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Attn: Section 8(e) Coordinator (CAP Agreement)

Re: CAP Agreement Identification No. 8ECAP-0110

Dear Sir or Madam:

Union Carbide Corporation ("Union Carbide") herewith submits the following reports pursuant to the terms of the TSCA §8(e) Compliance Audit Program and Union Carbide's CAP Agreement dated August 14, 1991 (8ECAP-0110). These reports describe investigations concerning employee pulmonary sensitization and other effects relative to tolylene diisocyanate (TDI; 80:20 mixture of the 2,4- and 2,6- isomers; CASRN 26471-62-5) exposure.

- 1) "Toxicity to Tolylene Diisocyanate", UCC (Chem. Div.), Institute, W. Va., Special Report (Medical Dept., by R. J. Sexton), June 22, 1964.
- 2) "Toxicity to Tolylene Diisocyanate: Report No. 2" UCC (Chem. Div.), Institute, W. Va., Special Report (Medical Dept., by R. J. Sexton), August 12, 1964.
- 3) "Toxicity to Tolylene Diisocyanate: Report No. 3", UCC (Chem. Div.), Institute, W. Va., Special Report (Medical Dept., by R. J. Sexton), October 20, 1964.

Complete summaries of these reports are attached.

are: Previous TSCA Section 8(e) or "FYI" Submission(s) related to this substance

TDI

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8-19-94

(None)

Previous PMN submissions related to this substance are: (None)

This information is submitted in light of EPA's current guidance. Union Carbide does not necessarily agree that this information reasonably supports the conclusion that the subject chemical presents a substantial risk of injury to health or the environment.

In the attached reports the term "CONFIDENTIAL" may appear. This precautionary statement was for internal use at the time of issuance of these reports. Confidentiality is hereby waived for purposes of the needs of the Agency in assessing health and safety information. The Agency is advised, however, that the publication rights to the contained information are the property of Union Carbide.

Yours truly,



William C. Kuryla, Ph.D.
Associate Director
Product Safety
(203/794-5230)

WCK/cr

Attachment (3 copies of cover letter, summaries, and reports)

SUMMARY

Union Carbide Corporation
Chemicals Division
Institute, West Virginia

Special Report
Medical Department
22 June 1964

TOXICITY TO TOLYLENE DIISOCYANATE

INTRODUCTION

It has been well documented in the medical literature that TDI is capable not only of causing acute respiratory illnesses but, unfortunately in some individuals and apparently after repeated exposures in certain other individuals, is capable also of sensitizing these individuals so that they develop an asthma-like syndrome. In addition, TDI is capable of causing acute irritation of the skin and probably is capable of sensitizing the skin so that urticarial and angioneurotic edema-type reactions occur. Since the start up of the TDI Unit at Institute, the Medical Department has seen employees who fit into all of these categories. The number of exposures to TDI, as well as exposures to phosgene (the latter has no connection to the information discussed here), appears to be excessive and the number of people that have developed acute illnesses and the number of people who have been sensitized from TDI exposures is extreme. Some of the men developing illnesses have had unusual exposures but many of the exposures have resulted from the personal observation that the best of housekeeping in the TDI Unit is not being practiced. Undoubtedly this is due to many reasons but prior to the writing of this report, efforts have been initiated to greatly improve the housekeeping practices which may result in a decrease in the number of exposures. Also, mandatory instructions have been issued to prevent the unusual exposures which occur when repairing or installing equipment in the unit. Because of the number of employees involved and because of the seriousness of the illnesses that some of these individuals have manifested, it is deemed desirable to bring this to the attention of local plant management.

SUMMARY

CONCLUSIONS

The number of exposures, illnesses and difficulties due to TDI are extreme. In a six-months' period, 74 exposures to TDI resulting in 35 men with acute illnesses, represents a severe problem. Unfortunately the seriousness of this problem remained undetected until viewed broadly. In retrospect, with eight men missing work following illness from TDI exposure, it would seem impossible that the severity of this problem could have been overlooked. However, now that maintenance and operating supervision are well impressed by the seriousness of this situation, it is believed that the preventive measures undertaken will reduce or eliminate further hazards from exposure to TDI and its residues.

SUMMARY

Union Carbide Corporation
Chemicals Division
Institute, West Virginia

Special Report
Medical Department
12 August 1964

TOXICITY TO TOLYLENE DIISOCYANATE

REPORT NO. 2

SUMMARY

The first report on this subject, dated 22 Jun 64, included information on all exposures and illnesses to TDI, the number of employees sensitized and the number assigned to permanent restricted work for the period between the start-up date in December of 1963 and 17 Jun 64. During that interval of time, 56 men reported a total of 74 exposures to TDI. Acutely ill from TDI toxicity were 35 men of whom eight men lost time from the job. Eight men also acquired pulmonary sensitization to TDI and it was necessary to assign three of these employees permanently to restricted work.

During the present period (18 Jun 64 to 10 Aug 64) an additional 23 men have reported 26 exposures. Three of the men were acutely ill but none needed assignment to permanent restricted work. To date, 94 exposures have resulted in 38 illnesses with eight men losing work, eight being sensitized and three being assigned to permanent restricted work.

Preventive measures initiated by the Operating and Maintenance Departments have been successful at least partially in reducing the number of exposures. Those measures initiated by the Maintenance Department have been in effect for only the last half of the period covered in this report but at least half the exposures reported had occurred prior to their institution.

SUMMARY

Union Carbide Corporation
Chemicals Division
Institute, West Virginia

Special Report
Medical Department
20 October 1964

TOXICITY TO TOLYLENE DIISOCYANATE

REPORT NO. 3

SUMMARY

It quickly became quite obvious that the maintenance department's efforts to ventilate specific equipment or certain shop areas to minimize or eliminate TDI exposures were not going to be completely successful because exposures to maintenance shop personnel have continued. Through the efforts of maintenance supervision, the problem of minimizing TDI exposures became not only the responsibility of maintenance supervision but also the responsibility of supervision of the operating and shipping departments. The present report discusses the problem of minimizing exposures to personnel and in addition related problems that have arisen in the meantime. These various problems are described and the solutions that have been decided upon are presented in detail.

Under General Information is included more background material which attempts to define the problem more clearly. In the section Exposures and Illnesses, the magnitude and complexity of the problem is discussed. Continuation of several case histories is included under the appropriate section title and a section entitled Corrective Measures includes eight enclosures explaining fully the responsibility designated to the various departments concerned. Also included in this section are illustrations of the material and equipment that will be used in the latest attempt to minimize TDI exposure to plant 512 personnel. It is the opinion of the author that the TDI exposure problem has not been solved completely and that sporadic episodes of acute illnesses, particularly in those employees believed sensitized to TDI, will occur in the future.

A study is being made of the physical well-being of TDI operators, shift utility mechanics and various maintenance personnel who have had many TDI exposures in the last eight months to determine recovery from acute illness due to TDI exposure and the possibility of permanent partial disability. It is not possible to include the results of this study here, but these will follow in a later report.

TOXICITY TO TOLYLENE DIISOCYANATE

INTRODUCTION

It has been well documented in the medical literature that TDI is capable not only of causing acute respiratory illnesses but, unfortunately in some individuals and apparently after repeated exposures in certain other individuals, is capable also of sensitizing these individuals so that they develop an asthma-like syndrome. In addition, TDI is capable of causing acute irritation of the skin and probably is capable of sensitizing the skin so that urticarial and angioneurotic edema-type reactions occur. Since the start up of the TDI Unit at Institute, the Medical Department has seen employees who fit into all of these categories. The number of exposures to TDI, as well as exposures to phosgene (the latter has no connection to the information discussed here), appears to be excessive and the number of people that have developed acute illnesses and the number of people who have been sensitized from TDI exposures is extreme. Some of the men developing illnesses have had unusual exposures but many of the exposures have resulted from the personal observation that the best of housekeeping in the TDI Unit is not being practiced. Undoubtedly this is due to many reasons but prior to the writing of this report, efforts have been initiated to greatly improve the housekeeping practices which may result in a decrease in the number of exposures. Also, mandatory instructions have been issued to prevent the unusual exposures which occur when repairing or installing equipment in the unit. Because of the number of employees involved and because of the seriousness of the illnesses that some of these individuals have manifested, it is deemed desirable to bring this to the attention of local plant management.

