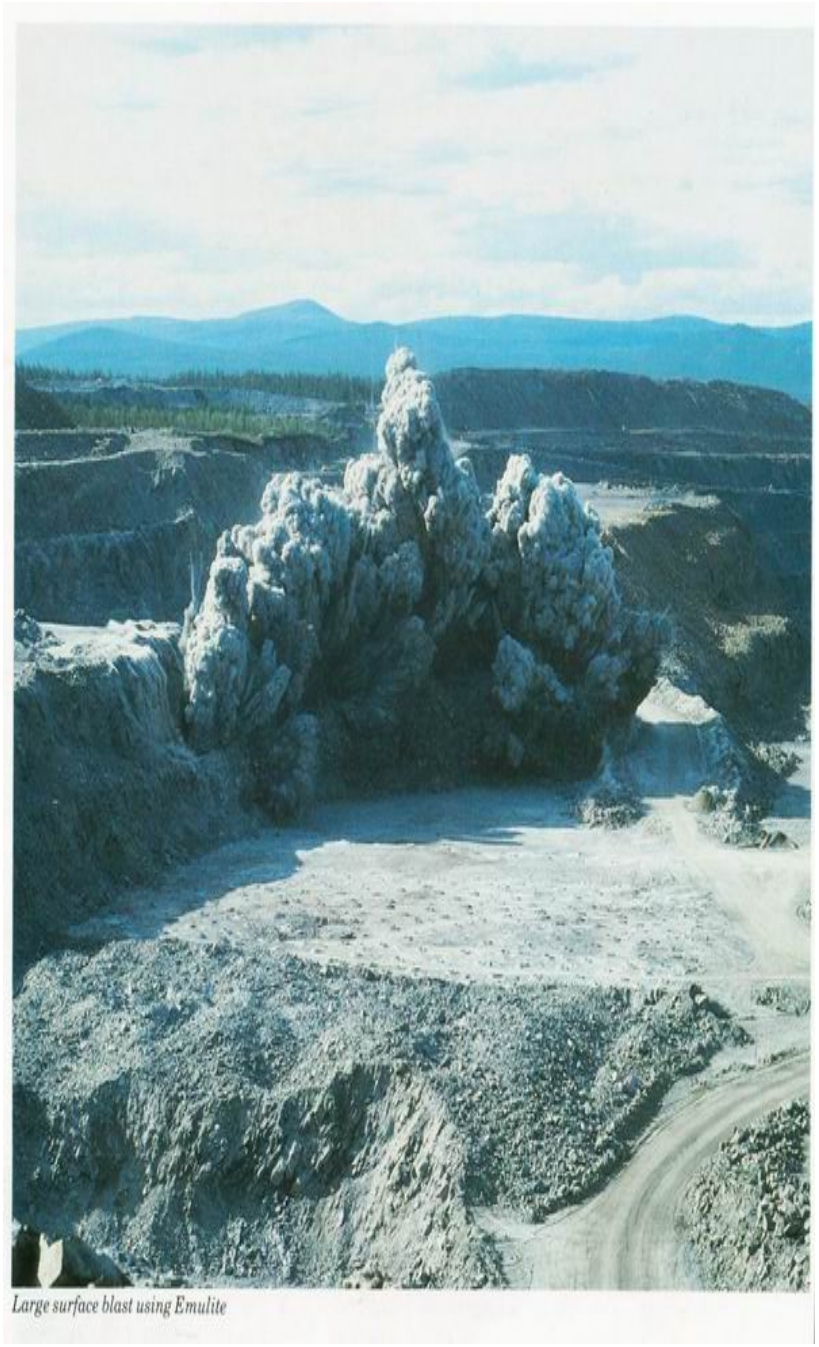
Explosive Properties

Lesson 2 and 3

Explosive Properties

1. Strength
2. Velocity Of Detonation (VOD) and Velocity of Deflagration
3. Density
4. Pressure of Detonation
5. Sensitivity
6. Water resistance
7. Fume
8. Permeability



Large surface blast using Emulite

1) Strength

- The term sterngth, traditionaly associated with the strength markings of different dynamite grades has little correlation with the effectiveness of an explosive in blasting and has no meaningfull relation to ANFO, emulsion or watergels.
- Strength is related to density and detonation velocity, as well as the heat and gas volume the explosive liberation upon detonation.
- This strength value can be calculated or measured using a variaty of tests (the ballistic mortar, underwater-bubble, the cratering, and the strain-pulse tests).

Strength

- Based on tests or computer calculations, explosives manufactures rate explosive energy in either kilocalories (Kcal) per unit weight or Kcal per unit volume, as follows:
  - Absolute weight strength = the heat of reaction available in each gram (weight) of explosive.
  - Absolute weight strength = the heat of reaction available in each cubic centimeter (volume) of explosive)
  - Relative weight strength = the heat of reaction per unit weught of an explosive as compered with ANFO, or
  - Ralative bulk strength = the heat of reaction per unit volume of an explosive as compared with ANFO.

