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The Manufacture and Storage of Lead Azide by a Computer Integrated System

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ABSTRACT

This paper describes a new approach to the production and storage of Lead Azide, by the use of a fully automatic computerized system.

The severe safety requirements necessary for handling this highly sensitive material necessitated the use of unconventional techniques for sensing and handling devices, including robots. In this pilot plant, the existing concept of batch work and small masses of material in process was retained. All production parameters, including lot details and storage data are automatically controlled and recorded by the system.
One of the main goals achieved was the fact that no operator need come near the material during the process or during storage or withdrawal.

This concept has led to a very safe system for the production of Lead Azide as well as achieving good control and recording of parameters during production.

1. INTRODUCTION

The handling of very sensitive chemicals with robots and production of these substances with computer controls is little known in the western world.

The reasons for this are:

1. The profitability of these facilities is uncertain.

2. The strict safety requirements for these installations are above normal standards.

I.M.I. decided to develop plan and build a pilot plant for the full automatic production, handling, transporting and storing (CIM) to meet the special requirements and constraints which are required for the production of Lead Azide.

Emphasis was laid on the safety and quality of product by using the most modern production technologies.
The intention was to use standard components available on the market.

It was soon found out that many components were not available. It was therefore necessary to develop several components that would comply with the special requirements. IMI Management understood these problems and allocated the necessary budget and support for the project.

2. INITIAL SITUATION

At the existing installation for the manufacture of this product, the production handling and storing of the material is carried out manually by coventional methods, applying all possible safety rules, as they are known at this branch. One of the reasons, for using robots is to avoid manual work, i.e. to remove the operator from the work cell. In order to achive this it was decided to introduce full automatic computer-controlled production including robots. After a survey it was found out that there were many restriction and constraints on accomplishing the task.

The main restrictions are:

- The use of electrical energy in the work cells is restricted to very low energies.

- Handling and the transport must be executed with very gentle movements, without vibration and very low acceleration, and deceleration.

- The necessity for building components, with materials that are not commonly used in mechanical engineering.

The chemicals used in the manufacturing process cause deterioration of standard materials.

3. TECHNOLOGIES

3.1 Power for actuation

Because of restrictions on the use of electric energy, the technical solutions for actuation were accomplished with pneumatic and hydraulic power.
All movements that handle Lead Azide use hydraulic power. This makes it possible to ensure very gently movements.

3.2 Actuator controls

All cylinders are controlled with flexible sequencing by direct programming of cylinder movement. By this system a very high degree of flexibility of operations for changing sequence is achieved by computer controls without the interference of the operator.

3.3 Sensors and signals

Because of the restrictions on the system, two types of signals were chosen.
These signals are transformed into electrical input signals to the computer.

- Pneumatic limit switches (standard on the market).

- IR light conducted by fiber optics.
  (Amplifiers were developed to answer the criteria. The equipment for production and quality control and fiber terminations were also developed. These components are standard with us and in production in our plant).

- Sensors for the chemical process that required the conversion into electrical energy located in the "Safe Area". They are of a type, that ensures that no medium which is in contact with the process has metallic contact with parts that are conducting electricity (fully insulated).

3.4 Controls

3.4.1 Computer

All processes and operations are controlled by the following computer system:

- Two micro computers, linked by RS 232 C (Hand Shake)

- Three controllers connected to the micro computers.

The system has about 650 digital and analog In - and Outputs.

4. PLANT DESCRIPTION

4.1 Definitions

The plant has to produce powder by a chemical process. It must carry out the following operations:

- Feed solutions into reactor by dosing.
- Stir and mix the solutions with RPM and temperature control.
- Dry the slurry into powder.
- Fill the powder by weighing into containers.
- Take samples for quality control.
- Transport the product into storage.
- Store the product and keep stocks.
- Neutralize and destroy rejected lots.
- Transport and supply the product to users.

All the operations will be performed fully automatically.