GENERAL INFORMATION AND CASE HISTORIES

An acute exposure to TDI via the respiratory tree results in the usual symptoms of irritation. This is a coryza-like syndrome similar to that of the common cold where the victim complains of burning and itching of his eyes, stuffiness and stinging of his nose, dry or sore throat and fairly severe spasmodic episodes of coughing which is dry and nonproductive. In addition, most of these people complain of insomnia. It has been our experience that prevention of further TDI exposures over a period of several days during the illness usually results in a termination of symptoms with only a minimum of symptomatic therapy. However, in some individuals, a fairly severe exposure results in an illness which is not only more prolonged but has much more pronounced symptoms than those of the coryza-like syndrome. These men have pain and tightness of their chest, spasmodic coughing episodes associated with bronchospasm and audible wheezing from rales or rhonchi. Again insomnia is a pronounced symptom, probably due to the audible

wheezing and also weakness and fatigue are other subjective complaints. These victims have reduced vital capacity and they are short of breath. Again, in most cases, removal from the TDI contaminated atmosphere and definitive therapy with bronchodilators, antihistamines and corticosteroids result in a cessation of symptoms after a week or ten days. The vital capacity improves after the victim becomes asymptomatic.

In certain men, pulmonary sensitization may develop after only one or two severe exposures or may result after repeated mild exposures. The pulmonary sensitization may be so pronounced that breathing the material contaminating a co-worker's clothing may reactivate the asthma-like syndrome. A number of each of the varieties of illnesses described above have occurred in employees working at the Institute Plant.

When an employee reports an exposure to a chemical, this is tabulated on a master sheet. In reviewing the TDI master sheet, it was found that between December, 1963, and 17 Jun 64, a total of 56 men reported a total of 74 exposures to TDI. Of these, 35 men were believed to be acutely ill from TDI toxicity and eight of the men, following their exposure to TDI, were absent from work with "some" illness of the lungs. Pulmonary sensitization has occurred in eight men of which two men also have manifested skin sensitization and three men, to date, have been assigned to permanent restricted work in other parts of the plant.

Case histories, which may help in exemplifying and amplifying the seriousness of this situation, are as follows:

Case No. 1 - A machinist (DAH - age 54) working on evening shift in the Maintenance Shop was cleaning and repairing rotary Cam pumps that had been in TDI service. These pumps are sealed and it is useless to send these to Chemical Cleaning prior to their receipt in the Machine Shop because they must be opened on a lathe. When the pump is opened, any liquid TDI or solid TDI residue contained within the pump spills on the floor of the Machine Shop.* In cool weather with the doors and windows of the shop normally closed, this vapor creates a fairly severe problem for all men working in the shop. However, in warm weather such as that being experienced at the time of the writing of this report, with the doors and windows open, a breeze may remove the vapors from the immediate vicinity of the machinist working on the pump and he is not affected but since the TDI vapor is carried by the breeze to remote portions of the shop, other men in other locations are exposed to the TDI vapor. An exposure of this latter type resulted in this machinist visiting the Medical Department on the evening of 4 Jun 64. He was absent from work from 5 Jun to 11 Jun 64 under the care of his personal physician. The personal physician has had experience with TDI patients in his private practice (Tank Trucking Company) and was well aware of the symptoms that result from TDI exposure. It was his opinion, as well as mine, that this man did have a fairly severe acute illness from TDI and may have pulmonary sensitization although the latter is not conclusive.

* Some machinists have said white or blue smoke comes out of the pumps.

Case No. 2 - A shift utility mechanic (WEB - age 53) working in all areas of the plant reported several exposures to TDI during January and February of this year. His illnesses were mild and his complaints disappeared promptly with symptomatic therapy. In May it was discovered inadvertently that this man's foreman unofficially had arranged a temporary restricted work assignment that kept the mechanic from having further exposures to TDI. The Medical Department became aware of this and informed this man that if TDI did make him ill, he should report it to the Medical Department where a record would be made of his exposure and illness. Then if the Medical Department decided that he needed to be restricted, it would be arranged officially. Approximately one week after discovering that this man had been having respiratory distress previously, he visited the Medical Department again acutely ill with the typical symptoms of TDI toxicity. He alleged that his exposure was not from exposure in the TDI Unit, but from the clothing of co-workers on his shift who used the same locker room that he used. He insisted also that he had not worked in the TDI Unit or in that locality where he would have been exposed. An industrial hygiene survey* of the locker room at shift change time (10:30 p.m. - 11:00 p.m.) disclosed that there was sufficient TDI in the atmosphere of the locker room to have precipitated this man's fairly severe acute illness. It is believed that this man has pulmonary sensitization and a request has been made to permanently restrict him from further exposure to TDI.

Case No. 3 - A rigger (JLW - age 24) was doing pipe work adjacent to the TDI Unit when vapor was vented from a stack in the TDI Unit. It was believed at the time that the vapor was phosgene and the only symptom resulting was mild coughing which responded promptly to symptomatic therapy. Two weeks later, this rigger was taking a pump out of a tank and some vapors accidentally vented from the tank which the patient inhaled. He became ill with shortness of breath, fairly severe spasmodic coughing episodes with associated bronchospasms and insomnia. His symptoms continued for approximately one week. He visited his personal physician who insisted that he stay off work and during this absence was hospitalized. He missed twelve working days and the diagnosis made by the personal physician was "interstitial pneumonitis". After returning to work, this employee continued to have chest complaints and although he was not working directly in the TDI Unit, he continued to work in Maintenance Area VII. Because of continual wheezing, and shortness of breath, he was treated by the Medical Department with more definitive therapy including corticosteroids, bronchodilators, anti-histamines and a request was made to permanently restrict him from further exposure to TDI. Shortly after this request was made, he was assigned permanently to another plant maintenance area and has been asymptomatic since his transfer.

Case No. 4 - An operator in the "SEVIN" Insecticide Unit (CJB - age 52) was working on the south side of the Naphthol Unit where TDI was also being distilled. This man did not work at any time directly with the TDI operation. He was distilling other miscellaneous materials in the same structure and very likely received exposure to TDI from vapors carried on the wind. During the middle of April, this man had

* Report 64-IH-1-I-3 dated 18 Jun 64 by R. E. Peele

what he called a "chest cold" and instead of visiting his personal physician or visiting the Medical Department, he did some self-prescribing, taking some capsules of an antibiotic (demethylchlortetracycline).

Several days later, he went on vacation to Florida and developed severe urticarial lesions. He visited a physician in Florida who treated him with a corticosteroid which relieved him temporarily but after several days, he again developed urticaria. On 4 May 64, at the end of his vacation, he still had severe urticaria and was not permitted to work because of his allergy. In addition to this, he still had a cough and he continued to wheeze. He complained of insomnia, sore throat and shortness of breath.

On 14 May 64, most of his symptoms had disappeared and he was released to work on evening shift. He returned to work in the Naphthol Unit where TDI was still being distilled and at 8:50 p.m. that evening, he visited the dispensary complaining of severe nonproductive cough and pain in his chest. He was treated symptomatically by the shift nurse although that night on retiring he had insomnia, wheezing and coughing with bronchospasms. The following day, he again had fairly severe urticarial lesions on his skin, sibilant rales in all lobes of his lungs and a reduced vital capacity. It was believed that this man had pulmonary sensitization to TDI and possibly skin sensitization, not from the demethylchlortetracycline, but rather from TDI. This man was placed on temporary restricted work as an operator in another part of the plant and within 24 hours he was asymptomatic.

Case No. 5 - A machinist (HFB - age 38) visited the Medical Department during May to report soreness of his chest and severe coughing episodes which he thought probably were due to some chemical vapor. One week later, he returned complaining of the same symptoms and stated that following his first illness he had gone to his personal physician whose treatment helped him. However, he was exposed again to some chemical vapor and immediately developed coughing and severe chest pain. In June, this man's personal physician called me stating the machinist had visited him with shortness of breath, soreness and pain in his chest, audible wheezing and auscultatory rales.

The personal physician was requested to have the machinist visit my office. An occupational history indicated that on 8 Jun 64 on evening shift this man worked on a TDI centrifugal pump. He said the pump had white powder on the inside and was covered with a "molasses-like" material on the outside. After working for a short time on this pump, he appeared to be choking, was short of breath and had pain in his chest. That night he was restless and had insomnia. He stated further that he had been working on TDI pumps off and on over a period of months and this vapor never seemed to bother him until the last few exposures. Undoubtedly, because of the repeated exposures, this man has developed pulmonary sensitization to TDI.