Ballistic Mortar Test

- The strength of a high explosive is determined by measuring the angle of recoil producedby a 10 g charge of explosive fired in a Dupont Ballistic Mortar and is expressed as a percentage of pollar blasting gelatine.
- The apparatus consists of a pendulum compsed of a mortar which server as its bob, suspended by a rigid frame of light aluminium plates on a knife-edge. It is so designed that the firing of a small (normally 10 g) charge of an explosive propels a tightly fitting projectie and the recoil of the mortar is recorded by the movement of the spring loaded clip on the scale kept in contact with a pointer fixed on the mortar. The scale is grduated in degrees and minutes.

Ballistic Mortar Method

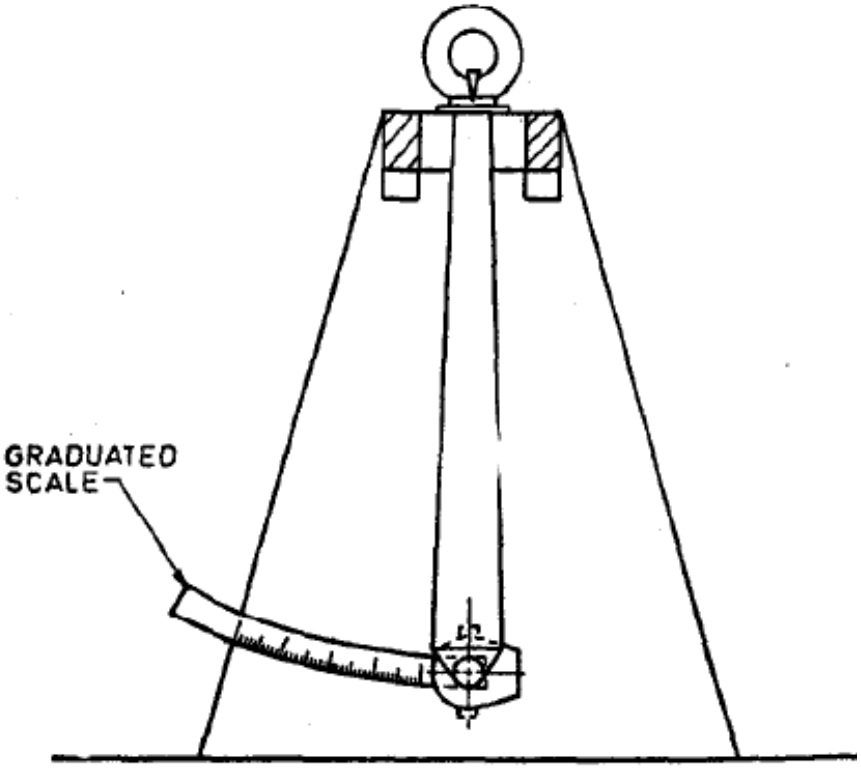
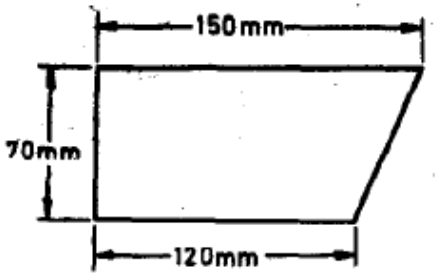
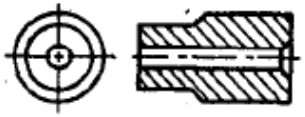


