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# DYNAMIT A.G. PLANT

AT

# TROISDORF

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COMBINED INTELLIGENCE OBJECTIVES
SUB-COMMITTEE

LONDON—H.M. STATIONERY OFFICE

# INVESTIGATION OF DYNAMIT A.G. PLANT AT TROISDORF, GERMANY.

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Artillery and Weapons (Explosives and Propellants)

COMBINED INTELLIGENCE OBJECTIVES SUB-COMMITTEE
G-2 Division, SHAEF (Rear) APO 413

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Personnel of Team

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1. INTRODUCTION.

Personnel interviewed:

Dr. Habbel, Manufacturing Director, Explosives Factory.
Dr. Heinrich, Plastics Sales Representative
Dr. Mienes, Plastics Manager.

No research papers of any value were found in the buildings. It was stated that the military authorities of the Reich had ordered the wholesale evacuation of important documents to Fulde where they were subsequently destroyed.

The estimated damage to the factory was

(a) Explosives: 60% to 70% destroyed.
(b) Plastics: 20% to 30% destroyed
(c) Engineering and Services: almost completely destroyed.

II. HIGH EXPLOSIVES

A. TETRYL

The tetryl producing section of the factory was capable of an output of 50 tons per month.

1. Nitration. The process of nitration was carried out continuously, there being two stainless steel vessels in series, each of 40 - 50 litres capacity, the tetryl/acid mixture discharged into filters where it was washed and filtered prior to purification.

2. Refining. The crude tetryl was refined by the standard "Troisdorf Acetone Granuletion" process.

3. Research. The manufacture of tetryl had been standardised for some considerable time and no work of a research nature was being carried out according to Dr. Habbel, Explosive Director.

4. General. The process did not appear to have any new features and there were no manufacturing instructions available in the factory.

B. P.E.T.N.

This section of the factory had a

capacity of 50 tons per month in the old plant and 150 tons per month in a new plant (of same design) which had recently been erected.

1. Nitration. The process of nitration was carried out continuously in three nitrating vessels in series: the vessels were made of stainless steel each being of 54 liter capacity and fitted with a stirrer rotating at 90 - 100 revolutions per minute. It was stated that all three vessels were maintained at 18°C to 20°C. The throughput of the plant was some 600 grams P.E.T.N. per 47 seconds.

2. Purification. The P.E.T.N. was precipitated from an acetone solution by steam, 10% or 15% of montan wax (melting point not greater than 70° C) having been added. This wax content rendered the P.E.T.N. safe for handling and shipping. The material containing 10% wax was used for 30 mm. shell and the 15% content for purposes where less sensitivity to shock was required.

3. Research. It was stated that no new work was being done on P.E.T.N. and the fact that the new 150 ton unit was built on exactly the same pattern appeared to confirm this.

4. General. Again no manufacturing instructions were available in the factory, the Explosives Director Dr. Habbel maintaining that specialist workers were employed and it was not their custom to have such information posted.

## III. INITIATORS AND DETONATORS.

### A. LEAD AZIDE

Sodium azide and lead nitrate were prepared by conventional methods. These were allowed to react as follows:

5.0 kg. lead nitrate and 0.15 kg. dextrin were dissolved in 40 liters of water and the lead azide was precipitated with 1.5 kg. sodium azide dissolved in 10.5 liters water. The temperature of the reaction was held within 50 to 55 degrees C.

### B. LEAD STYPHNATE

The plant prepared its own styphnic acid from resorcinol. Lead styphnate was precipitated as follows:

A stainless steel kettle of about 10 gal. capacity provided with an agitator served as the reaction vessel. Into it were introduced 40 liters water, 2.4 kg. styphnic acid, 0.44 kg. magnesium oxide. The formation of magnesium styphnate produced heat and when the temperature was about 55 degrees C, a solution of 4 kg. lead nitrate in 12.5 liters water was run in. The yield was 3.6 kg. lead styphnate.

C. GASLESS DELAY FUZE POWDER AND FILLING METHOD.

This powder was used to explode detonators and was ignited by an electric match head. It consisted of about 70% antimony powder and 30% potassium permanganate for slow burning, or about 46% antimony powder and 54% potassium permanganate for fast burning.

The permanganate was ground in a type of disc or plate crusher mill to approximately 80 mesh. It was stated the rate of burning was independent of the permanganate grist.

The antimony was ground from lumps in a vibratory ball mill. The powder was introduced by a screw feed into an air separator. The air in the separatory chamber was kept in rotation by a high speed concentric fan. The fines collected did not exceed 10 microns in particle size and apparently extended into the colloidal range.

The two ingredients were blended by tumbling and the mixture was compressed into tablets in a rotary multiple punch press. The tablets were formed apparently to give intimate contact between the ingredients. They were immediately broken down in a plate crusher mill and the powder was sent to the classifying room.