Case No. 6 - Another machinist (R[NMI]C - age 44) early in March visited the Medical Department on several occasions complaining of tickling in his throat, coughing and insomnia. On 12 March, he again visited the dispensary with angioneurotic edema mainly of his lips although he had some urticarial lesions on his body and extremities. He had been seeing his family physician for this for some time but he was continuing to have difficulties despite the physician's treatment. At that time, because he had been spraying ceramic solution (METCO) frequently it was believed that he might be allergic to a chemical in this material. However, on 13 Mar 64 he reported that he had been working on a phosgene pump from the TDI Unit and the vapors from this pump had affected his throat. He was having coughing spasms as well as swelling of his lips and hives on his body. It was suggested that he visit, locally, an allergist for skin testing.

Early in June it was reported that this man was off work under the care of his personal physician and he was absent from work from 4 Jun to 15 Jun 64 allegedly from inhaling TDI vapors. At the time he visited his personal physician, he had wheezing, shortness of breath, insomnia and spasmodic coughing episodes with pain and soreness in his chest. The cough was dry and nonproductive. This employee stated that since he had visited the Medical Department in March in regard to the METCO episode, he had wheezing at least two days out of five and in the last month he had insomnia at least two or three nights out of every five. On weekends when he was not working, he would feel well and sleep fine but on returning to work, after a very short time, he would again start wheezing and have shortness of breath. This employee was concerned about his illness but, after learning that it was probably due to TDI vapors, he appeared to be more concerned about his absence from work because he stated, "This is the only time that I have missed work since I began working for Carbide in 1952 and it is the only time that I have missed work in the last 18 years that I have been working." It is believed that this man's angioneurotic edema and urticarial reactions were due to TDI skin sensitization and probably he has developed also pulmonary sensitization.

CORRECTIVE MEASURES FOR PREVENTION OF FURTHER EXPOSURES

Opportunities for exposures to TDI and TDI residues (very high in TDI content) are excellent, not only in the operating unit itself but also in several of the maintenance shops where repair work on pumps and motor valves is accomplished. Of the total of 74 exposures to TDI between December 1963, and 17 Jun 64, there were only 36 exposure reported in operating personnel. Of these, 21 were in shift utility mechanics so the actual operators in the TDI Unit have had a minimum of exposures although, undoubtedly, there were many exposures not followed by acute illness that were never reported to the Medical Department. One operator became ill on several occasions and it was believed that he had developed pulmonary sensitization to TDI. Therefore permanent restricted work was arranged for this man and he was transferred to another operating area.

In regard to exposures reported by shift utility men, it has been stated that it appears to be "Standard Operating Procedure" for any shift utility man who has worked in the TDI Unit to report to the Medical Department, ill or not, following completion of his job assignment in the TDI Unit. This visit is not to report an exposure but only to report that he worked in the TDI Unit. The author contests this statement and feels that this is erroneous because having seen, questioned and examined personally many of these shift utility mechanics visiting the Medical Department, it is believed that in practically all cases these Medical Department visits by shift utility mechanics were warranted and were authentic to report either exposure or illness following exposure. Certainly the shift utility mechanics as a group doing emergency repairs have much more opportunity than operating personnel, or even maintenance personnel in the maintenance area, for exposure to TDI and TDI residues.

Maintenance personnel working in the TDI operating area removing pumps, etc., have opportunities for exposure because it seems impossible to thoroughly flush out these pumps and motor valves before they are removed from service. Here again, undoubtedly, there have been many exposures that have not been reported but these are brought into the open when finally acute illness follows an exposure.

Maintenance and shop personnel probably have the greatest opportunity for exposure to TDI and TDI residues. Pumps and motor valves are being sent to the shop which are covered not only on the outside by TDI or TDI residues but also the parts inside these pieces of equipment contain TDI or TDI residues. When the pumps and motor valves are dismantled the material contained within has been the chief cause of exposure to TDI or TDI residues. The machinists, as stated earlier, have had exposures, illnesses and absences from work presumptively from sensitization. General repairmen have had exposures in dismantling centrifugal or screw-type pumps. Electricians have had exposures in working on TDI equipment in the Electrical Shop and instrument mechanics have had exposures from working on motor valves that have been contaminated with TDI and its residues. Many exposures by these workmen have never been reported and it is believed that if these exposures continue, there will be many more personnel sensitized to TDI.

Extensive efforts are now being made to reduce greatly or eliminate completely exposures to TDI particularly in the shops. By the end of this week, 26 Jun 64, it is expected that a hood, ventilated and vented to the atmosphere, will be installed in the Machine Shop which will be used by the machinists and electricians working on TDI equipment. This should eliminate exposures in these groups. At the end of two weeks (3 July 64) a hood, ventilated and vented to the atmosphere, will be installed in the Pump Shop so that instrument mechanics and general repairmen who work on motor valves and open type pumps will be protected from TDI vapors. In the field, an attempt is being made to improve the housekeeping of the TDI Unit thus eliminating exposures. In addition, all equipment being removed from the TDI Unit will be sent to Chemical Cleaning* prior to being worked on in the maintenance shops. Also, orders have been issued that each time equipment is being worked upon or being removed from service in the TDI Unit, fresh-air equipment must be used.

* Or cleaned in Pump Cleaning Unit in Maintenance Pump Shop

CONCLUSIONS

The number of exposures, illnesses and difficulties due to TDI are extreme. In a six-months' period, 74 exposures to TDI resulting in 35 men with acute illnesses, represents a severe problem. Unfortunately the seriousness of this problem remained undetected until viewed broadly. In retrospect, with eight men missing work following illness from TDI exposure, it would seem impossible that the severity of this problem could have been overlooked. However, now that maintenance and operating supervision are well impressed by the seriousness of this situation, it is believed that the preventive measures undertaken will reduce or eliminate further hazards from exposure to TDI and its residues.

Submitted by:



R. J. Sexton, M.D.
Plant Medical Director

RJS:gh

ADDENDUM

Since this report was written, the two machinists described as case numbers 1 and 5 again have had difficulties following TDI exposures as follows:

Case No. 1 continued - This machinist (DAH) was on vacation from 14 to 21 Jun 64 and, as described in the main body of the report, was absent from work (5 to 11 Jun 64 inclusive). He did work, however, in the Machine Shop during the daytime on 12 June 1964. While on vacation he states that he felt fine and he returned to work Monday morning, 22 Jun 64. He felt well all that day and was asked to work overtime the evening of 22 Jun 64. At 8:30 p.m., while working in the Machine Shop, he became short of breath, started coughing and felt badly. He reported to the Medical Department. He was treated promptly with oxygen under positive pressure, was permitted to breathe isoproterenol, was administered a bronchodilator orally, a long-acting antihistamine, and was sent home.

He was seen again the following morning (23 Jun 64) and stated that he felt much better and he was not wheezing. Rales or ronchi could not be heard in his lungs. A complete blood count revealed that this man had a 10% eosinophil count which is considerably above normal limits and indicates that he was undergoing some sort of an allergic reaction.

Investigation this morning (23 Jun 64) revealed that last night a TDI evaporator tube bundle, which had been torn apart, was lying on the floor of the Boilermaker Shop. This tube bundle was viewed by me this morning, although it has now been moved to the Welding Shop, and on the ends of the tubes was brown TDI residues and white milky-looking material which evidently was TDI reacted with water. The bundle was fairly clean. However, if this machinist has pulmonary sensitization (which is strongly suspected) only one or two breaths of air containing the vapor would be enough to precipitate another allergic pulmonary crisis.

Case No. ^β5 continued - In the body of the report, it states that this man (HFD) was interviewed by me on 8 Jun 64. I saw him again on 10 Jun 64 and his symptoms had subsided considerably. He worked the evenings of 10, 11 and 12 June and on 12 Jun 64, he had another exposure to TDI. This was not known until yesterday, 22 Jun 64, when he appeared in the Medical Department at 3:45 p.m. to be released to work following an absence of five days (15 to 19 June inclusive).