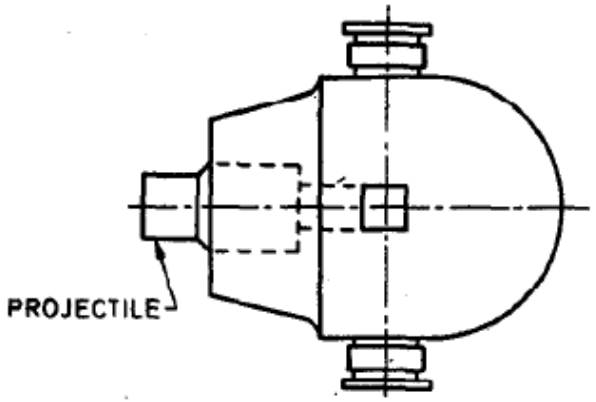
FIG. 5 DUPONT BALLISTIC MORTAR



TINFOIL WRAPPER



PROJECTILE



MORTAR AND PROJECTILE

Calculation strength

$$\text{Strengthof explosive} = \frac{1-cosA}{1-cosA_o} x100$$

Where

A = Swing produced by exploseve under test, and

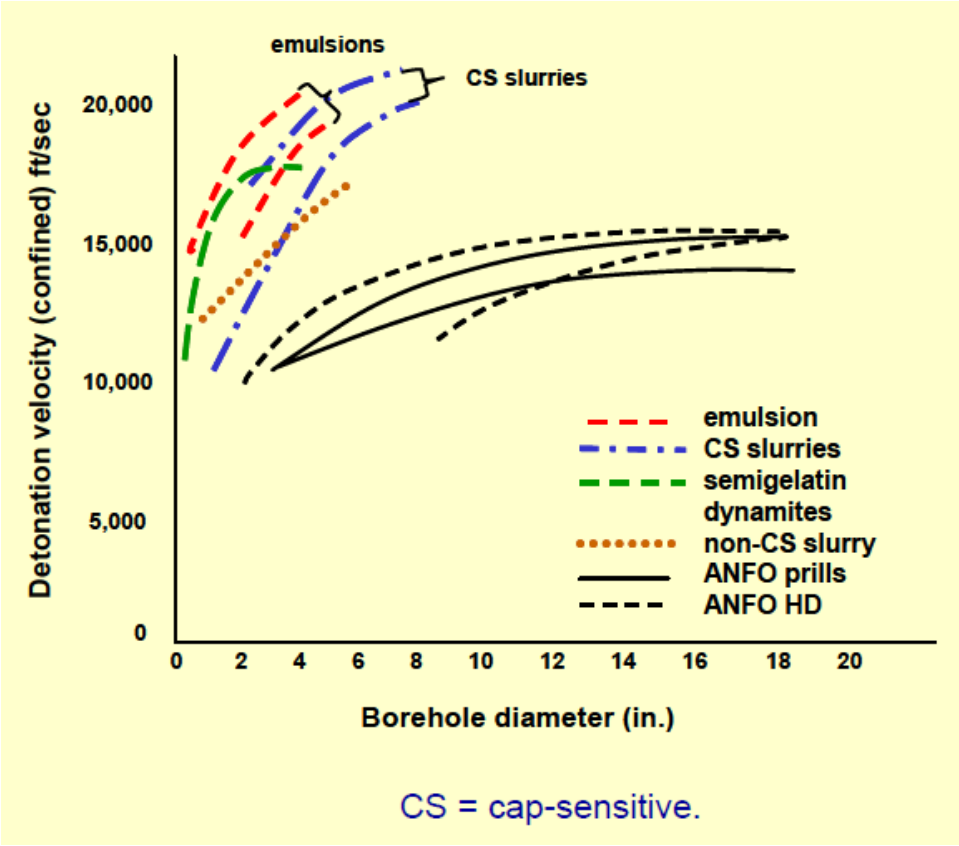
A_o = Swing produced by the polar blasting gelatine

Energy Explosive, Volume Gas and Weight strength relative with Dynamite and ANFO

Type Explosive	Energy (MJ/Kg)	Vol. Gas (m^3/kg)	Weight Strength	
			Dynamite	ANFO
Dynamite I	5.00	0.850	1.00	1.19
Dynamite II	4.42	0.904	0.91	1.08
ANFO	3.89	0.973	0.84	1.00
TNT-Al slurry	4.50	0.700	0.89	1.06
Light slurry	3.44	0.900	0.75	0.89
ANFO 10 % Al	5.56	0.800	1.09	1.30
TNT	4.1	0.960	0.82	0.98
RDX	5.54	0.908	1.09	1.30
PETN	6.12	0.780	1.17	1.39
Nitroglycerin	6.27	0.715	1.19	1.42
Nitromethane	6.4	0.723	1.21	1.44

2) Detonation Velocity

- The detonation velocity of an explosive is the speed at which the detonation, once it achieves a steady state, travel through the explosive.
- This value is a function of formulation, density, borehole diameter, primer size, dan confinement.
- The figure to the right shows generalized relationships between borehole diameter and detonation velocity for various explosive types



CS = cap-sensitive.

