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DERMATOSES INVESTIGATION

Conducted by

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Division of Occupational Health
Public Health Service
U. S. Department of Health, Education, and Welfare
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Installation: Diamond Alkali Company
Electrochemicals Division
80 Lister Avenue
Newark, New Jersey

Date : March 28, 1963

Requested by: New Jersey State Department of Health
Trenton, New Jersey

Personnel Contacted:

1. Mr. Raymond A. Guidi, Plant Manager
2. Mr. William Hill, Technical Supervisor
3. Mr. Charles E. Packard, Personnel and Safety Supervisor
4. Dr. Jacob Bleiberg, dermatologic consultant
5. Dr. Roger Brodkin, dermatologic consultant
6. Dr. I. L. Appelbaum, Director of Medical Education and Consultant in Medicine, North Beth Israel Hospital, Newark

Nature of Operations:

The Newark Plant, Electrochemicals Division, Diamond Alkali Company, manufactures 2,4-D and 2,4,5-T. Basic materials for 2,4-D synthesis are acetic acid and phenol, which are chlorinated to monochloracetic acid and dichlorophenol,

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respectively. These intermediates are reacted together with caustic to produce the sodium salt of 2,4-D. This is acidified to 2,4-D acid. Subsequent operations include filtering, centrifugation, esterification, amine neutralization, and formulation.

Basic materials for 2,4,5-T synthesis are tetrachlorobenzene, caustic and methanol. The tetrachlorobenzene is delivered in tank cars and must be heated to be pumped into storage and measuring tanks. The reaction between the basic materials takes place in two pressure reactors or autoclaves. Excess methanol is distilled off and recycled, and the reaction product, sodium trichlorophenol, is pumped to the steam distillation tank or stream strip via a holding tank. Here unreacted tetrachlorobenzene and a by-product, anisole, are removed. Sodium trichlorophenol from the steam strip passes through a dilution tank and intermediate storage tanks into a condensation reactor where monochloracetic acid and caustic are also added. Here sodium 2,4,5-T is produced. This is filtered on a filter wheel to remove the mother liquor and slurried with sodium sulfate to wash off excess sodium trichlorophenol. The slurry is pumped to the acidification tank where it is treated with sulfuric acid to make 2,4,5-T acid. This product is stored in a holding tank until it is centrifuged. The centrifugate contains 85-90%

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2,4,5-T acid, about 1% trichlorophenol, a fraction of a percent ash (sodium sulfate), and water. The 2,4,5-T acid is either neutralized with an amine, for example dimethylamine, or esterified with 2-ethylhexanol or butyl alcohol. The technical esters and amines thus produced may be shipped as such or the technical esters may be formulated by adding emulsifiers and kerosene.

Two buildings house the entire production operation. Initial steps in 2,4-D and 2,4,5-T production are carried out in a new building which was built three years ago after an autoclave explosion destroyed the previous building. Autoclaves and steam distillation are located just outside the new building. The remainder of the operations (condensation reaction, acidification, filtering, centrifugation, amine neutralization, esterification, and formulation) are carried out in a building approximately 50 years old. The condensation reactor is exhausted to a caustic scrubber on the roof. A third building of relatively new construction contains warehouse, maintenance shop, operations supervision, and a small dispensary. Administrative offices, laboratory, and shower and locker rooms are housed in another new building.

Problem and Investigation:

In the 12 years of operation of the Newark plant, about 46 of 48 cases of chloracne have occurred in the production of 2,4,5-T. Forty of the affected workers are cur-

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rently employed at the plant. The population at risk is about 60, all males. Currently, the plant operates three shifts per day, seven days a week. The first case was observed about 12 years ago. Small outbreaks of chloracne occurred two years ago (shortly after completion of the new production building) and last summer. All of the affected workers are employed in either the new or old production buildings, but there is considerable rotation of jobs to avoid prolonged exposure in the so-called "hot spots" (areas most likely to produce chloracne) - the condensation reactors and centrifuge. Although most of the production operations are enclosed, there are breaks in the process, evidenced by contamination of equipment, ceilings, floors, stairs, and hand railings, particularly in the old building. In addition to the chloracne, several workers have developed findings suggestive of porphyria, namely red urine, hyperpigmentation, and hirsutism. The company has attempted to find areas of high exposure to chloracnegens by sending various intermediates from within the production lines to Mellon Institute for reproduction of chloracne in rabbit ears. Several acnegens have been found, but it has not been possible to pinpoint sites of contamination of workmen. Also puzzling was the development of new cases after the new building was constructed, with new autoclaves, a previous "hot

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spot," located outside the building. Plans are being made to renovate the old building by installing a new reactor, floors, stairs, roof, ventilation system, and scrubbers. Clean uniforms are furnished by the company. Separate locker rooms for street and work clothes are provided. Clean modern shower stalls and Bradley basins are provided, along with towels and soap. Daily showers at the end of the shift are encouraged, but are not mandatory.