Occupational history revealed that this man had an exposure to TDI from a tube bundle that had been torn apart and was lying in the Boilermaker Shop. Evidently the exposure to TDI resulted in fairly severe coughing, wheezing and shortness of breath. He was under the care of his personal physician. On routine periodic physical

examination on 13 Mar 61, this man's total vital capacity was 5 liters but yesterday, prior to his return to work, his vital capacity was only 4.3 liters. He is still complaining of shortness of breath.

The information on Case No. 1 and Case No. 5 has been added to further amplify the seriousness of TDI pulmonary sensitization.

Submitted by:



R. J. Sexton, M.D.
Plant Medical Director

RJS:gh

Dated: 23 June 1964

TOXICITY TO TOLYLENE DIISOCYANATE

REPORT NO. 2

SUMMARY

The first report on this subject, dated 22 Jun 64, included information on all exposures and illnesses to TDI, the number of employees sensitized and the number assigned to permanent restricted work for the period between the start-up date in December of 1963 and 17 Jun 64. During that interval of time, 56 men reported a total of 74 exposures to TDI. Acutely ill from TDI toxicity were 35 men of whom eight men lost time from the job. Eight men also acquired pulmonary sensitization to TDI and it was necessary to assign three of these employees permanently to restricted work.

During the present period (18 Jun 64 to 10 Aug 64) an additional 23 men have reported 26 exposures. Three of the men were acutely ill but none needed assignment to permanent restricted work. To date, 94 exposures have resulted in 38 illnesses with eight men losing work, eight being sensitized and three being assigned to permanent restricted work.

Preventive measures initiated by the Operating and Maintenance Departments have been successful at least partially in reducing the number of exposures. Those measures initiated by the Maintenance Department have been in effect for only the last half of the period covered in this report but at least half the exposures reported had occurred prior to their institution.

GENERAL INFORMATION

From December of 1963 up to and including 17 Jun 64, 56 employees reported a total of 74 TDI exposures. Many of these involved only showering and a change of clothing with no apparent injury and no chemical symptoms followed, but 35 men were ill and eight men lost time from the job. It was believed that eight men developed sensitization to TDI, necessitating the assignment of three employees to permanent restricted jobs.

At that time, because the seriousness of this situation was apparent to the supervisors of both Operating and Maintenance Departments, measures were initiated to control exposures and prevent future illnesses and sensitization. In installing the protective equipment in the Maintenance Shops, a period of several weeks passed and during that time

additional exposures occurred. In the period 18 Jun 64 to 10 Aug 64, an additional 23 men reported 26 TDI exposures. The majority of these again were "no apparent injuries" and the men so reporting were given showers and clean clothing, but three men did develop acute* illnesses. The ill employees were treated on the job in the Plant Medical Department and none of the three were referred to outside consultants nor required hospitalization.

In the field, the incidence of TDI exposures continued despite the preventive measures but in practically all cases, except one, these were minor exposures. One man, exposed in the field while installing a pump, stated that he received a respiratory exposure to TDI despite the use of personal protective fresh-air equipment.

Since the case histories of the three men ill during this period were similar to the case histories of those recorded in the first report on this subject, there seems no point in describing these in detail. It is believed that sufficient attention has been concentrated on the acute illnesses and pulmonary sensitization that results from exposure to this chemical and it is believed further that now employees are convinced that exposure to TDI must be avoided. To date, 10 Aug 64, 79 men have reported 94 exposures, resulting in 38 acute illnesses of which eight employees were sensitized and eight employees lost time from the job.

PREVENTIVE MEASURES

OPERATING DEPARTMENT

Exposures to TDI in the unit have been eliminated almost entirely by two procedures insisted upon by the Operating Department as follows: (1) mandatory use of personal protective devices including fresh-air equipment whenever breaking into or reinstalling equipment or lines and (2) completion with correct information and the use of special tags to be placed on operating equipment that is to be removed from the TDI Unit for repair.

MAINTENANCE DEPARTMENT

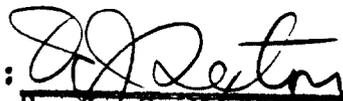
Exposures in the Maintenance Department (Area V Shops) were occurring when canned pumps were being opened on a lathe in the Machine Shop, when pumps were being rewired in the Electrical Shop, when pumps were being opened in the General Repairmen and Millwright Shops, when pumps were being cleaned in the Pump Shop and when diaphragm motor valves were being repaired in the Instrument Shop. Exposures have occurred not only from the release of TDI vapors when the pumps were opened, but also

*Acute means rapid and sudden. The symptoms and physical signs characterizing the respiratory distress after TDI exposure appears within several hours after exposure and are sufficiently severe to cause the victim to seek medical treatment. With the proper therapy, the victim can continue to work and the symptoms diminish quickly.

from the vapor of the liquid TDI which would drain out of the opened pump onto the floor when the pump was unsealed. Ventilating fans (heater fans being used to circulate air in summertime) in the shops would circulate this released vapor to practically all parts of the shops causing TDI exposures.

The corrective measures instituted by the Maintenance Department were the provision of exhaust ventilation over the lathe used to open canned pumps (Figure 1), exhaust ventilation used to evacuate the TDI vapor when pump motors were being rewired (Figure 2), the exhausting of vapor when pumps were being opened in the Millwright and General Repairmen Shops (Figure 3), the exhausting of vapors when pumps were being opened and cleaned in the pump cleaning facilities outside the General Repairmen Shop (Figure 4) and the removal of vapors released from motor valves when these were repaired in the Instrument Shop (Figure 5). Additional preventive measures not illustrated (Figures 1, 2, 3, 4 and 5) are the use of trays under the lathe, work benches, etc., to collect the liquid TDI draining from the pumps and valves as they are opened. This prevents spillage of the liquid on the floor and prevents circulation of the toxic TDI vapor.

Submitted by:


R. J. Sexton, M.D.
Plant Medical Director

RJS:gh

REPORT ILLUSTRATIONS



Figure 1

Section of ventilator adjacent to the lathe is detachable. Long arm of the ventilator swings away from lathe and can be stored flush against wall in the background. Note paper on grill of ventilator demonstrating the powerful suction of the ventilating equipment.



Figure 2

Ventilating facilities of the Electrical Shop. Again note sheet of paper adhered to grill of ventilator demonstrating the powerful suction of the equipment which evacuates the air of the Electrical Shop almost continuously.

REPORT ILLUSTRATIONS



Figure 3

Shows the ventilating facilities of the Millwright and GR Shops. Installation of equipment not quite completed at the time photograph was taken.

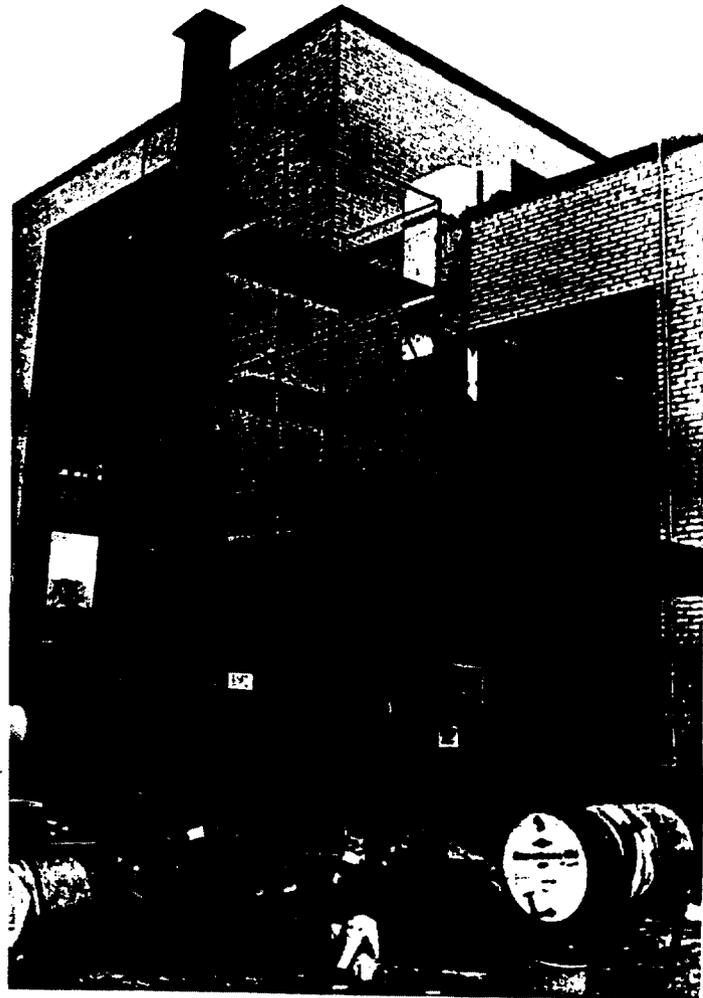


Figure 4

Pump cleaning facilities, located outside of and to the west of the GR and Millwright Shops. Note ventilating stack extending into the air above the roof of the shop building to blow contaminated air away from the working environment.