It was stated that greater uniformity of burning time was obtained by avoiding large virations in particle size of the powder, but that burning time was independent of the particular particle size used. Therefore the ground mixture was sieved to separate it into fairly well defined grists, and each grist was used separately to fill delay elements.

The filling was done with volumetric plates of 88 holes each. Obviously the size of the holes had to be varied according to the grist. The punches were independently loaded by a compressed air manifold so that the density of the filling would not be affected by variations in weight of charge. The pressure was 1200 kg/sq. cm.

D. DETONATORS

From 12 to 15 million detonators were manufactured per month. This included some 3 million electric detonators.

The detonators were filled with two increments of tetryl, the first being fully compressed and the second lightly tamped with a hand press. The final increment was the sensitive composition and the whole was closed with a metallic cover.

The sensitive composition comprised either 70% azide and 30% styphnate or 80% azide and 20% styphnate if a higher order of detonation was desired. It is interesting to note that the ingredients were not weighed in preparing the mixture. The quantities for each batch were estimated visually in the wet state and placed on drying trays. It was said that visual estimation was accurate within - 3% and that this was considered satisfactory. The trays were put into a drying house ventilated with dry air. After drying was complete, moist air was introduced before the operator entered the building to remove the trays.

The contents of the trays were emptied by remote control into a papier mache grocer's scoop rubbed with graphite to dissipate static electricity.

The scoop was carried to the sieving room where, again by remote control, the materials were sieved twice and delivered through a divided tube into four boxes to await transportation to the filling room. The mixture was given no other blending than the two passes through a sieve.

E. ELECTRIC MATCH HEADS

The wired assemblies were made by stamping "combs" from strip metal. The fuze wire was normally soldered to successive pairs of conductors, but when the plant was bombed there had been under development a machine for welding the wire electrically. The wires were crimped by folding over the tips of the conductors and were then welded to secure good contact. The machine had not been fully developed for mass production and was too badly damaged for salvage.

The resistance was held between 1.2 to 2.5 ohms and the match heads were separated into lots having a range of 0.3 ohms. Dr. Habbel's opinion was that this was unnecessary as

recent tests had shown time of function to be constant within the range 1.2 to 2.5 ohms.

The match heads were coated with compositions chosen according to their intended use. For gasless closed systems a coating of lead mononitroresorcinate was preferred. The standard product for electric blasting caps was coated with an initial dip of lead picrate and a final dip of potassium perchlorate charcoal mixture. Special hot flame matches contained both cerium and magnesium powder, the exact composition being already known to the I.C.I. Ardeer Works at Glasgow. All of these compositions were applied in suspension in Zapon nitrocellulose lacquer.

## IV. PLASTICS

### A. GENERAL

The Plastics plant normally employed about 4,500 people, about 1,000 of whom were engaged on engineering and machine design essential to the plastic plant. The relatively extensive nature of the engineering side enabled the firm to supply allied German plastic manufacturers with tools, moulds, etc., for Plastics production. On the night of 29th December 1944 the factory was subjected to a heavy raid which destroyed the engineering buildings almost entirely and subsequent artillery fire also caused some damage to the plastics plant. The machines in the plastics section of the works were largely serviceable and Dr. Mienes estimated that approximately 80% of the plant could be made to operate in a very short time. The factory is stated to possess sufficient raw material to cover an estimated 2 months' production of plastic products.

### B. PLASTICS MANUFACTURED.

The factory was capable of producing 700 tons a month of nitrated cellulose, either for use in the manufacture of camphor-plasticised celluloid or for the production of gun-cotton. The latter material was usually consigned to Dunaberg, no nitroglycerine or cordite being made at Troisdorf. Beechwood cellulose pulp was reported to be the primary raw material and the conventional system of nitration was followed, the spent acids being removed by centrifuging and the final nitrocellulose stabilized by cooking.

The plant appeared to be in very good condition and had been obviously abandoned by the factory personnel in

great haste. Approximately 50 to 100 tons of dry guncotton were found in the various centrifuges, vats and storage vessels of the plant, a circumstance arising from the failure of the plant's water supply and constituting an obvious hazard. The American authorities are stated to be aware of the danger and the factory is under military control. Some German workmen were engaged in the task of spraying this nitrocellulose with stirrup-pumps but the warm weather and exposed nature of the plant made this procedure of dubious efficacy. The ultimate disposal of this material presumably rests with the military authorities controlling the area.

Phenol-formaldehyde resins of "Novolak" and "Resol" type constituted another of the factory's manufactures, conventional compression mouldings of multifareous character being made. The factory was stated to have prepared large numbers of field telephones for the German army, cups, combs, handles etc.,; mouldings examined being of good quality and workmanship. No oil-reactive varnish resins were made at Troisdorf and production was entirely for synthetic moulding purposes.

