NEW NTO WORKSHOP AND ASSOCIATED PRODUCT CHARACTERIZATIONS

A. Delage, P. Chabin, G. Alvarez, V. Chauffour & G. Eck

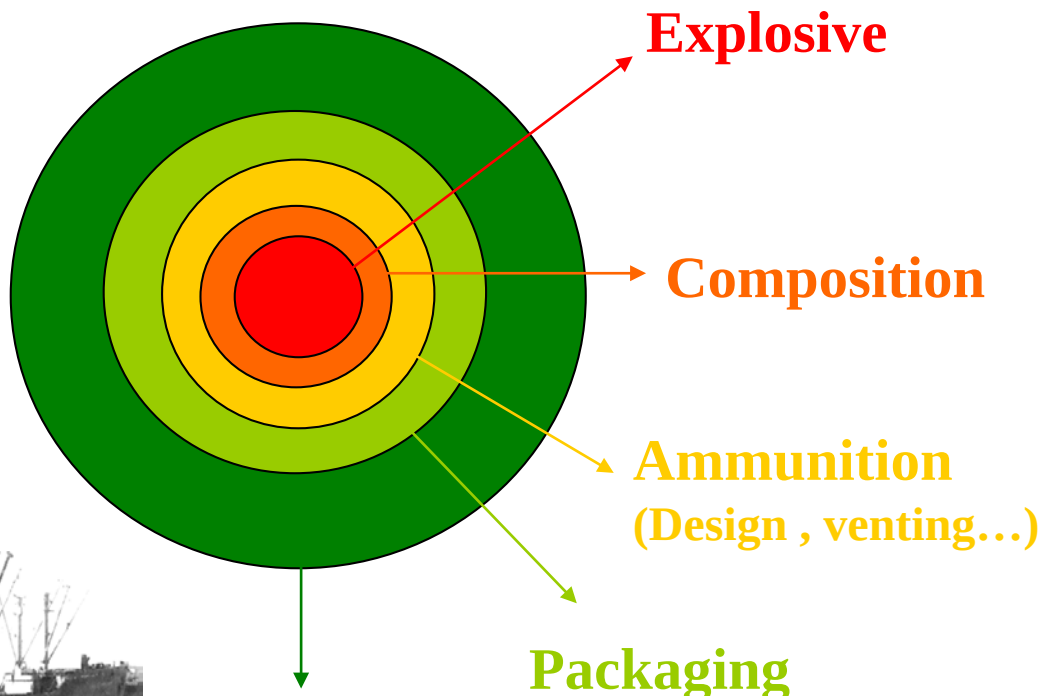
- **Introduction**
- **Applications**
- **Process**
- **New plant vs Old plant**
- **Characterization program**
- **Results**
- **Conclusion**