REPORT ILLUSTRATIONS

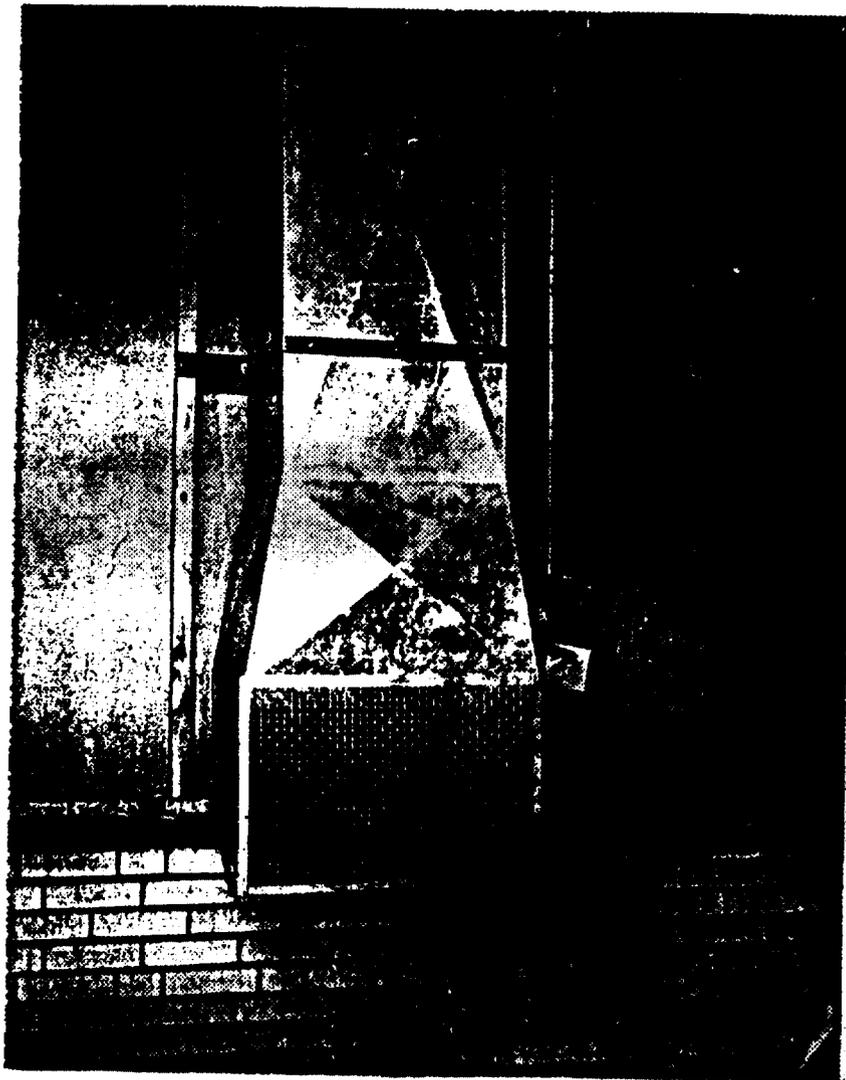


Figure 5

Ventilating facilities of the Instrument Shop. Installation of the equipment has just been completed and the work bench or table upon which motor valves would be repaired is not yet in place. However, the ventilation provided by this exhaust hood should prevent further exposures to TDI in the Instrument Shop.

TOXICITY TO TOLYLENE DIISOCYANATE

REPORT NO. 3

SUMMARY

It quickly became quite obvious that the maintenance department's efforts to ventilate specific equipment or certain shop areas to minimize or eliminate TDI exposures were not going to be completely successful because exposures to maintenance shop personnel have continued. Through the efforts of maintenance supervision, the problem of minimizing TDI exposures became not only the responsibility of maintenance supervision but also the responsibility of supervision of the operating and shipping departments. The present report discusses the problem of minimizing exposures to personnel and in addition related problems that have arisen in the meantime. These various problems are described and the solutions that have been decided upon are presented in detail.

Under General Information is included more background material which attempts to define the problem more clearly. In the section Exposures and Illnesses, the magnitude and complexity of the problem is discussed. Continuation of several case histories is included under the appropriate section title and a section entitled Corrective Measures includes eight enclosures explaining fully the responsibility designated to the various departments concerned. Also included in this section are illustrations of the material and equipment that will be used in the latest attempt to minimize TDI exposure to plant 512 personnel. It is the opinion of the author that the TDI exposure problem has not been solved completely and that sporadic episodes of acute illnesses, particularly in those employees believed sensitized to TDI, will occur in the future.

A study is being made of the physical well-being of TDI operators, shift utility mechanics and various maintenance personnel who have had many TDI exposures in the last eight months to determine recovery from acute illness due to TDI exposure and the possibility of permanent partial disability. It is not possible to include the results of this study here, but these will follow in a later report.

GENERAL INFORMATION

Despite the efforts made to control or prevent exposures to TDI (described and illustrated in Report No. 2, dated 12 Aug 64), maintenance personnel in particular have continued to report exposures to the medical department and some of these men have been ill on occasion. The high hopes of both maintenance and operations supervision on the corrective measures, actuated in August to control exposures through the use of fresh air equipment in the field and in the use of ventilating equipment in the shops, were dampened somewhat, particularly when exposures not only continued to occur but one employee, previously sensitized to TDI and assigned to permanent restricted work, had an insidious exposure to TDI that resulted in the most severe acute attack of respiratory distress yet observed in an employee since the TDI unit has been in production (described in the section Case Histories as Case No. 6 continued).

It would appear that Institute plant employees' continuing TDI exposures and illnesses have precipitated several difficulties for management as follows:

(1) The problem of placement of permanently restricted craftsmen with TDI pulmonary sensitization, such as machinists who, because of the location of their equipment, are confined into a shop area where TDI contaminated equipment is handled and repaired.

(2) The problem of deciding whether or not the eight absences from work, cited in reports* from "some" respiratory illness, should be classified as lost-time accidents and included in the Lost-Time Injury Safety Awards Program presently being conducted at the Institute plant.

(3) The problem of re-evaluating and changing the work practices and procedure presently being used to neutralize TDI liquid and vapor, i.e., when spills occur, canned pumps are opened, pump motors are rewound by electricians and tank trucks are loaded.

(4) The problem of educating maintenance and shipping personnel regarding the hazardousness of TDI and encouraging them to report exposures without frightening them to the extent that an employee, or employees, might refuse to work in the TDI area or work on TDI equipment.

At the time of writing this report, it is believed that each of the four above problems has been solved or corrected as follows:

(1) Decontamination of TDI contained or coated equipment will be carried out in the TDI unit area (maintenance area VII) in a special decontamination shop so that machinists, millwrights, electricians, etc., who have been ill or who have developed pulmonary sensitization to TDI can work in the maintenance shops (area V) and will not be exposed further to TDI vapors in area V. This is discussed and illustrated in detail in the section Corrective Measures.

(2) After considerable discussion, it has been decided by plant management that the eight absences and illnesses, which were suspicious of resulting from TDI exposure, will not be included into the Lost-Time Injury Record of the Institute Plant's Safety Award Program and, furthermore, will not be counted as lost-time non-accident injuries against the plant record.

(3) Considerable progress has been made in the attempt to prevent further exposures to TDI by maintenance department and shipping department personnel. This required the cooperation of a number of departments and supervisors but instrumental in initiating efforts to control and eliminate exposures as well as motivating supervisors of other departments to cooperate in this venture were Messrs. Booth, Dugan and Miller of the Institute plant maintenance department.