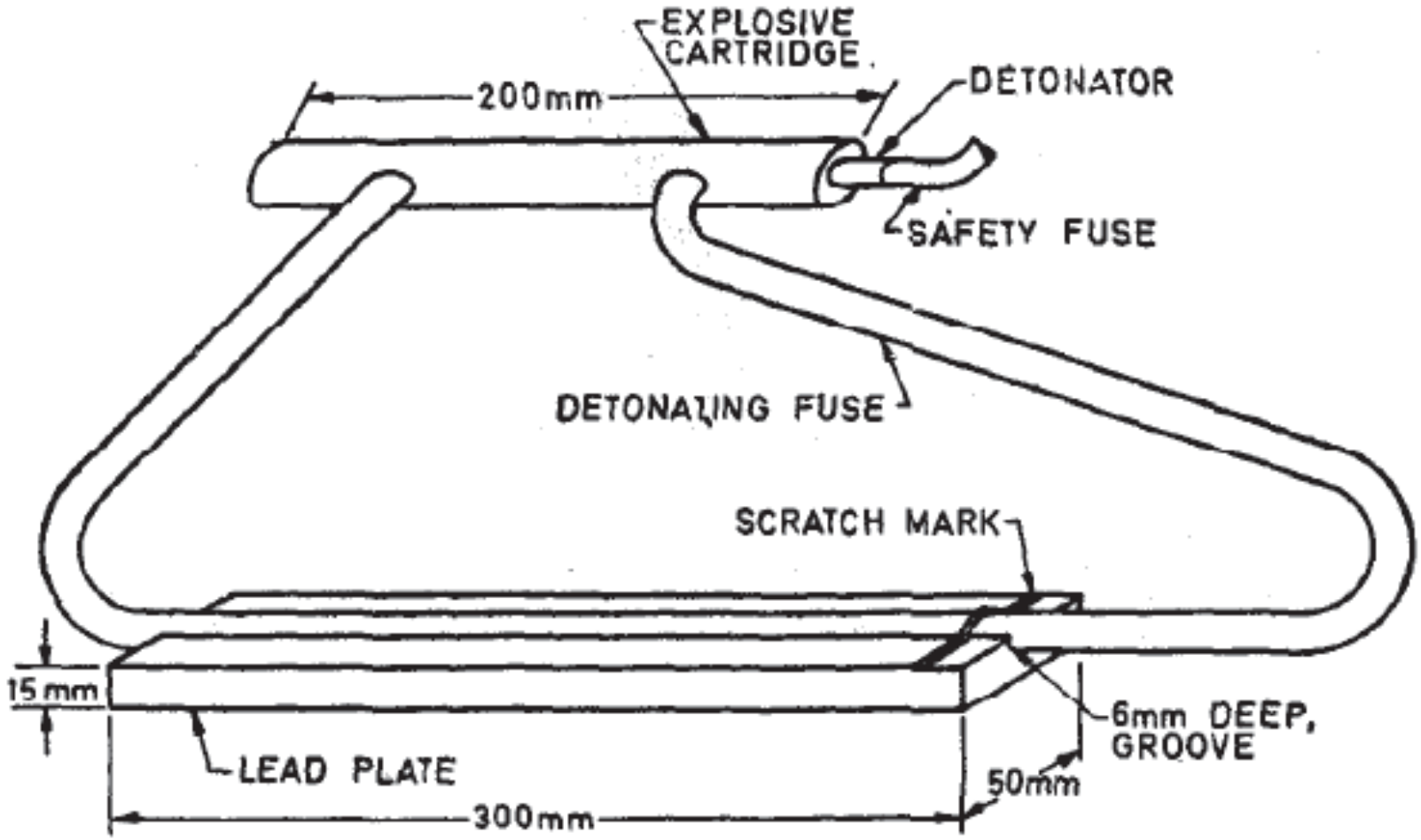


FIG. 4 ARRANGEMENT FOR THE DETERMINATION OF VELOCITY OF DETONATION BY DAUTRICHE METHOD

Velocity of Detonation by Dautriche Method

- The time lag between the intiation of two ends of length of detonation fuse of known velocity of detonation, inserted radially into an explosive charge at a known distance (d) apart, causes the two detonation fuse to meet at a point (DL) away from the centre of the fuse. Knowing the distance (d), the velocity of the detonation (VOD) of detonating fuse, the velocity of detonation (VOD) of the explosive is calculated and is expressed in m/s.

3) Sensitivity

- The term sensitivity, as it pertains to explosive, has to meanings that seem, on first consideartion to contradict each other.
- The first meaning of the sensitivity as it relates to explosive refers to various safety aspects and decribes to ease with which an explosive may be detonated or its sensitivity to accidental detonation from shock, impact, fricton, electrostatics dischrage, and heat.
- There are sensitivity :
  - Sensitivity to Gap.
  - Sensivity to shock (impact).
  - Sensivity to friction.
  - Sensivity to heat.
  - Sensivity to cap.

Sensitivity test

4) Density

- Density is normaly expressed in terms of specific gravity or mass devided by volume, as follows:

  Grams/cubic centimeter = g/cm^3 = g/cc
- Explosvie with bulk densities less than 1,0 g/cc may not readily sink in water, whereas explosives with densities greater than 1,0 g/cc should sink in water, including standing blasthole water.
- Two types of density are important:
  - Package and
  - Free-runnuing product

The two types density

- Package density, the density of an explosive as package in a cartridge or tube at the mixing plant (1) is set by formulation and does not change (unless the package is broken during loading) and (2) must be grether than the density of that same explosive in the blasthole. If air gaps are intruduced around the explosive when loading its cartridge or tube into a blasthole, its charges may decouple.

- Bulk density, the bulk density of a free-running explosive poured from a bag or bulk-loading trcuk is improved with good coupling along the side of the blasthole. The density is somewhat modified by the particle sizes and fall height of the mix.