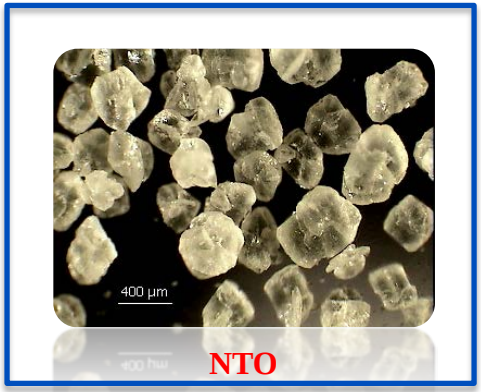
Reduction of sensitivity

PRESSED COMPOSITIONS
MELT CAST COMPOSITIONS

CAST CURED COMPOSITIONS

- **Insensitive Munitions (IM) are to be considered as a whole**






Composition P16945

NTO
Most well known IM explosive
Available from 10 µm up to 450 µm

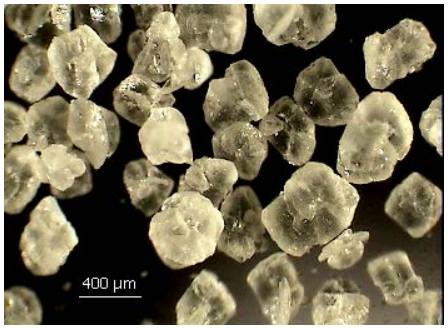
Class 4
D_{50} ~ 10 µm

Class 3
D_{50} ~ 50 µm

Class 2
D_{50} ~ 350 µm

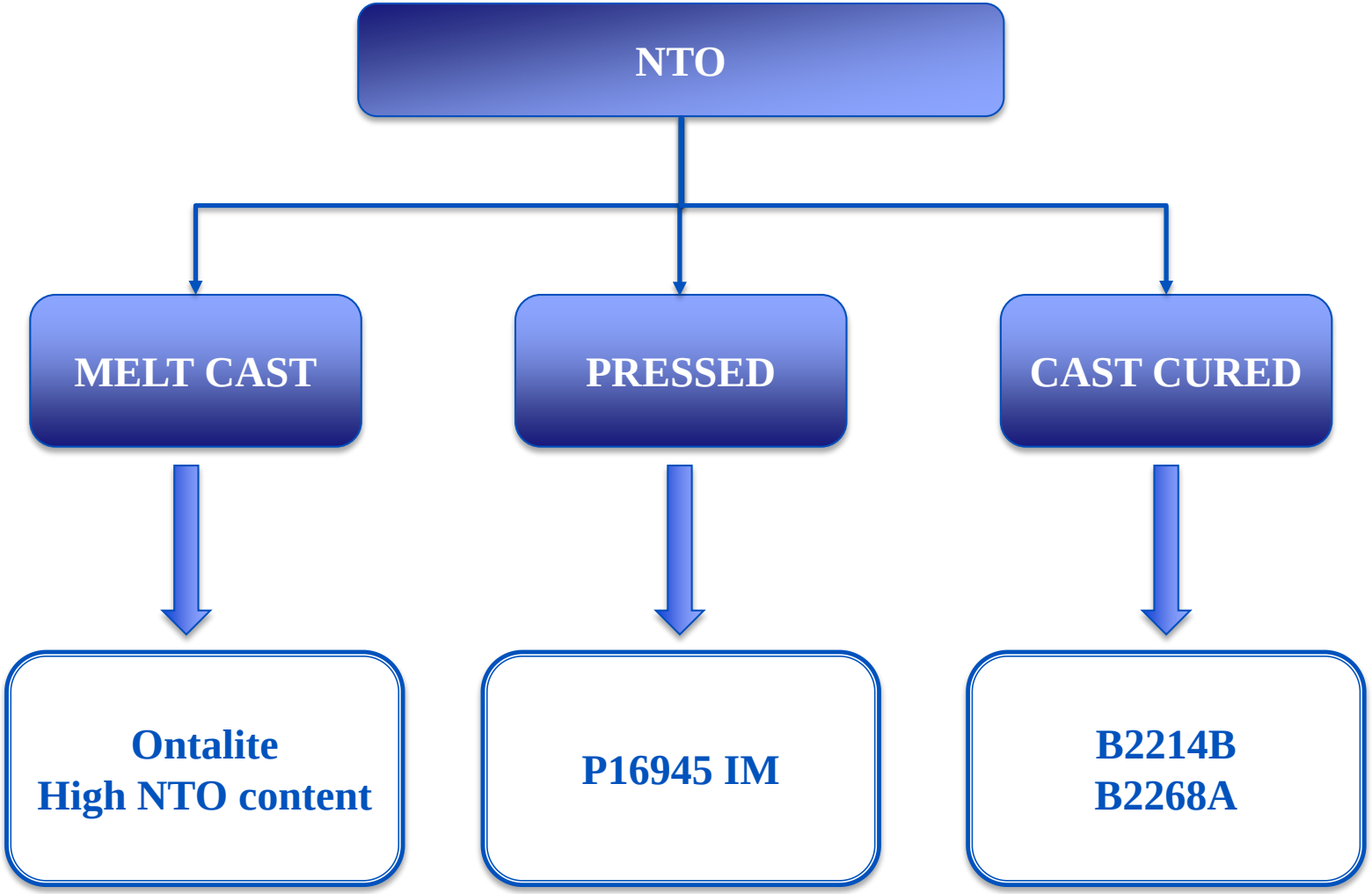
Class CF
(High Bulk de
D_{50} ~ 450 µm

Cast cured compositions
Most of melt cast IM compositions
Pressed