As stated above, after initial attempts by maintenance and operations supervision to control exposure to TDI through the use of mandatory fresh air equipment in the field and the mandatory use of ventilating equipment in the shops, it quickly became obvious that this was not the entire answer to the problem. The problem may have continued due to a number of factors; some of which follow:

(a) Some employees, not exposed to health education on the hazardousness of TDI and not having been ill from exposure to TDI, seemed reluctant to accept the fact

*TDI Toxicity, Medical Department, Special Report with Addendum, dated 22 Jun 64; Toluene Diisocyanate Toxicity, Report No. 2, dated 12 Aug 64.

that TDI is a very hazardous chemical. Because of this lack of understanding and evidence of indifference, these individuals did not follow the prescribed operating and maintenance safety procedures and at times co-workers were inadvertently exposed to TDI, resulting in cases of illness.

(b) Even though efforts were made by maintenance personnel to work on TDI contaminated equipment under a hood, at times small amounts of vapor escaped into the working environment to which TDI pulmonary sensitized employees were subjected and resulted in cases of illness.

(c) A few work practices, which were not considered when the preventive measures outlined in Report No. 2 were instigated, continued to result in cases of illness from TDI, e.g., burning the varnish or plastic covering off the windings of canned pumps outside the maintenance electrical shop on occasion resulting in smokey fumes, containing TDI vapor, to enter the shop, thus causing cases of illness.

(d) Inadvertent exposure to TDI vapor from the clothing and shoes of co-workers in confined spaces such as the episode related as Case No. 2 continued (see section Case Histories) in which a second similar episode to this same employee has occurred. The re-evaluation and initiation of additional corrective measures to prevent further TDI exposures is contained in a later section of this report.

(4) Between 14 Jan 64 and 9 Sep 64, there were 104 employees in the Institute plant who reported a total of 126 exposures to TDI. Many of these exposures were nothing more than TDI on clothing, TDI contaminating the skin and inhalation of TDI vapor which were labeled "no apparent injury" and subsequent follow-up on these employees revealed that no illness or injury resulted from many of these exposures. However, of these 126 exposures there were 43 cases of illness, a good many of which were mild and required only very minor symptomatic therapy, but there were some illnesses that required rather intensive medical therapy. None of the employees treated in the plant medical department lost work because of these illnesses. Then, also there were nine employees (eight from plant 512 and one from plant 514 on loan to plant 512) that were absent from work with "some" respiratory illness labeled as bronchial pneumonia, interstitial pneumonia, bronchial asthma, etc., and all labeled "non-occupational" in etiology by the outside personal physician on the group insurance statement of claim. Some of these men on returning to work and again being exposed to TDI -- a few very quickly, within hours -- reported back to the medical department complaining of symptoms exactly like those from which they had suffered when they lost work previously. This led to the medical department's belief that these men, who had been ill following TDI exposure, now had pulmonary sensitization to TDI and permanent restricted work assignments were necessary if we wished these employees to remain in good health. Hence, the plant 514 employee was returned to that plant and as they have no TDI in plant 514, it is presumed that his health is excellent. The remaining eight plant 512 individuals thought to be suffering from TDI pulmonary sensitization have either been assigned to, or the request has been made for, permanent restricted work assignments. Despite the adherence, by the restricted employees and their supervision, to the restriction of "no further exposure to TDI, chlorine or phosgene", some of these men have been exposed to TDI because of the indifferent and haphazard attitude elaborated upon under No. 3a above and because of the work practices and procedures elaborated upon under Nos. 3b, 3c and 3d above.

Prior to the start-up of the TDI unit in November, 1963, the Institute plant medical department was requested by TDI technical supervision to present health education information to TDI operating department personnel. The plant training department scheduled these sessions during daytime working hours, together with other TDI training sessions for operating department personnel, in a period of one week. Shift utility men were not included because, to have scheduled sessions for these men on each shift, it would have required at least two sessions for each of the four shifts and overtime pay would have been necessary had these men been brought in on their own time to attend the operators' training sessions. Therefore, in November, 1963, shift utility men were not included in the TDI health education sessions.

In fifteen years of scheduling and presenting health education for a variety of old and new chemical processes, the Institute plant's medical department has attempted always to include auxiliary service departments' personnel -- laboratory, shipping, maintenance, etc. -- in the training sessions. For some unexplained reason, neither maintenance nor shipping personnel were invited to attend the TDI operators' training sessions. However, had maintenance been invited, it would probably have been personnel only from maintenance area VII and not personnel from maintenance area V (shops), since evidently it was not obvious at that time that shop personnel would ever be exposed to TDI.

In April, 1964, the supervisors of the shift utility mechanics, requested the training department to schedule TDI health education sessions for all of their personnel on each of the four shifts, because shift utility mechanics had reported a number of exposures to TDI and several had been mildly ill. Therefore, as these men seemed intensely interested in their own safety, it was decided to present the same health education information to shift utility mechanics that had been presented to the operating department. These sessions were scheduled for presentation in May and the first week of June of this year.

During the time these sessions for the shift utility mechanics were being held, the weather became exceptionally warm and the number of exposures to TDI in the plant being reported to the medical department increased and the number of employees becoming ill increase. Due to this fact, along with the information that now had accumulated on the nine men with TDI pulmonary sensitization, Mr. Booth, maintenance superintendent, and Messrs. Dugan and Miller, assistant maintenance superintendents, requested that the medical department present at once -- September -- health education sessions to all maintenance personnel of area V (shops), area VI (garage, salvage and chemical cleaning) and area VII (maintenance field force).

The medical department decided, since maintenance shop personnel and many of the other maintenance personnel being scheduled for the health education sessions in September would never contact nor ever be exposed to many of the raw materials, catalysts, intermediates and end products of the TDI process, to confine remarks in these sessions, which necessarily had to be much shorter than four hours since it was desirable to conclude this as quickly as possible and because there were 400 plus employees involved, and to cover only the physiological effects from TDI itself with appropriate background and succeeding treatment, stressing the necessity of prevention. The background information was shortened by omitting information pertaining to the eyes, skin and gastrointestinal routes of entry and more stress with much more detail was placed on the anatomy, physiology and reaction to contaminants with succeeding injury of the respiratory tree from the chemical TDI only. Also since eosinophilia is a manifestation of TDI pulmonary sensitization, simple explanations on complete blood count procedures were offered and as TDI induces an asthma-like syndrome resulting from an allergic phenomenon -- analogies, Rhus poisoning and extrinsic bronchial asthma -- were used. The three planes of treatment for chemical injuries and illnesses were presented and emphasis was placed on prevention and specific treatment of the acute illness.

*The information offered to the operating department (fall, 1963) and the shift utility mechanics (spring, 1964) covered the physiological effects from exposure of all four body systems commonly involved in chemical exposures as well as the hazard of systemic illness from skin penetration. This included the eight raw materials and catalysts (Figure 1) and the seven intermediates and end products (Figure 2). It was preceded by background information on toxicology, physiology, anatomy, pharmacology and industrial hygiene pertaining to all four body systems. The information on physiological effects was succeeded by a detailed explanation of the three planes or levels of treatment for chemical injuries or illnesses. The above information was presented to each group in two sessions of two hours each.

EXPOSURES AND ILLNESSES

Tabulated in the medical department's chemical exposure book under the listing Tolylene Diisocyanate from 14 Jan 64 (when the first reported TDI exposure was entered) to 1 Oct 64, there have been entered 169 reported exposures with 43 illnesses of which 9 men* were absent from work, 10 men** were sensitized and 10 men* have either been assigned to, or the request has been made for, permanent restricted work with the restriction "no further exposure to TDI, phosgene or chlorine." On 9 Sep 64, the medical department presented to maintenance personnel of areas V, VI and VII and to shipping department personnel, health education information on the toxicity of TDI[†]. During those sessions, the men were told that from 14 Jan 64 to 9 Sep 64 inclusive, 126 exposures to TDI had been reported with 43 men being ill. Since that time, there have been 45 additional exposures tabulated so that on the date of writing this report, 20 Oct 64, a total of 172 exposures have been reported. All additional exposures between 10 Sep 64 and 20 Oct 64 were to maintenance employees except three exposures -- two reported by shift utility mechanics and one reported by a shipping department employee.