Loading density

An explosive is loading density (de) is defined as the weight of explosive per unit length of the borehole at a specified hole diameter. Expressed in pounds per foot, de is computed as:

$$de\ (lbs/ft) = 0{,}3405\ \rho\ De^2$$

where:

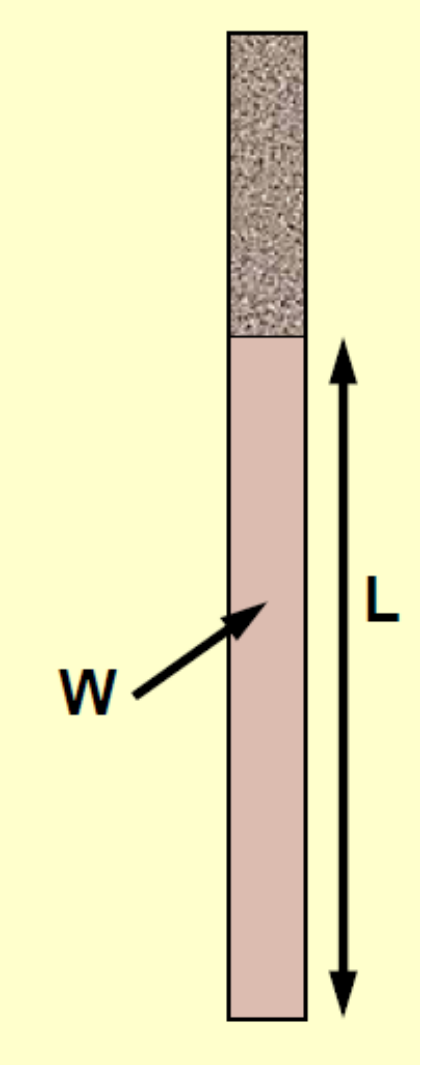
De is the borehole diameter (inch)

ρ is the explosive density (g/cm3)

The de value may also computed bu deviding the total explosive charge weight loaded into a hole (W) by the length of the hole (L0, thus:

$$de = W/L$$

Konwing the de of an explosive is typically of greatest use in the field.



- Relationship between D_e, SG, SC, and d_e as follows:

$$d_e = 71{,}63\ D_e^2/SC \qquad (kg/m)$$

$$d_e = 0{,}508\ D_e^2(\rho) \qquad (kg/m)$$

$$SG = 141/SC$$

5) Detonation pressure

- The pressure associated with a detonation moving throught an explosive, measured in kilobars (kbar) or pounds/sq in (psi), is defined as detonation pressure. Detonation pressure is a a function of detonation velocity and density. Approximating formula, like the ne that follows, are
- Detonation pressure, (P) = $\rho D^2/4$
  - P = detonation pressure on VoD Ideal (Pascal)
  - ρ = Density explosive (kg/m^3)
  - D = VoD = velocity of detonation (m/det)
- Example, ANFO density 0,85 gr/cc and VoD 4.000 m/det, has pressure detonation ideal is 3.400 MPa.

- Detonation pressure is chiefly responsible for the intense rock shearing near borehole, such pressure for commercial explosive ranges from 25 to over 240 kbar.

- Although the detonation pressure of an explosive depends upon, aprt from the density and the VOD, this parameter can be estimated from the following equation:

$$P = 432\ x\ 10^{-6}\ x\ \rho\ x\ \frac{VOD^2}{1 + 0{,}8\ x\ \rho}$$

Where: P = detonation pressure (MPa), r = desnity of explosive (g/cc), VOD = Detonation velocity (m/s)

- Detonating pressure with decoupling efffect :

$$P_d = (P/2)\ (d_1/d)^3 = P_B\ (d_1/d)^3$$

Where; d = borehole diameter(meter), d1 = explosive diameter (meter)