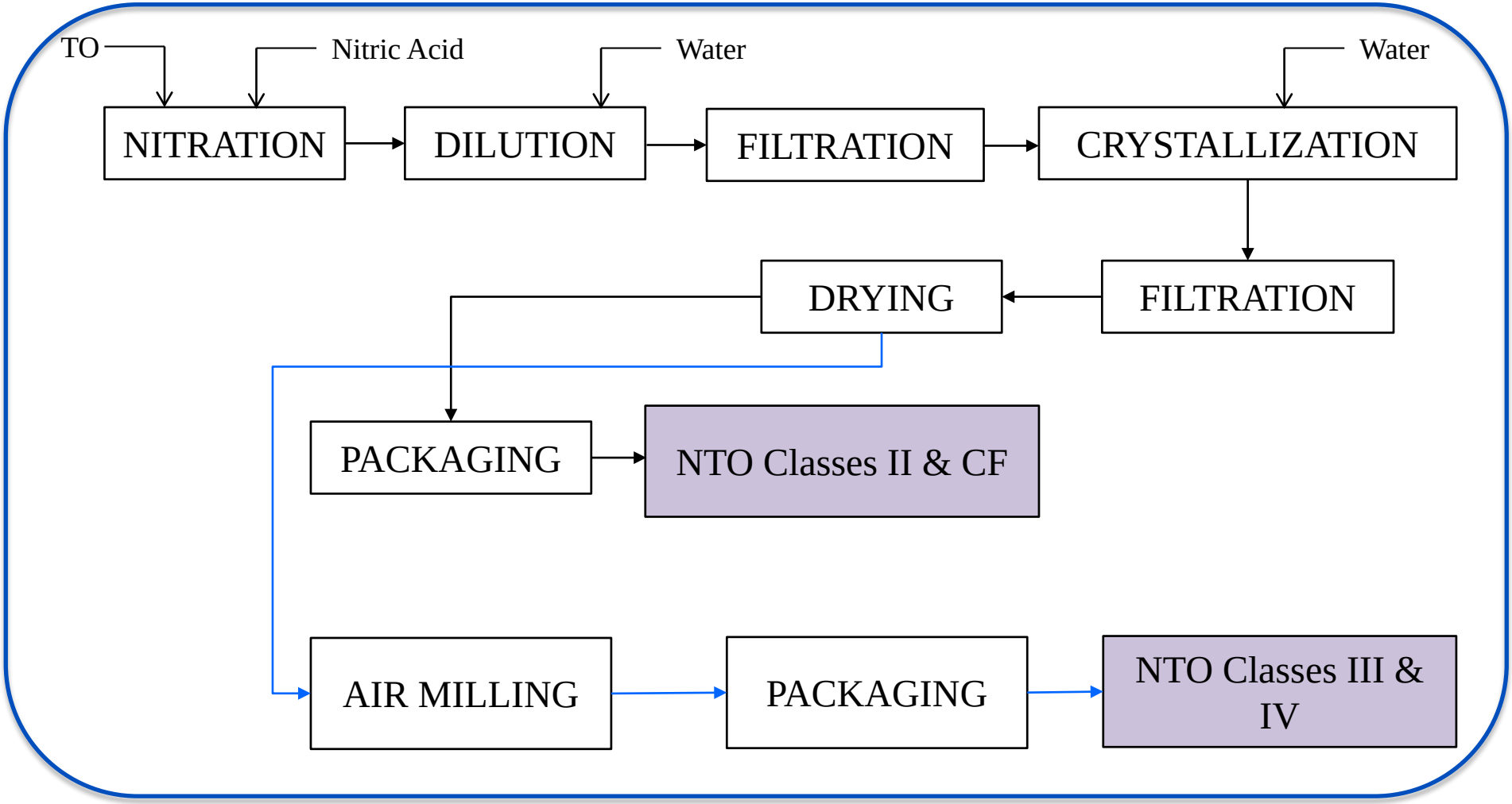


- **Introduction**
- **Applications**
- **Process**
- **New plant vs Old plant**
- **Characterization program**
- **Results**
- **Conclusion**

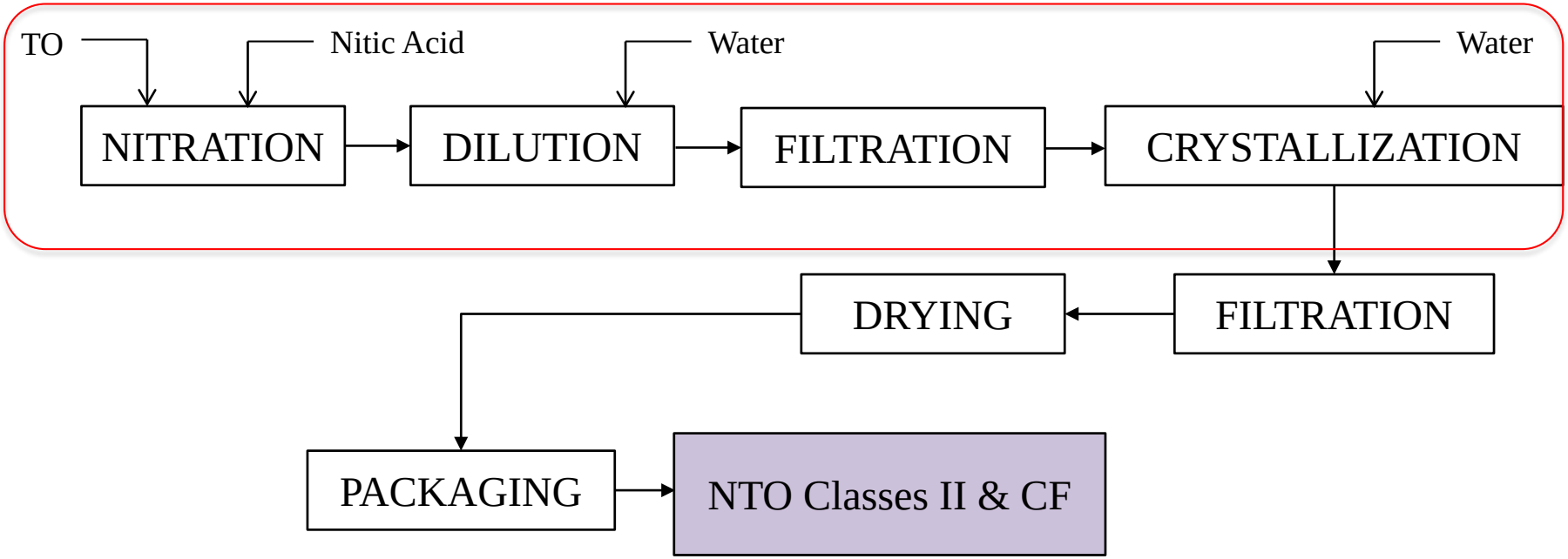
APPLICATIONS



- **Introduction**
- **Applications**
- **Process**
- **New plant vs Old plant**
- **Characterization program**
- **Results**
- **Conclusion**


TO
Nitric Acid
Water
Water
NITRATION
DILUTION
FILTRATION
CRYSTALLIZATION
DRYING
FILTRATION
PACKAGING
NTO Classes II & CF
AIR MILLING
PACKAGING
NTO Classes III & IV