Following one of the health education sessions held for maintenance and shipping department personnel, a very intelligent question, although difficult to answer, was asked by one of the men as follows: "What is considered an exposure to TDI? If I smell TDI and then develop no symptoms, is this considered an exposure to TDI and am I required to report it to the medical department and to my supervisor?" The answer advanced was that such an incident definitely is considered an exposure and theoretically must be reported. Although it is believed that a very mild exposure, as that described in the question, occurring to an individual who previously has never been ill from TDI, would not necessarily result in subjective symptoms and objective findings and for practical purposes could be reported to the supervisor only. However, if the exposure were heavy enough to cause irritation in an unsensitized individual, the symptoms resulting from irritation would require reporting to the medical department in person. The question is difficult to answer too because not known is the minimum concentration of TDI in the atmosphere that will cause subjective symptoms and objective findings in an individual, particularly in an exposure after he has been sensitized to TDI. Theoretically, a person could be sensitized on his last exposure and not develop symptoms or findings until his next following exposure to the allergan.

In the health education sessions the analogy of Rhus poisoning (poison ivy dermatitis) was used. According to the literature, somewhere between 40% and 60% of all individuals will become sensitized to poison ivy at some time during their lives. No one is born sensitized to poison ivy, and the sensitization when it occurs must be acquired through at least one or more exposures to the allergan which, in the case of Rhus poisoning, is urushiol contained in the leaves, vines and roots of the Rhus toxicodendron plant. The second exposure or perhaps the "Xth" exposure to the allergan will be followed by the typical manifestations -- itching and an edematous, vesicular eruption of the skin. Therefore, if the "Xth" exposure to TDI has caused the development of sensitization in the exposed individual, the "Xth" plus one additional exposure -- and this may be from breathing a very minute concentration of the vapor as shown by our industrial hygiene studies -- may manifest the typical asthma-like syndrome observed in TDI pulmonary-sensitized individuals.

Certainly, it is not known at this time what percentage of individuals, if exposed frequently enough and long enough to TDI, would develop pulmonary sensitization to this material. Theoretically, it probably should be 100% but not necessarily so and, if

*One man, a Plant 514 loanee (GWB) for many years suffering from bronchial asthma, was returned to Plant 514.

†Medical Department TDI Report, Health Education Summary, Report No. 3, dated 22 Sep 64.

assuming the 100% is correct, it is to the benefit of the man and the company that all exposures, regardless of severity, be reported. It is to the utmost advantage of everyone concerned that exposures to TDI, in the future, be eliminated completely or if they occur, be reported as an exposure. During the health education sessions, a definite attempt was made to convince the employees attending that TDI potentially is a most hazardous chemical, but at the same time, the sessions very pointedly were strictly educational -- not of the "scare" variety.

The question has been asked by a number of Institute plant personnel interested in this problem: "Why have maintenance department field and shop personnel, and in particular the latter, had so much difficulty with TDI illness and sensitization when the operating department, whose personnel work with this material day in and day out since the start-up of the unit in November, 1963, has had so very little difficulty, toxicologically, with this chemical?"* The only explanation appears to be, at present, that operating personnel, although working directly with this chemical, just do not have the actual exposures to the material in routine operation of the unit that have been experienced by maintenance men repairing TDI contaminated equipment -- pumps, valves, lines, etc. The shift utility men performing work on shifts, similar to that performed by maintenance field and shop personnel on straight-day work, have accumulated reported exposures and illnesses similar to those experienced by maintenance department personnel. At the time of writing this report, although rumors have continued to circulate that some TDI operating personnel have coughed and wheezed and been mildly ill on a number of occasions but never reported these exposures or resulting illnesses, only one TDI operator to date, thought to have been pulmonary sensitized to TDI, has been transferred out of the 166 department.

It is impossible to express an opinion why the employees of the plant shipping department have not reported an excessive number of exposures to TDI and also why, on a number of occasions, shipping department employees have not been made acutely ill from TDI exposure. The expense of the health education sessions held during September for maintenance and shipping department employees certainly could be justified, if for no other reason, on the value of the information obtained by supervision through the questions asked during the sessions. There were a number of questions asked by those attending, recorded by Messrs. Dugan and Morris of the maintenance department, which definitely pointed out gross deficiencies in plant work practices in day-to-day use -- in the inadequate clean-up of TDI spills, in the inadequate preparatory clean-up of TDI contaminated equipment needing repairs and in shipping department procedures in the loading of TDI into tank trucks. A glaring example of a hazardous work practice experienced by shipping department employees is as follows: A Carbide customer transports TDI in his own tank trucks which are three-compartment tankers and the TDI is loaded through open manholes via a hose. In order to determine when the tanker compartment is filled, the shipping department employees must lean over the manhole of the tanker and look down into the tank as the fluid level reaches the "full" mark. No protective equipment is worn because this would interfere with the employee seeing into the tank compartment. The severity of TDI exposures in this particular incidence must be almost unbelievable. Why many of these employees have not been ill is unexplainable[†]. To date only one shipping department employee has been ill following exposure to TDI. This employee (CMR) after several illnesses, was thought to have developed pulmonary sensitization to TDI. The medical department recommended, through routine channels, that he be assigned to permanent restricted work. His restriction was approved and granted.

*It is not a definite conclusion that TDI operators were not having a problem with this chemical and this will be discussed in a later report on a study now being conducted to determine the possibility of permanent partial disability.

[†]It appears to be that some individuals (percentage unknown) can tolerate TDI vapor in high concentrations on many, many exposures, yet never suffer any ill effects.

CASE HISTORIES

Case No. 2 continued* - (WEB) A shift utility mechanic was thought to have developed pulmonary sensitization to TDI and in June, 1964, a recommendation for permanent restricted work was approved and granted 26 Jun 64. During April of this year, he had an insidious exposure to TDI which resulted in symptoms and discomfort severe enough so that he visited his personal physician. His physician ordered a chest x-ray which was reported as showing a peribronchial inflammation of the lower lobe of the left lung and he was advised by his physician to avoid exposure to "an industrial toxin or its dust on the clothing of fellow workers in a closed room." The employee alleged later to the plant medical department that the exposure to TDI which precipitated his attack of respiratory distress occurred because of breathing vapors (TDI) from the clothing of his co-workers using the same locker room that he used.

During May, he again developed symptoms from a similar situation but this time the symptoms were mild. Early in June, a third similar episode occurred (breathing TDI vapor from clothing of co-workers in a closed locker room) and the employee was placed on temporary restricted work with the following restriction: "no exposure to TDI, phosgene or chlorine." Since this shift utility mechanic kept insisting TDI vapors from the shoes and clothing of co-workers, contacted during lunch time and at shift change time in the locker room where the windows were closed on cool nights, were causing his respiratory difficulties, air sampling for TDI was conducted in the locker room on the midnight shift. These industrial hygiene procedures disclosed that, in the locker room, there was a concentration of TDI, although all samples were less than the threshold limit value of 0.02 ppm, sufficiently high enough to have precipitated symptoms in an individual who had been pulmonary sensitized.¹ Mr. Peele's report² showed that sampling on two different shifts varied in the concentration of TDI from 0.0015 ppm to 0.016 ppm.

Through the hot weather months, July and August, this man had no respiratory difficulties. However, in the fall (middle of September), because the windows and doors in the shift utility mechanics' locker room again were being closed at night due to the cool weather, he reported to the medical department on 15 Sep 64 at 4:15 A.M. (on midnight shift) complaining of wheezing and respiratory distress. He stated that on each succeeding night of midnight shift, his symptoms were gradually increasing in severity. Following rather intensive medical therapy, his symptoms subsided very quickly. It is assumed, of course, that he purposely avoided this locker room thereafter. It is planned to perform additional air analyses in this particular locker room during the cold winter months.

Case No. 6 continued* - This machinist [R(NMI)C] has worked regularly in the area V machine shop and from March until early in June he alleged that he had mild episodes of respiratory distress at least several times a week. Then his symptoms became so severe tha

*From Report No. 1, dated 22 Jun 64.

¹Of course, it is not known what concentration of TDI is necessary to reactivate the allergic phenomenon in a sensitized individual and it could well be that 0.0015 ppm of TDI is of a sufficiently high concentration to do this. At the same time, several years ago, the threshold limit value for TDI was established by the American Conference of Governmental Industrial Hygienists at 0.10 ppm and it was decided that this was too high so more recently the threshold limit value has been re-established at 0.02 ppm. It has been rumored that the duPont Company believes that the present threshold limit value of 0.02 ppm is too low. However, for an individual who has been pulmonary sensitized to TDI, it could very well be that 0.0002 ppm might still be far too high. Doctor C. U. Dernehl informed me that exposure to as little as one molecule may result in reaction -- his personal opinion of course.