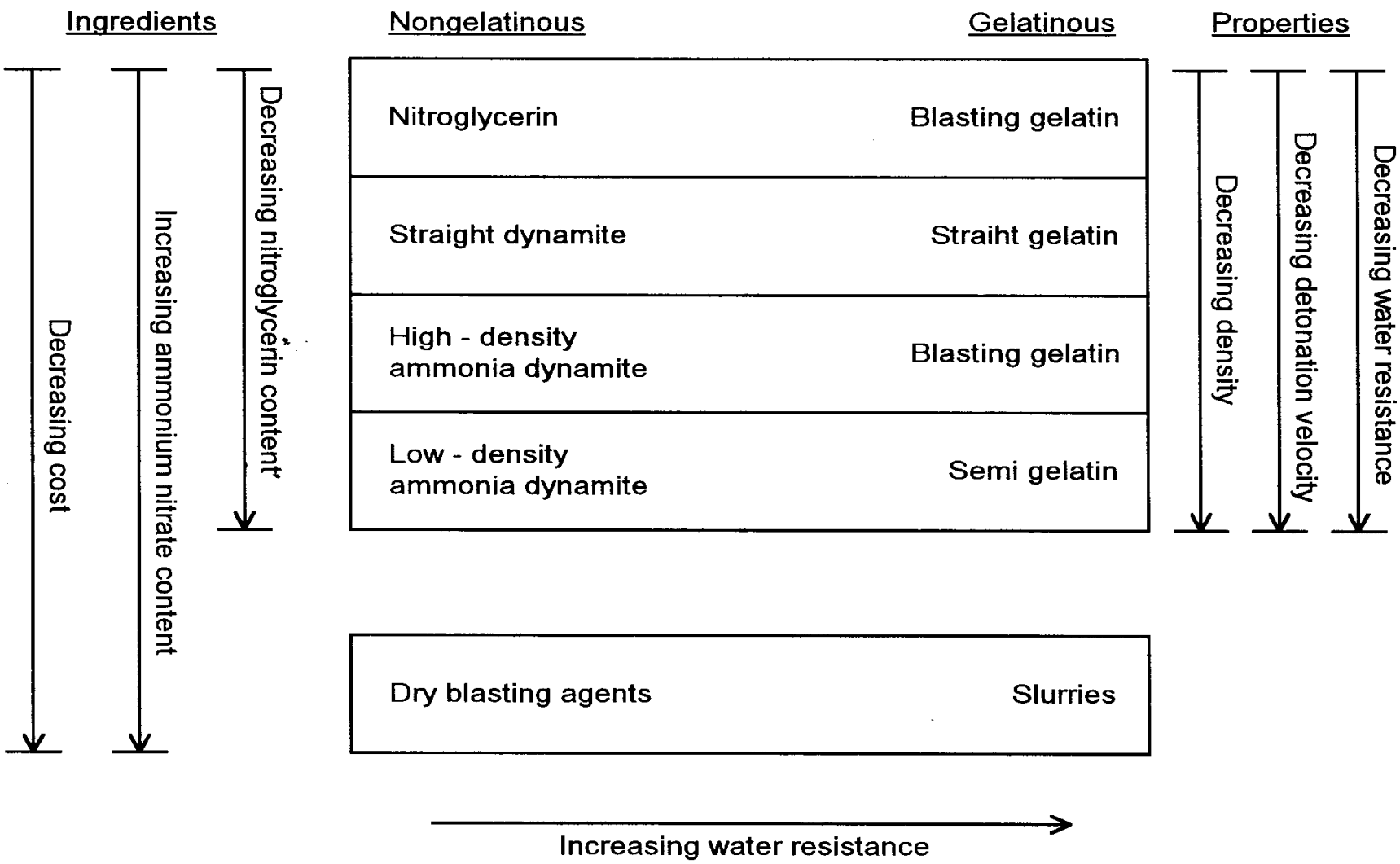
Example, ANFO detonating pressure ideal 3.400 MPa, borehole diameter 20 cm dan explosive diameter 18 cm, detonating prssure

Pd = 3400/2 $(0{,}18/0{,}2)^3$ = 1700 x 0,729 = 1240 MPa

6) Water resistance

- This is the capacity to resist a prolonged exposure to water without losing its characteristics. It varies with the composition of the explosive and is generally linked to the proportion of nitroglicerine or special additives that it contain; thus watergels, gelatine dynamites and emulsions are quite resistance to water.
- The scale of classification generally accepted are :
  - *excellent* a resistance of more than 12 hours,
  - *very good* a resistance of between 8 - 12 hours,
  - *good* a resistance of between 4 - 8 hours
  - *fair* a resistance of less than 4 hours
  - *poor* has no resistance to water.

The change *ingredients,* properties and water resistance



7) Fumes

- The detonation of any commercial explosive produces steam, nitrogen, carbon dioxide, and eventually, solid and liquids. Among the harmless gases mentioned, there is always a certain percentage of toxic gases such a carbon monixide and nitrogen oxides. There resulting products are called fumes.
- Table fumes calssification (Institute of Makers of Explosive, USA