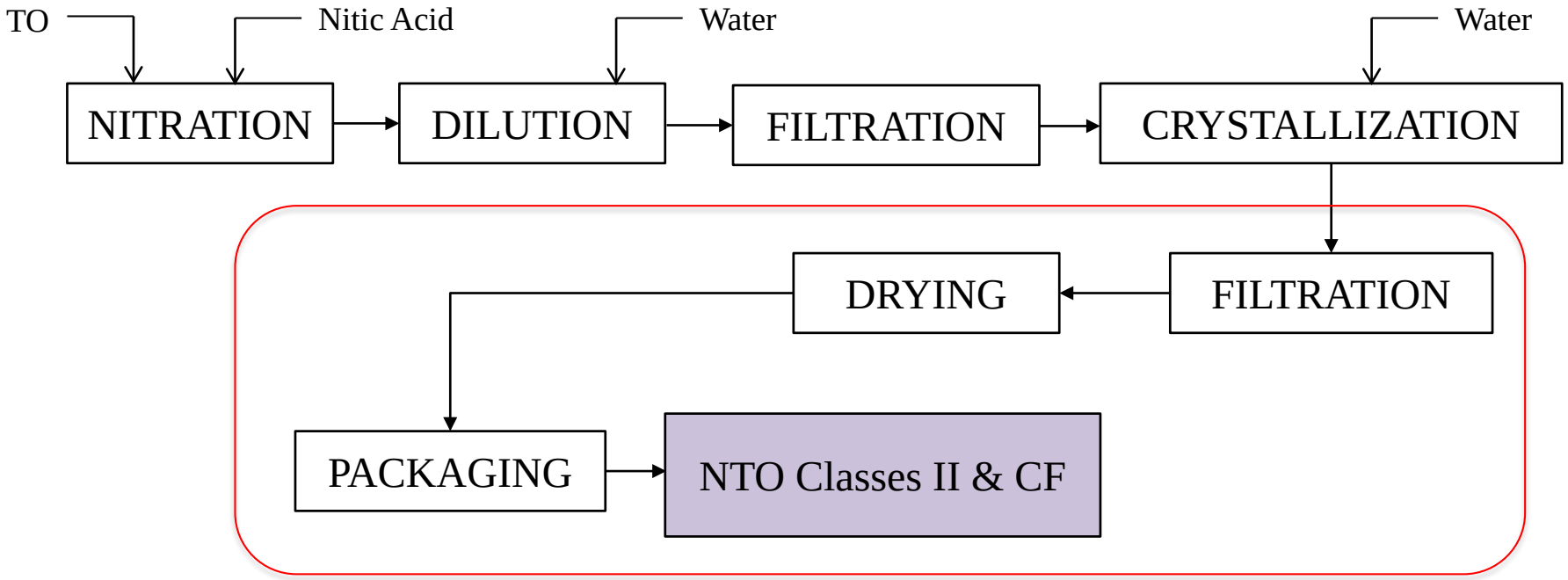
- **Introduction**
- **Applications**
- **Process**
- **New plant vs Old plant**
- **Characterization program**
- **Results**
- **Conclusion**



Workshop n° 320

Synthesis

Crystallization



Drying: workshop n° 362
Packaging: workshop n° 205

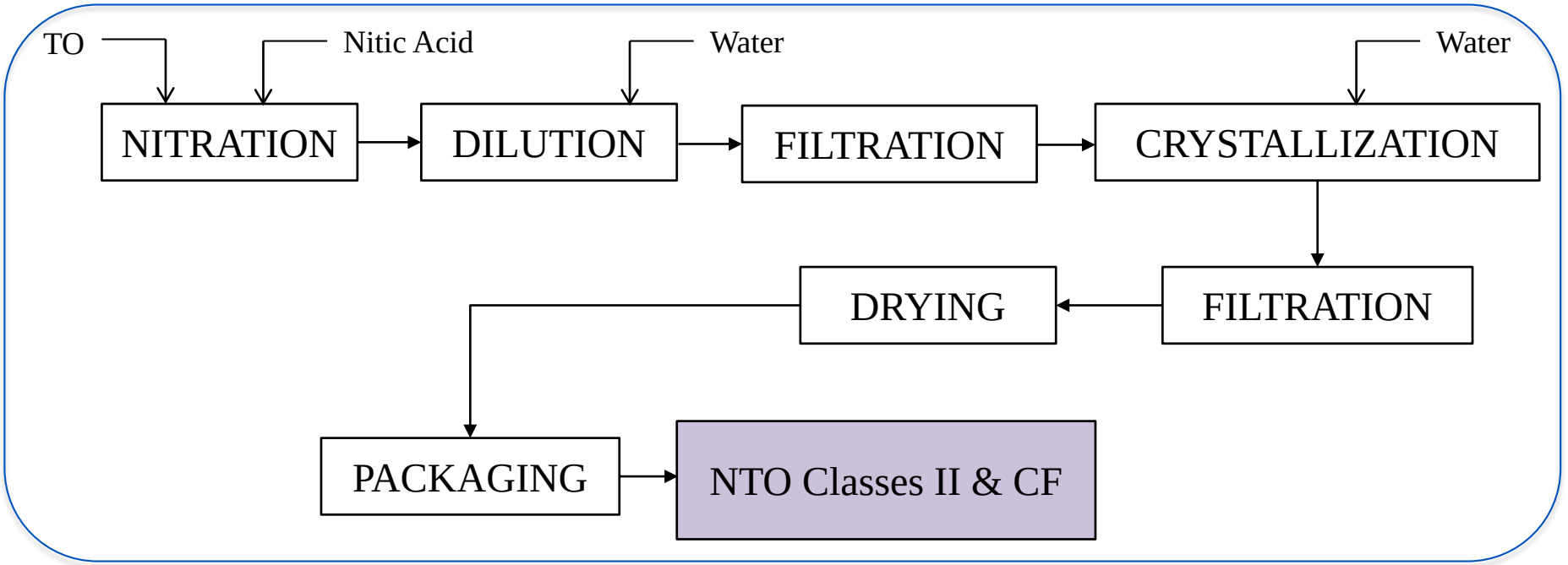
Outside view

Sieving

No specific instrumentation was automated and the control station and command control wasn’t deported

Impossible to reach the required level regarding safety and environmental regulation.