4.2 Equipment

It was necessary to plan, construct and build the following work stations and equipment for automatic production, computer controlled as follows:

- Reactor with mixer
- Dosing and feeding systems for solutions
- Drying cell
- Filling and weighing cell
- Handling system,
  one conveyor and five robots
- Automatic storing system
- Neutralization cell and waste solution neutralization
- Heating and cooling systems for temperature control.

5. PRODUCTION CONTROL

Due to the fact that all production parameters are computer-controlled, production can be kept to narrow tolerances. This guarantees higher quality and permits accurate reproduction of each batch of Lead Azide.

6. SAFETY AND THE MAN / COMPUTER INTERFACE

All equipment handling sensitive material is located behind protecting walls.
The access to dangerous areas is through safety doors. controlled by the computer and permitted only under accepted conditions.
All required commands are given and received by the touch screen, with the aid of a menu. These commands are checked by the computer.
The computer is programmed so that it will not accept a wrong or invalid command.
The screen indicates the state of any cell operation with graphic symbols and text.

This includes:

- Temperatures
- Flows
- Mixer R P M
- Humidity
- Storage data
- Any irregular event or extreme condition during the process or handling of the material, etc.

For events like an "emergency stop" or a power failure etc. an immediate freeze of the whole system occurs.
For a restart the operator will have to decide according to the state of the freeze of the system whether to continue production or to abort the batch.
He will be guided by a menu on the screen. This procedure is checked by the computer and will not allow illogical decisions.
The power for the computer is backed up with an UPS.
This will save all data and system conditions during power failure for a new start up.
All the data. i.e. production parameters, storage and stock details are recorded by the computer and can be traced on the screen or be printed in hard copy.