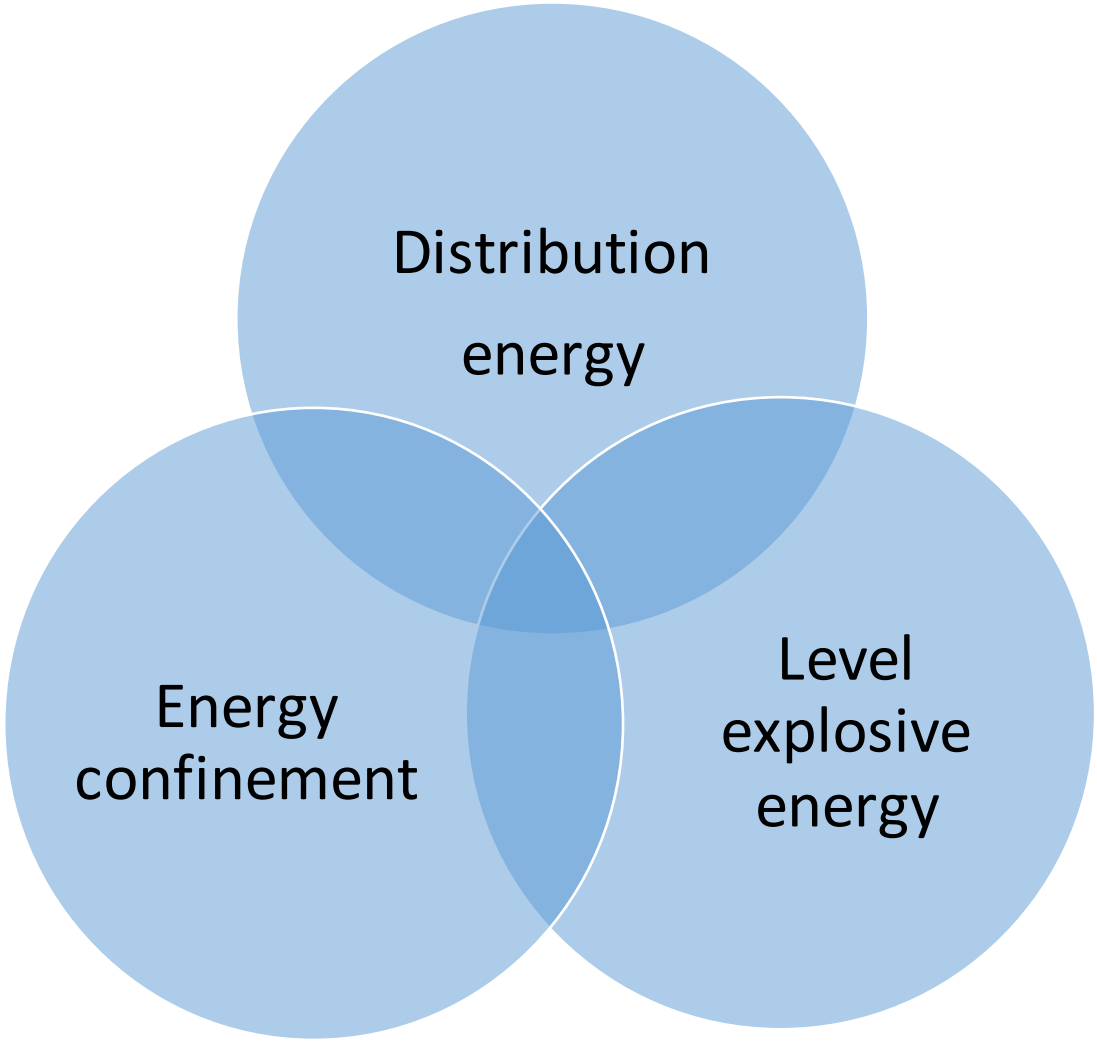
Class	Volume of toxic gases (CO-NO_2) – dm^3
1	0 – 4,53
2	4,53 – 9,34
3	9,34 – 18,96

Bureau of mines for permissible	
Class A -	0 to 53 litres toxious gases /1.5 lb explosive
Class B -	53 to 106 litres toxious gases /1.5 lb explosive
Institute of maker of explosives for non permissible	
Class 1	0.00 - 0.16 cuft toxious gas
Class 2	0.16 - 0.33 cuft toxious gas
Class 3	0.33 - 0.67 cuft toxious gas

8) Permissible Explosive

- Permissible explosives are these designed for use in underground coal mines where the presence of explosive gases and dust iis dengerous for normal blasting. Their main characteristics is the low explosion temperature.
- Permissible explosive are classified in two groups. The first is that in which the composition has an additive that the role of explosion inhibitor, usualy sodium chloride. The second group and more recent group is called reinforced safety or of ionic exchange and obtains lower explosion temperature with diverse ingredients that react at moment of detonation. These esplosive are usually made up of a small percentage of NG, a fuel adn the par saline sodium nitrate-ammonium chloride.

Three Key of The Explosive Optimum Performance



The other factor to choose explosive

- Price of explosive and blasting accesories
- The availability in the market and continuity of supply
- Characteristics rock mass
- Volume of target blasting
- Ground condition and water
- enviroment
- regulations

Handling, Storage and Transport of Explosives

- In order to carry out drilling and blasting under safe conditions, the following aspects must be observed:

1. Comply with the Rules and Regulations that are in effect.
2. Proper technical intruction for the operators, blasters and personnel who handle explosives.
3. Machinary, explosives, accessories and initiation systems must be under safety conditions.

PENGAJUAN IZIN HANDAK PENGGUNA AKHIR

Sumber :Badan Intelejen Keamanan POLRI

NO.	JENIS IZIN	PERSYARATAN		KET
		PERMOHONAN REK ke KAPOLDA	PERMOHONAN IZIN ke KAPOLRI	
1.	IZIN GUDANG	- MENYEBUTKAN ALASAN PENDIRI AN GUDANG. - MENYEBUTKAN JMLH/MACAM dan KAPASITAS GUDANG. - LOKASI GUDANG/GAMBAR dan FOTO GUDANG.	- REKOMENDASI KAPOLDA. - BERITA ACARA PEMERIKSAAN GUDANG. - PERSYARATAN LAIN SEPERTI PER MOHONAN KE KAPOLDA.	- KHUSUS DI LUAR / NON TAMBANG. - UTK PA DI WIL. KERJA TAMBANG DI DITUJUKAN KPD DITJEN GEOLOGI dan SUMBER DAYA MINERAL / DITJEN MIGAS
2.	IZIN 3P	- DATA PERUSAHAAN. - IZIN GUDANG. - SURAT PERJANJIAN KONTRAK / PELAKSANA PROYEK/SIPD. - DATA KA TEKNIK. - JURU LEDAK/TEMBAK (BERSERTI-FIKAT & MEMILIKI KIM/KJT). - DATA KEKUATAN SATPAM.	- REKOMENDASI KAPOLDA. - BERITA ACARA PEMERIKSAAN GUDANG. - PERSYARATAN LAIN SEPERTI PER-MOHONAN KE KAPOLDA.	