- **Introduction**
- **Applications**
- **Process**
- **New plant vs Old plant**
- **Characterization program**
- **Results**
- **Conclusion**



Workshop n° 320

From Raw materials to Packaging final product at the same plant

New technologies of: Filtration, Drying & packaging

EURENCO

Synthesis cell

- **Synthesis Step:** Continuous nitration of TO by nitric acid ➔ NTO
- **Dilution Step:** Eliminating the impurities

EURENCO

Crystallization cell

Pycnometers

Crystallizers

- **Pycnometers:** ratio NTO/water
- **Crystallization:** purify the product & final quality of NTO

EURENCO

Drying & Packaging cell

Drying

Packaging

- **Drying:** Fluidizing Technology

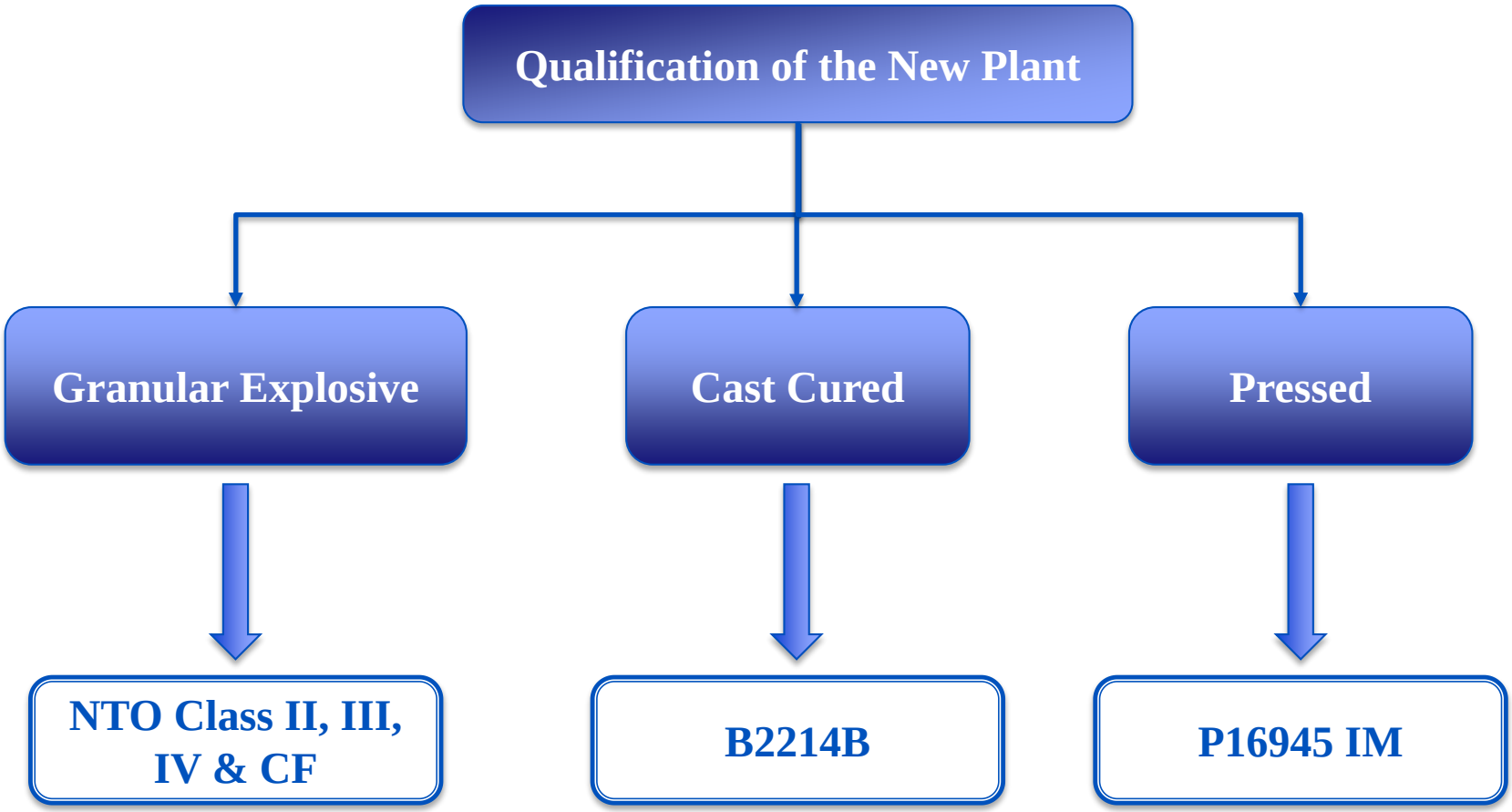
EURENCO

❑ Advantages of the New Plant:

- **Continuous & Integrated Process** from the introducing of the Raw material's to the packaging of the final product
- **New Process Technology**:
  - Filtration: dynamic band filter for the cleaning phase of the NTO (separation between acid and NTO)
  - Pycnometer: Ratio NTO/H_2O ➔ final quality of the NTO
  - Filtration & Drying: fluidizing technology: a compress air is used to dry the NTO particles in movement inside the vessel
  - Packaging: detectors are used to ensure the no-presence of foreign matter or metallic particles in the product.
- All the specific instrumentation are **automated** and the control station and command control are **deported** ☺
- **Safety and environmental regulation** ☺
- **> 200T/Year** ☺

- **Introduction**
- **Applications**
- **Process**
- **New plant vs Old plant**
- **Characterization program**
- **Results**
- **Conclusion**