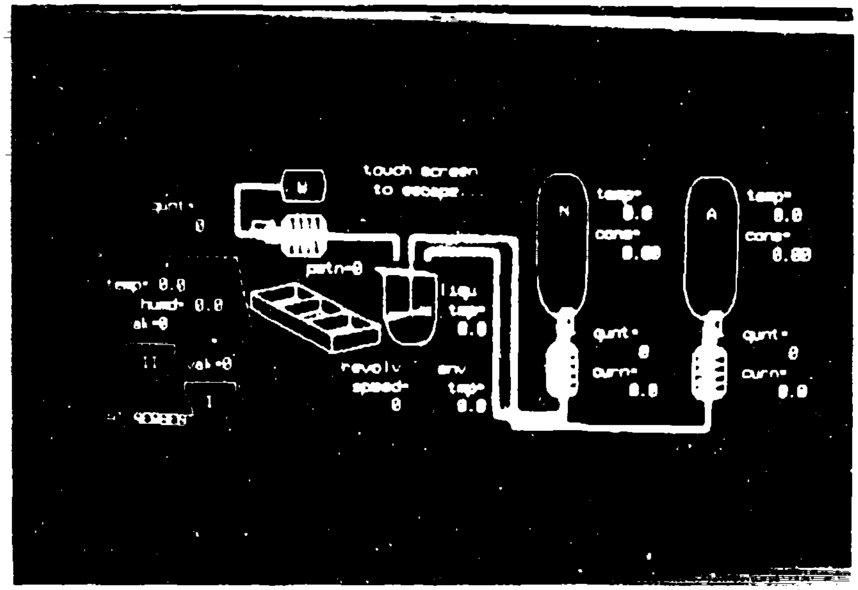

Fig. 1. Touch screen

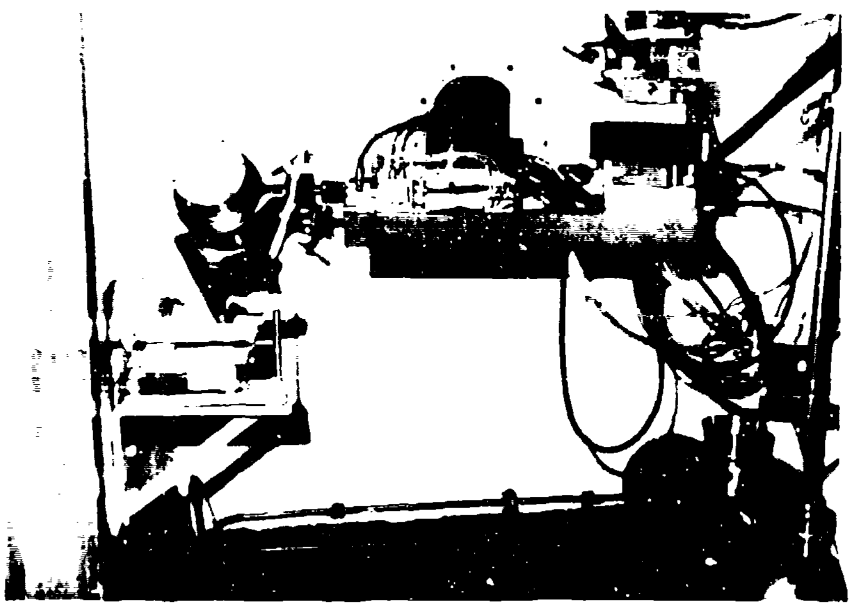

Fig. 2. Drying cell

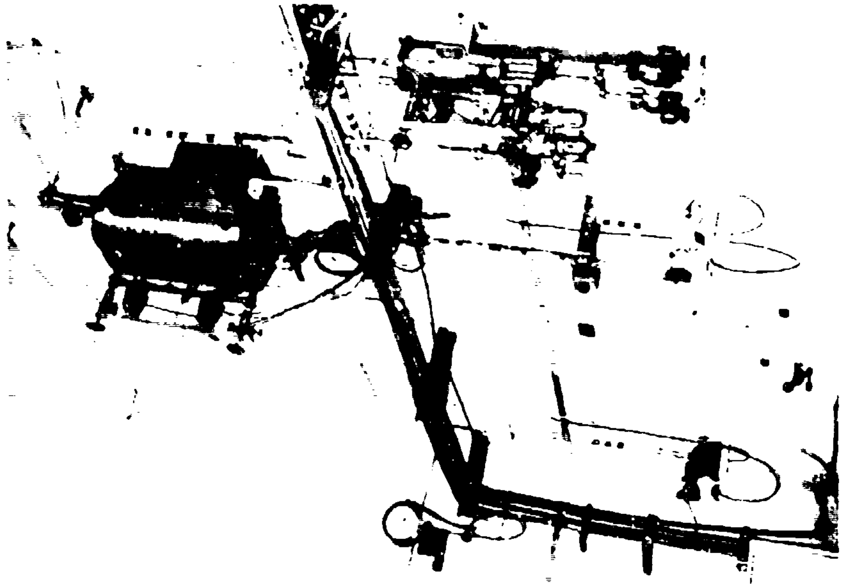

Fig. 3. Operators post

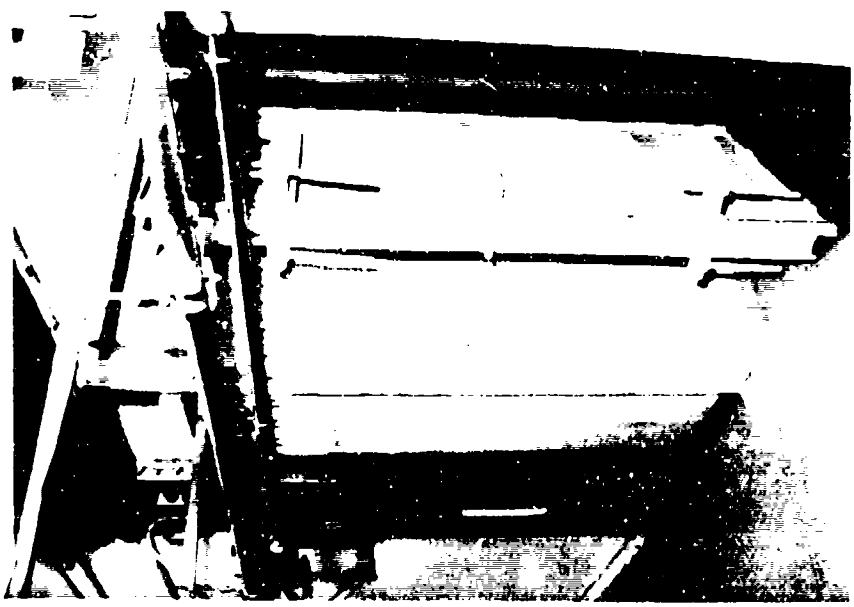

Fig. 4. Safety door

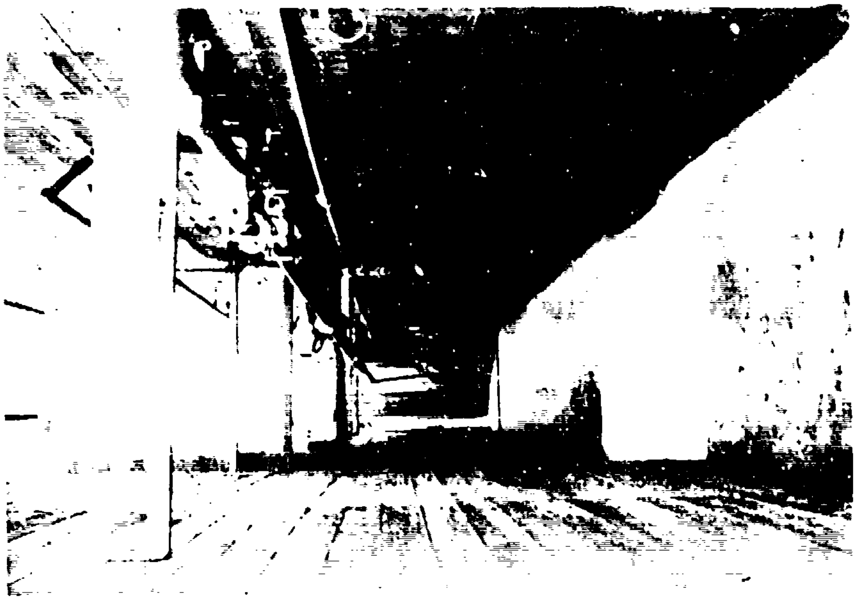

Fig. 5. Conveyor rail

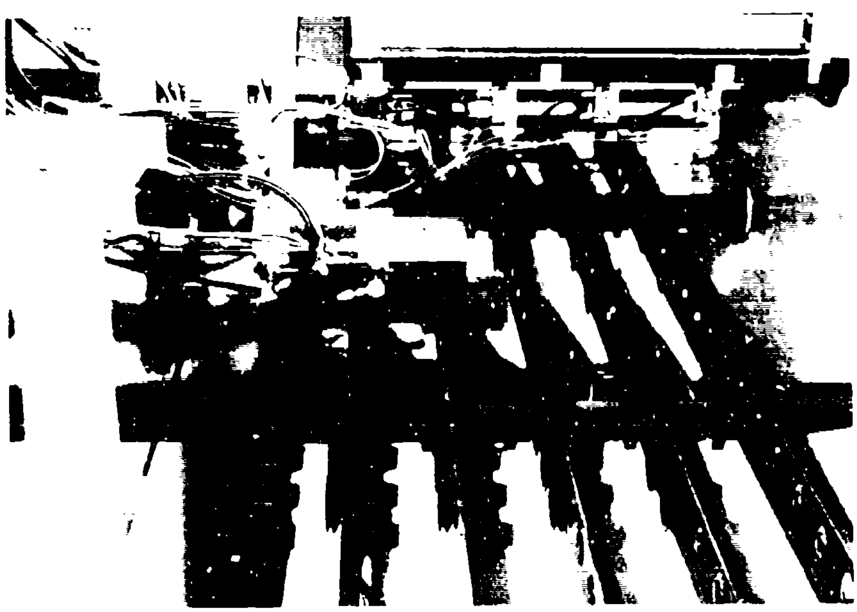

Fig. 6. Automatic storing system

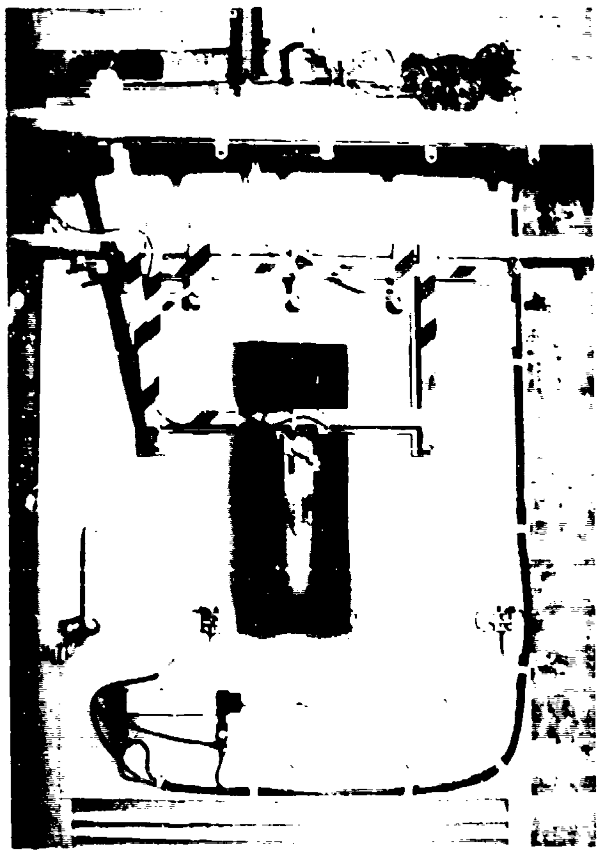

Fig. 7. Loading through safty hatch

If the Army controls only the top drawing of a technical data package, the only classification issued will be for the completed item. This has happened to both Honeywell and Ford on the 25mm Bushmaster program. Only the final assembly is granted a DOT Hazard classification, not the individual explosive assemblies which make up the round. It is difficult to build a complete round of ammunition when its impossible to transport the propellant, fuses, high explosive and tracers from their manufacturer to the final assembly point. The problem is compounded when