NO.	JENIS IZIN	PERSYARATAN		KET
		PERMOHONAN REK ke KAPOLDA	PERMOHONAN IZIN ke KAPOLRI	
3.	IZIN PEMBELIAN dan PENGGUNAAN	- MENYEBUTKAN JUMLAH/JENIS. - RENCANA PEMBELIAN dan PENGGUNAAN. - SPPA. - DATA KA TEKNIK. - DATA JURU LEDAK. - COPY SI 3P & GUDANG.	- REKOMENDASI KAPOLDA. - REKOMENDASI DITJEN MIGAS / GEOLOGI & SDM/KADIS TAMBANG dan ENERGI PROV. TK. I (SUS TAMBANG BATU GOL. C).	- UNTUK KEPERLUAN TAMBANG MENGAJU-KAN REK. KEPALA DIRJEN GEOLOGI & SDM/DIRJEN MIGAS.
4	IZIN PENGALIHAN PENGGUNAAN	- MENYEBUTKAN JMLH/JENIS & ASAL USUL HANDAK. - MENYEBUTKAN ALASAN. - SURAT PERSETUJUAN/PERNYATA AN ALIH GUNA. - SPPA PENERIMA HIBAH/ALIH GUNA - COPY SI HANDAK (ASAL HANDAK) - COPY SI 3P & GUDANG - BAP STOCK AKHIR GUDANG	- REKOMENDASI KAPOLDA. - PERSYARATAN LAIN SEPERTI PERMOHONAN KE KAPOLDA.	

NO.	JENIS IZIN	PERSYARATAN		KET
		PERMOHONAN REK ke KAPOLDA	PERMOHONAN IZIN ke KAPOLRI	
5.	IZIN PENG ANGKUTAN ANTAR POLDA MAUPUN SATU POLDA	- MENYEBUTKAN JMLH/JENIS dan ASAL-USUL HANDAK. - MENYEBUTKAN KEPERLUAN. - BADAN USAHA ANGKUT & SARANA ANGKUT dan TUJUANNYA.	- REKOMENDASI KAPOLDA ASAL dan KAPOLDA TUJUAN. - PERSYARATAN LAIN SEPERTI PER MOHONAN KE POLDA.	- SI ANGKUT SATU POLDA DI KELUAR KAN OLEH POLDA SETEMPAT
6.	IZIN PENGGUNA/ PENGGUNAAN SISA	- MENYEBUTKAN JMLH/JENIS & ASAL USUL HANDAK. - LAP. REALISASI & PENGGUNAAN HANDAK. - COPY SI 2P (ASAL HANDAK). - COPY SI 3P. - BAP/STOCK OPNAME HANDAK YG ADA DI GUDANG.	- REKOMENDASI KAPOLDA ASAL & KAPOLDA TUJUAN. - PERSYARATAN LAIN SEPERTI PER MOHONAN KE POLDA.	
7.	IZIN PEMUSNAHAN	- MENYEBUTKAN JUMLAH / JENIS HANDAK. - ASAL-USUL HANDAK. - MENYEBUTKAN ALASAN. - BAP GUDANG.	- REKOMENDASI KAPOLDA ASAL & KAPOLDA TUJUAN. - PERSYARATAN LAIN SEPERTI PER-MOHONAN KE POLDA.	

JENIS DAN TARIF PNBP SESUAI PP 50 THN 2010 UTK HANDAK BADAN INTELIJEN KEAMANAN POLRI

JENIS IZIN	SATUAN	TARIF
1. IZIN IMPOR	PER SI	Rp. 500.000
2. IZIN EKSPOR	PER SI	Rp. 500.000
3. IZIN RE-EKSPOR	PER SI	Rp. 500.000
4. IZIN GUDANG	PER SI	Rp. 500.000
5. IZIN PEMILIKAN, PENGUASAAN DAN PENYIMPANAN	PER SI	Rp. 500.000
6. IZIN PEMBELIAN DAN PENGGUNAAN	PER SI	Rp. 500.000
7. IZIN PRODUKSI	PER SI	Rp. 500.000
8. IZIN PEMUSNAHAN	PER SI	Rp. 500.000

BADAN USAHA DI BIDANG HANDAK

PRODUSEN / DISTRIBUTOR

- PT DAHANA (PERSERO)
- PT MULTI NITROTAMA KIMIA
- PT PINDAD (PERSERO)
- PT ARMINDO PRIMA
- PT TRIFITA PERKASA
- PT ASA KARYA MULTI PRATAMA
- PT TRIDAYA ESTA
- PT MEXIS

MELAKUKAN GIAT UTK MEMENUHI KEBUTUHAN HANDAK END USER

- Tambang Migas : 130 Perusahaan
- Tambang Umum : 249 Perusahaan
- Non Tambang : 58 Perusahaan

437 Perusahaan