CHARACTERIZATION PROGRAM



Characterization program Validated by the French MoD

EURENCO

❑ Granular Explosive: NTO

Analyses		NTO Class II	NTO Class III	NTO Class IV	NTO CF
Technical Specifications	Appearance	x	x	x	x
	Humidity	x	x	x	x
	Purity	x	x	x	x
	Acidity (HNO_3)	x	x	x	x
	TO Content	x	x	x	x
	Chlorine content	x	x	x	x
	Volatile matter	x	x	x	x
	Granulation	x	x	x	x
	Bulk density	x	x	x	x
Safety & Vulnerability	Friction sensitivity (BAM)	x	x	x	x
	Impact sensitivity	x	x	x	x
	Progressive heating	x	x	x	x
	DSC	x	x	x	x
	Vacuum stability	x		x	x
	Gutter combustion	x		x	x
	Electric spark	x		x	x
Others	Optical microscope	x	x	x	x
	SEM	x		x	x
	Density	x		x	x
	Melting point	x		x	x

Comparison between New NTO & The reference (old NTO), Technical specifications, Chart controls

EURENCO

❑ Cast Cured Composition (B2214B) & Pressed Composition (P16945)

Analyses	B2214B
Density	x
Constituent content	x
Mechanical properties at 20 °C	x
Impact sensitivity (t0 & t6month)	x
Friction sensitivity (t0 & t6month)	x
Hammer 30 Kg	x
Progressive heating	x
Gutter combustion	x
Electric spark	x
Vacuum stability	x
Card Gap test (t0 & t6 month)	x
Critical diameter (t0 & t6month)	x
DSC (t0 & t6month)	x
Friability	x
Velocity of detonation	x
Critical temperature for thermoinitiation	x

Analyses	P16945
Bulk density	x
Constituent content	x
Volatile matter	x
Impact sensitivity	x
Friction sensitivity	x
Granulation	x
Progressive heating	x
Electric spark	x
Vacuum stability	x
Card Gap test	x
Critical diameter	x
DSC	x
Friability	x
Velocity of detonation	x

Comparison with Reference, Technical specifications & Chart controls

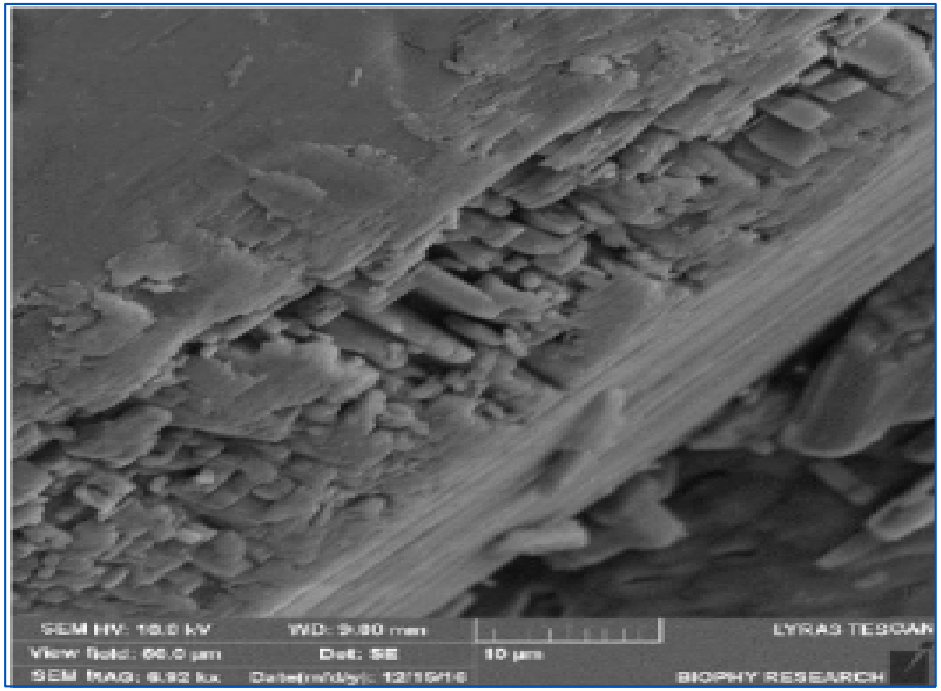
- **Introduction**
- **Applications**
- **Process**
- **New plant vs Old plant**
- **Characterization program**
- **Results**
- **Conclusion**