During the visit to the plant on March 28, Drs. Bleiberg, Brodkin, Appelbaum, Birmingham, and Key examined 17 cases of chloracne, several of which had findings suggestive of porphyria (red urine, hyperpigmentation of exposed areas, and hirsutism, but no bullae or atrophic scars). However, a case of porphyria cutanea tarda was observed in this plant several years ago. The chloracne was manifested by comedones and cysts on exposed areas (especially the face) and at sites of friction. In one case, the chloracne was generalized.

Discussion:

The clinical picture of comedones, cysts, and hyperpigmentation of exposed areas is typical of chloracne. Additional diagnoses of porphyria and liver damage in a few cases can be made or excluded only by appropriate laboratory studies.

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Outbreaks of chloracne in 2,4,5-T production have been observed in Germany,[1] France,[2] and the United States. In one outbreak,[1] the chloracnegenic chemical was identified as tetrachlorodibenzodioxidine.

It is commendable that the company management has undertaken the hygienic program now in effect, and is definitely planning a renovation of the old building. For control of chloracne it has usually been necessary to redesign equipment to minimize contamination and to enforce daily showering and change of clothes. Further, the work of the dermatology consultants has been most helpful. Their current plans to hospitalize and study the health status of the affected workmen are sound and necessary.

Recommendations:

1. The old production building should be renovated as soon as possible. Enclosure of the process and good housekeeping are most effective ways of preventing contamination of the workmen.
2. All workmen with severe chloracne, hyperpigmentation, hirsutism, accompanied or unaccompanied by red urine, should be hospitalized to investigate the possibility of liver damage in general or porphyria in particular.
3. In the future, when the company purchases new work clothing, it should be the one piece coverall type.

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This will help prevent chloracne at the belt line.

4. Showers after work should be made mandatory.

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References:

1. Kimmig, J. and Schuz, K. H.: Occupational Acne (So-Called Chloracne) Caused by Aromatic Cyclic Ethers. Dermatologica 115: 540-546, 1957.

So-called chloracne, previously erroneously thought to be due to free chlorine, was also seen to occur in industries where chlorinated naphthalene compounds were handled ("Perna disease"). The authors observed the clinical manifestations of chloracne in 31 workers employed in the preparation of 2,4,5-trichlorophenol and its transformation into 2,4,5-trichlorophenoxyacetic acid or its esters. Animal experiments (brushing test substances onto a rabbit's ear) revealed that chloracne is not caused by trichlorophenol itself but by a toxic by-product formed by alkaline hydrolysis of 1,2,4,5-tetrachlorobenzol to 2,4,5-trichlorophenol. Since the materia peccans could not be isolated, various synthesized combinations were tested, of which trichloro- and tetrachlorodibenzofuran and also tetrachlorodibenzodioxidine proved very active. Since 2,3,6,7-tetrachlorodibenzodioxidine could be isolated from the above mentioned by-products it is concluded that tetrachlorodibenzodioxidine is an essential, if not the only causative factor in so-called chloracne.

2. Dugois, P. and Colomb, L.: Chloracne from 2,4,5-Trichlorophenol. Bulletin de la Societe Francaise de Dermatologie et de Syphiligraphie 63: 262-263, May-June 1956.

All the workmen involved in the preparation of 2,4,5-trichlorophenol used in herbicide and germicide syntheses were affected with chloracne. The skin was grayish in color, and both comedones and cysts were present. Seven of the seventeen patients had generalized involvement.

Patients with moderate and severe chloracne also complained of conjunctivitis, asthenia, anorexia, and weight loss. The digestive complaints could have been due either to gastritis or to liver insufficiency. Relapses and exacerbations were seen several months after cessation of exposure. In the chemical process, the chlorinated benzols were heated to produce polymerization, and tars and chlorinated naphthalenes were probably formed.

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