final assembly is on a GOCO plant, and there is no "official" DOD storage and compatibility data for magazine storage or for submission of a safety site plan.

Taking a look at the Navy, we feel that the Navy follows the Army a distant second place for granting DOT hazard classifications. The problem, however, appears to be that the Navy is severely understaffed. I would especially not want my observation here to be construed as a comment against the Navy's overall abilities, or technical knowledge, they do a good job.

Finally, taking a look at the Air Force, we find its hazard classifications to be the most elusive and difficult to obtain. In the past, when an interim classification was finally obtained, it was usually good for only one shipment. We are pleased to note that recently the Air Force has started to issue interm classifications for longer periods of time.

Now, I would like to turn to what we believe to be an example of good documentation for DOT/DOD hazard classifications. This is the Army's form of Hazardous Component Safety Data Sheets (HCSDS). This form provides a wealth of information, and is used for both interim and final hazard classifications. We believe it would be good for the other services to emulate this Army form. Unfortunately, obtaining the HCSDS sometimes proves to be difficult. Supposedly, the applicable HCSDS comes with the contract or proposal, but often this is not the case. Frequently, production or development is started on a letter contract which does not include HCSDS's. The 1 December 1980 version of this form states it is not valid unless issued as a part of a procurement/production package. This statement raises several questions for us. How can a DOT classification be valid one day and not the next? How can a DOT classification be valid for one contractor or the government and not another contractor? Does this mean that at contract conclusion all the storage and compatibility data from a HCSDS is invalid for residual items? Together, we should discuss the uses, limitations and critical need for HCSDS.