❑ Granular Explosive: NTO Class II

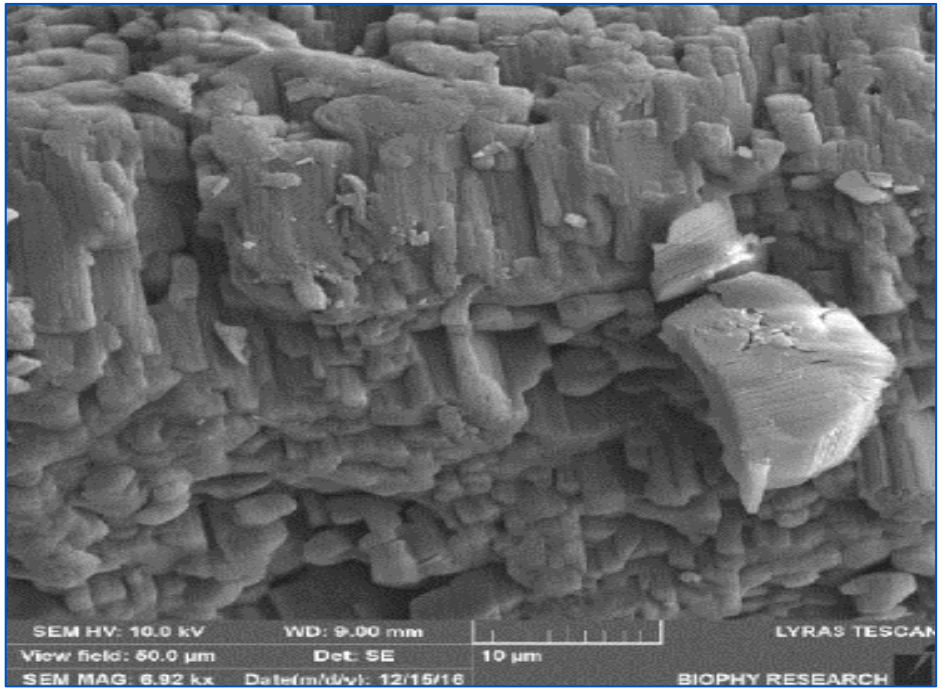
Analyses	NTO Class II (New line)	NTO Class II (reference)	Definition File (Specifications)
Purity (%)	99.2	99.9	≥ 99
Acidity (HNO_3) (%)	0.00	0.03	≤ 0.05
TO Content (%)	0.03	0.13	≤ 0.2
Chlorine content (%)	0.00	0.00	≤ 0.02
Volatile matter (%)	0.02	0.00	≤ 0.1
Bulk density (kg/m^3)	994	814	-
Friction sensitivity (BAM) (N)	5 + at 353 N	4 + at 353 N	-
Impact sensitivity (J)	18	19	-
Progressive heating (°C)	266	265	-
DSC (Onset point °C)	270.5	271	-
Vacuum stability (cm^3/g)	0.38	0.4	-
Gutter combustion	No propagation	No propagation	-
Electric spark (mJ)	> 792	> 792	-
Melting point (°C)	Decomposition at 250°C	Decomposition at 250°C	-

EURENCO

- Granular Explosive: NTO Class II



ONTA class II



Reference ONTA class II

NTO class II complies to the specifications & similar to the reference

❑ Granular Explosive: NTO Class III

Analyses	NTO Class III (New line)	NTO Class III (Reference)	Definition File (Specifications)
Purity (%)	99.1	99.3	≥ 99
Acidity (HNO_3) (%)	0.03	0.03	≤ 0.05
TO Content (%)	0.03	0.07	≤ 0.2
Chlorine content (%)	0.00	0.00	≤ 0.02
Volatile matter (%)	0.02	0.02	≤ 0.1
Laser granulometry (µm)	55.2	56.5	50 ± 10
Bulk density (Kg/m^3)	560	510	-
Friction sensitivity (BAM) (N)	9 + at 353 N	8 + at 353 N	-
Impact sensitivity (J)	9.1	11	-
Progressive heating (°C)	267	266	-
DSC (onset point °C)	270.4	270.5	-

NTO class III complies to the specifications & similar to the reference

❑ Granular Explosive: NTO Class IV

Analyses	NTO Class IV (New line)	NTO Class IV (reference)	Definition File (Specifications)
Humidity (%)	0.01	0.02	-
Purity (%)	99.7	99.3	≥ 99
Acidity (HNO_3) (%)	0.01	0.01	≤ 0.05
TO Content (%)	0.02	0.04	≤ 0.2
Chlorine content (%)	0.01	0.00	≤ 0.02
Volatile matter (%)	0.01	0.01-0.02	≤ 0.1
Laser Granulometry (µm)	12.5	11.7	12 ± 3
Friction sensitivity (BAM) (N)	3 + at 353 N	0 + at 353 N	-
Impact sensitivity (J)	13	8.1	-
Progressive heating (°C)	269	269	-
DSC (Onset point °C)	272.4	271.6	-
Vacuum stability (cm^3/g)	0.16	0.26	-
Gutter combustion	No propagation	No propagation	
Electric spark (mJ)	> 792	> 792	-

NTO class IV is conform to the specifications & similar to the reference

❑ Granular Explosive: NTO Class CF

Analyses	NTO CF (New line)	NTO CF (reference)	Definition File (Specifications)
Humidity (%)	0.03	0.02	-
Purity (%)	100	99.7	≥ 99
Acidity (HNO_3) (%)	0	0	≤ 0.05
TO Content (%)	0	0.001	≤ 0.2
Chlorine content (%)	0	0	≤ 0.02
Volatile matter (%)	0.01	0	≤ 0.1
Bulk density (Kg/m^3)	927	939	> 900
Friction sensitivity (BAM) (N)	0 + at 353 N	0 + at 353 N	-
Impact sensitivity (J)	16	13	-
Progressive heating (°C)	266	265	-
DSC (Onset point °C)	272.4	271.6	-
Vacuum stability (cm^3/g)	0.12	0.16	-
Gutter combustion	No propagation	No propagation	
Electric spark (mJ)	> 792	> 792	-

NTO CF complies to the specifications & similar to the reference

EURENCO

❑ Cast Cured Composition: B2214B

Analyses	B2214B (NTO New line)	Reference	Specifications
density (kg/m^3)	1630	1643	1605-1645
Constituent content (NTO, HMX, binder) (%)	72.2/12.5/15.3	72.2/11.6/16.2	
Mechanical properties at 20 °C (Stress Mpa)	0.89	0.75	0.7±0.3
Impact sensitivity (J)	31	27	-
Friction sensitivity (N)	15 + at 353N	4 + at 353 N	-
Progressive heating (°C)	234	232	233
Gutter combustion	No propagation	No propagation	-
Electric spark (mJ)	> 792	> 792	
Card Gap test (phi 75 mm)	35 mm	35mm	-
Velocity of detonation (m/s)	7414	7482	-