C. PLASTICS MOULDED.

None of the common thermo-plastic materials were actually manufactured in the factory but polymerized resins were supplied by associated German firms, e.g., I.G. Farb, from which various articles were made. Polyvinyl Chloride "Mipolam" for acid-resisting tubes, waterproof capes,etc., and Cellulose Acetate "Trolit" for transparent sheets etc., were extensively employed; injection mouldings of Polystyrene "Trolitul" having also been made on a lesser scale for the construction of electrically insulating components. Polymerized methacrylate derivatives were not employed in the factory, Messrs.Rohn & Kaas of Darmstadt being cited as the main users of this type of material for the production of aircraft parts.

No varnishes or lacquers, based on the dissolution of synthetic resins in suitable solvents, were made at Troisdorf although polyvinyl acetate solutions were sometimes employed by the firm as label adhesives for explosive stores.

The hydraulic press method of imparting a polished finish to plastic sheets of polyvinyl chloride, cellulose acetate and nitrocellulose was of some interest. The presses operated under a pressure of 120 kgs. per sq. cm., the plastic sheets being sandwiched between nickel-plated steel sheets of

approximate dimensions 5 ft. by 2 ft. The temperature of pressing was 120° C - 140° C for polyvinyl chloride, the pressure being maintained on cooling in order to impart a glossy finish to the thermoplastic material. The steel sheets were electroplated whenever their surfaces showed serious wear or scratches.

A continuous method of conducting this operation had not yet been devised but was exercising the minds of those concerned. The plant appeared to be in good condition and was being used for the production of polyvinyl chloride and cellulose acetate sheet at the time the factory was abandoned. Some of these sheets had been employed for the preparation of blast-proof windows to the buildings and had stood up fairly well to blast effect.

## D. APPLICATION OF PLASTICS TO EXPLOSIVE MANUFACTURES.

The following data list the uses of plastic materials in certain instances intimately connected with the fabrication of ammunition and explosive stores.

1. The initiator sections where lead azide and styphnate were mixed possessed a floor covering of conducting material although Dr. Habbel expressed the view that the flooring did not particularly decrease an individual's electrostatic charge. Dr. Mienes was unable to find the formulation of this material in the factory records but stated that it consisted essentially of polyvinyl chloride pigmented with Carbon Black and plasticized with tricresyl phosphate.

In materials involving P.V.C. resin, the tricresyl phosphate was usually used in amounts of from 50% to 60% by weight. Tributyl phosphate was sometimes used and also substitute plasticizers of poor quality but T.C.P. was stated to be undoubtedly the best material to use.

2. The electric igniter section (Zundpille) possessed a machine capable of sheathing 200 metres of iron wire per minute with a P.V.C. covering applied under pressure at a temperature of 80° C. These insulated wires were finally employed in the preparation of electric detonators.

3. The mouth closure of electric detonators containing 1/2 sec.-10 sec. delay systems was effected by crimping on to a piece of polyvinyl tube fitting snugly into the mouth of the detonator and carrying the insulated conducting wires. An auxiliary crimping operation, 1/2 inch from the mouth of the detonator prevented too great an insertion of this waterproofing plastic tube. The British method employs a lead seal for a similar weatherproofing purpose.

4. "Zapon" nitrocellulose lacquer was generally employed in the factory as the vehicle for the suspension of the pyrotechnic mixes employed for the "dipping" of electric igniter wires.

5. Detonating fuze was manufactured at Troisdorf by the introduction of 9 gm. per metre of P.E.T.N. powder into a cellophane tube which was subsequently reinforced with two windings of cotton and covered with a final sheathing of polyvinyl chloride. The P.E.T.N. was introduced in the manner usually employed for the fabrication of the ordinary gunpowder Bickford fuze.

6. Match igniter heads (electric), made from a comb of Chrome steel, were observed to have a small slab of P.V.C. (about 1/4 inch square) acting as an insulating bridge between the metal poles. Samples of these combs were brought for examination, the electric welding method employed for sealing the nichrome wire to the two poles of the igniter being a novel feature. The welding machine was reported completely destroyed but the method may be worthy of further investigation from a production standpoint.

7. No evidence was obtained of the employment of lutings or cements for weatherproofing the various detonator or cap assemblies made by the factory. Dr. Habbels stated that he had heard that other German factories employed such materials but deprecated the use of oil lutings etc. in proximity to sensitive delay compositions of the antimony-permanganate type.

8. The extensive use of iron or copper plated iron in various detonator assemblies suggests that certain metals (e.g. copper and aluminium) were in short supply in Germany. Detonator tubes were also being manufactured from Zinc, and boxes for the transportation of tetryl were lined with zinc metal.



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