For planning, bid proposals, safety site plans, shipment of existing materials, and storage, HCSDS's are invaluable. Defense Contracts Administrative Services (DCAS) provides a vital service by providing HCSDS's as quickly as they can on request. The Army will also provide the HCSDS's via a request to the ACO. But, either route is rarely responsive to time sensitive matters and does not meet the needs of the industry. Could HCSDS's be located in DCAS Management Area offices? In many situations, a hard copy is not necessary, only some information from the form. We would suggest that HCSDS's be made available locally to a contractor. If this were done, a great service would be provided to the ordnance industry. When a final DOT/DOD hazard classification is issued, it should be incorporated into Hazard Classification of US Military Explosives and Hazardous Munitions, and when applicable OP5 Vol II.

An alternative for obtaining DOT Hazard Classifications is the DOT itself. More expedient and responsive than the DOD components, it is the only means available for contractors to receive a hazard classification for independent research and development items. When a classification is granted, their system of an "EX" number provides a ready reference to the original documentation. Shortcomings for the DOT are very few. Their dependence upon the Bureau of Explosives, American Railroad Association or the Bureau of Mines for recommending a classification, and the lack of DOD storage and compatibility information do present problems. With the impending closure of the Bureau of Explosives only the Bureau of Mines has an alternative laboratory that can recommend hazard classifications. A major crisis is brewing. Most contractors have never dealt with the Bureau of Mines and are concerned. Can the Bureau of Mines handle all the new work load, and what is their experience with ordnance products?. There is a critical need for such a laboratory as the Bureau of Explosives. Alternatives for evaluating and recommending hazard classifications must be found now, or many IR&D programs, as well as some contract work will be affected. Lack of obtaining a DOD classification is not a true shortcoming of the DOT, for it is the DOD's responsibility to grant such information. It is a problem for contractors because they have to request hazard classification through dual channels, namely the DOT and the DOD.

A constant irritation experienced by many companies performing ordnance development work is the very narrow definition or interpretation in the DOT standards of what constitutes an engineering change to an item. When an engineering change occurs, as described by the standards, there is a need for a re-evaluation of the DOT hazard classification. This definition creates a needless administrative burden, when there is no change to explosive content or type, or effect to the arming and firing characteristics of the munition. Minor changes, additions or deletions of metal parts, or any change that will not increase the hazard for transportation or affect explosive content, should not be required for resubmission, particularly when the item is already a Class A explosive.

New performance-oriented packaging for ordnance items is approaching fast. A proposed regulation change (Docket Number HM181) would remove container specifications from CFR Title 49, and institute procedures more in line with United Nations and international civil air and maritime requirements. In essence, ordnance and explosive materiel packaging will have to be tested and certified against performance standards stated in these international regulations. Each specific type container used for a specific ordnance item or explosive component, will have to undergo drop, compression, and vibration testing. This differs from current DOT regulations which require packaging to conform to specific design standards. Such a regulation change, while not

yet in effect, will create formidable challenges for manufacturers. Research and development work may be impacted severely. In many cases hardware isn't available to perform the transportation test. Further, if there is hardware available, without a properly equipped and sited testing laboratory, it will be difficult to move the test items to a test location. This new standard will have a severe effect on many manufacturers. Movement of explosives, when defined as "reactive waste" by the EPA, for disposal, is another great problem facing our industry today. Contractors already face difficulty in obtaining DOT hazard classifications for explosive "reactive waste", but a monumental problem will result when performance packaging takes effect.