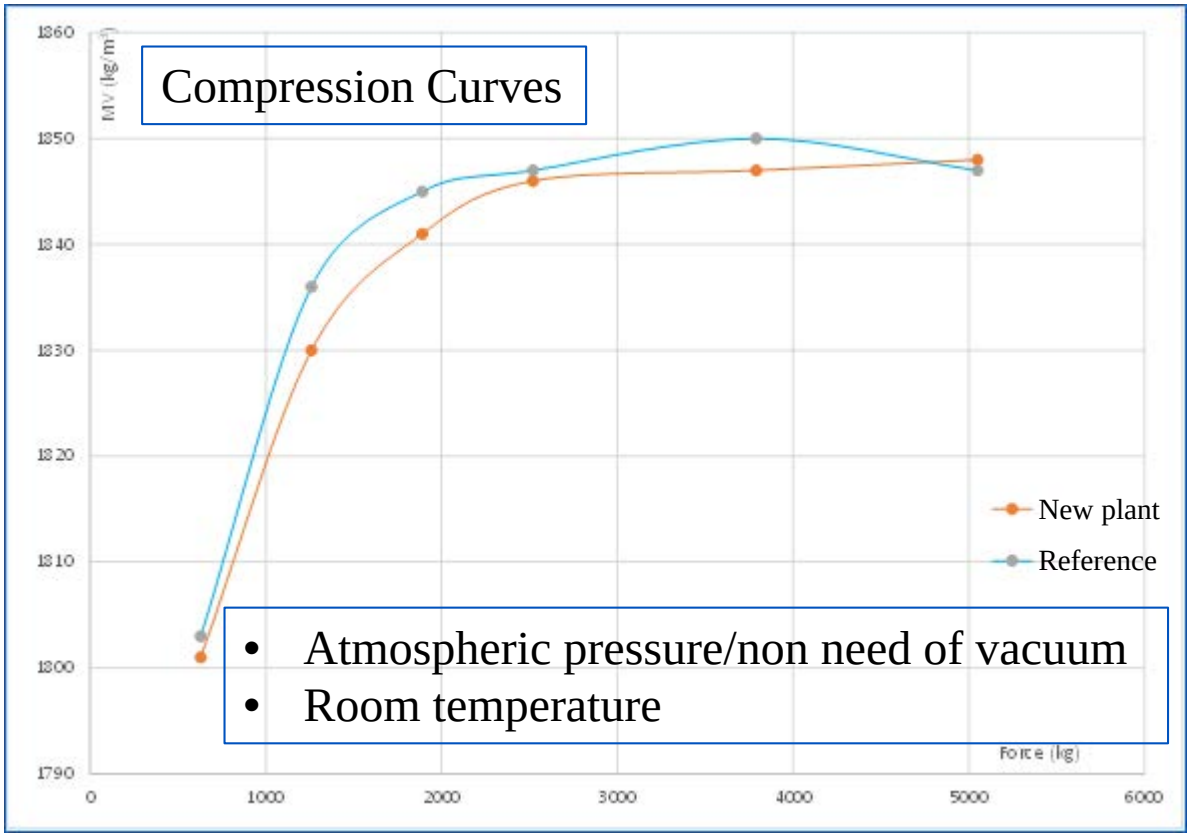
B2214B complies to the specifications & similar to the reference

EURENCO

❑ Pressed Composition: P16945

Analyses	P16945 (NTO New line)	Reference	Specifications
Bulk density (kg/m^3)	693	721	-
Constituent content (NTO, RDX, Binder & graphite) (%)	75.2/19.3/5/0.5	75.3/19.6/4.5/0.6	75±3/20±2/5±0.5/0.5±0.3
Impact sensitivity (J)	9.7	10	-
Friction sensitivity (N)	3 + at 353N	2+ at 353N	-
Granulation (% retained on)			
> 0.800 mm	43	49	-
> 0.500 mm	63	73	> 50
> 0.315 mm	81	88	> 80
> 0.040 mm	100	100	> 98
Progressive heating (°C)	210	209	-
Electric spark (mJ)	> 792	> 792	-
Vacuum stability (cm^3/g)	0.14	0.31	-
Card Gap test (phi 40 mm)	200	190	-
DSC (Onset point °C)	202	205	-
Velocity of detonation	In progress	7893	-

- Pressed Composition: P16945



P16945 complies to the specifications & similar to the reference

- **Introduction**
- **Applications**
- **Process**
- **New plant vs Old plant**
- **Characterization program**
- **Results**
- **Conclusion**

- ❑ **Process: Robust, automated & Reproducible ☺**
- ❑ **Safety and environmental regulation ☺**
- ❑ **All the Grade of NTO (II, III, IV & CF) are conform to the specifications & identical to the references ☺**
- ❑ **The new NTO has then been also tested and checked in two IM compositions, one cast PBX B2214B and one for a pressed application P16945 ☺**
- ❑ **> 200T/Year ☺**
- ❑ **The line is fully qualified and commissioned ☺**

ACKNOWLEDGEMENTS

- G. Eck, P. Chabin, G. Alvarez & V. Chauffour who coauthored this work
- Process Engineering & production team who have worked intensively for the success of the new Plant
- Laboratory team who characterized the NTO & the compositions

Thank you for your attention

Questions?

EUROPEAN LEADER IN ENERGETIC MATERIALS