²Industrial Hygiene Report 64-IH-1-I-3, dated 18 Jun 64, by R. E. Peele.

after visiting his personal physician early in June he was absent from work (4 Jun to 15 Jun). On his return to work, the request was made to place this employee on temporary restricted work with the following restriction: "no exposure to TDI, phosgene or chlorine." This request was honored by not assigning this machinist to work on equipment from the TDI unit and it was believed that this, plus the corrective measures outlined and illustrated in TDI Toxicity Report No. 2, dated 12 Aug 64, would prevent him from having further exposure to tolylene diisocyanate vapor.

On 11 Jul 64, he experienced a mild episode of respiratory distress resulting allegedly from exposure to TDI vapors when a pump from the TDI unit was brought into the machine shop and placed on a lathe behind the lathe on which the employee was working. This rather mild illness responded promptly to specific therapy and it was believed that, by placing him in the far end of the machine shop away from the ventilated lathe illustrated as Figure 1 in Report No. 2, he would have no further exposure to TDI.

This man worked on straight evening shifts and on Friday, 28 Aug 64, between 9:00 P.M. and midnight, he began coughing, wheezing and complained of shortness of breath. At the end of his work shift, 12:20 A.M., Saturday morning, he visited the medical department and complained to the shift nurse who immediately started him on oxygen inhalations under positive pressure. This patient's difficulties increased, his wheezing continued, his respirations were 32 per minute, he coughed almost continuously and began to develop a sallow, yellowish-gray color of his skin and in addition, developed anxiety from acute air hunger. The attending nurse said later that she believed that he was going to die. I saw him at 1:10 A.M. on 29 Aug 64 and he was coughing almost continuously. Auscultation of his chest revealed inspiratory and expiratory bubbling rales in all lobes of both lungs, anteriorly and posteriorly with very short inspiratory and expiratory phases of respiration. This man had acute air hunger, he was mildly cyanotic from continual bronchospasm and extremely anxious. Evidently this was a terrifying experience, but by beginning corticosteroid therapy, administering a bronchodilator and by encouraging him to breathe deeply and more slowly, at 3:30 A.M. this patient began to improve. He was kept in the medical department overnight, since it was believed useless to send him to one of the local hospitals, and by 5:00 A.M. this patient stopped coughing, breathed more normally and finally fell asleep. He awakened at 8:00 A.M. very much improved and was sent to one of the local hospitals for a complete blood count* and erythrocyte sedimentation rate*. His white blood count was 15,000 cells/cu mm and his erythrocyte sedimentation rate was 41 mm in one hour (Westergren). His total vital capacity* at 12:20 A.M. when he first appeared in the medical department was 1.6 liters, but on Saturday morning at 11:00 A.M., after he had responded to the medication, his total vital capacity had increased to 3.5 liters. On a physical examination previously performed (58 inches tall, weighing 164 pounds), it was recorded that his total vital capacity on 13 Feb 61 was 3.7 liters (considered his normal). At noon on Saturday, 29 Aug 64, he returned to his home and the following week was able to work on his regularly scheduled straight evening shift.

His condition has continued to improve. On 1 Sep 64, his white blood count had decreased to 13,150 cu mm and his erythrocyte sedimentation rate was still 40 mm in one hour and his total vital capacity was 3.8 liters. He has been followed periodically since and on 9 Sep 64 his white blood count was 12,350 cells/cu mm and the erythrocyte sedimentation rate was 35 mm in one hour. On 13 Oct 64, his white blood count was 13,700 cells/cu mm and the erythrocyte sedimentation rate was 33 mm in one hour. His total vital capacity was 3.6 liters on this date. His only complaint was occasional shortness of breath. On auscultation, his breath sounds were physiological and no rales were audible, even on forced expiration.

*Normal Values:

White blood count: 5,000-10,000 cells/cu mm of blood.

Erythrocyte sedimentation rate: 1-13 mm in one hour.

Vital capacity: Varies, depending on height and weight. For this man, 4.75 liters.

The incident of 28 Aug 64 was investigated and reported through the usual channels. However, the exposure that this machinist received was rather baffling. Initially the man reported to the nurse and to me also that on the evening of 28 Aug 64, three pumps -- one canned, one gear and one centrifugal -- had been brought into the shop. This man went to pick up a job -- the gear pump -- and he discovered that it was tagged as a TDI pump so he did not work on it. He believed that he did not receive any exposure from the gear pump. That evening outside the electrical shop, electricians were burning the varnish and coverings off the windings from a canned pump and some of the smoke generated during this procedure had drifted into the shop. The employee thought that this smoke may have contained some TDI vapor because sometime during the evening he had been sitting in the doorway between the metalizing shop and the machine shop (the large ventilating fans in the metalizing room were pulling air through the doorway) and he thought, being exposed to this moving air (containing TDI?), he received his exposure thusly. Later investigation revealed that, in repairing broken sewers in the "SEVIN" insecticide unit earlier that day, back pressure had resulted in a spill from a TDI storage tank in the unit area and the wind, blowing from east to west that night, may have brought TDI vapor into the machine shop causing the exposure. There was some discussion as to the distance that TDI vapor could be carried on the wind, and it also created the problem listed as "1" under General Information -- placement of this employee, since it was obvious that he now should be restricted permanently from further exposure to TDI. The placement problem was complicated further because if TDI vapor is carried long distances on the wind, no shop or unit in the plant would be free of TDI vapor, if a spill occurred. It was the discussion about the etiology of this case that prompted maintenance supervision -- Messrs. Booth, Dugan and Miller -- to investigate means and method of decontaminating TDI equipment thoroughly and completely before it is brought into the shop for repairs.

CORRECTIVE MEASURES

The Institute plant maintenance department, namely Messrs. Booth, Dugan and Miller, concerned about the severe illness manifested by the machinist [R(NMI)C] on 28-29 Aug 64, called a meeting with the objective of minimizing the exposures of maintenance personnel to TDI. A copy of the conclusions of that meeting and the names of those attending etc., is included in this report (Enclosure No. 1).

Almost immediately afterwards, Mr. N. S. Eastman, assistant plant manager, called a meeting on 11 Sep 64 with the objective of reviewing the entire problem on minimizing TDI exposures to Institute plant personnel and to correlate the responsibilities of various departments in its accomplishment. A second meeting, held on 18 Sep 64, finalized the conclusions that were developed during these meetings. Attending the two meetings held by Mr. Eastman were Messrs. Cole, Booth, Frincke, Kelly, Weddell, Ayers, Slaughter, Dugan, Pontius and the author.

The conclusions reached in these meetings were as follows:

OPERATING DEPARTMENT:

1. Provide written instructions for procedures to be followed in neutralizing spills or emissions of TDI in the unit area.
2. Provide the necessary equipment and materials to be used to neutralize TDI during spills or emissions of TDI* (Enclosure No. 2, pages 1 and 2).

*The materials for and methods of decontamination of TDI was fully outlined in Enclosure No. 2 Procedure for Handling Any TDI Spill in Order to Minimize Personnel Exposure, John M. Ernst, 11 Sep 64, page 2.

SHIPPING DEPARTMENT:

1. Develop written procedures to be followed by employees in loading TDI into tank trucks or tank cars (Enclosure No. 3).

SHIFT SUPERINTENDENTS:

1. Develop instructions to be used by shift utility mechanics to minimize exposures and neutralize spills or emissions of TDI when working in the TDI operating area (Enclosure No. 2).

MAINTENANCE DEPARTMENT:

1. Develop written instructions for procedures to be followed by maintenance employee in the removal of TDI equipment for repairs (Enclosure No. 4).
2. Provide necessary equipment and instructions for the neutralization of all contaminated equipment to be carried out in the TDI area prior to it being sent to the maintenance shops (area V) for repair. (Explained fully in items I to VI inclusive, Enclosure No. 1.)

INDUSTRIAL RELATIONS:

1. Provide health education information to maintenance and shipping employees (Enclosure No. 5).
2. Develop and put into operation the necessary equipment for TDI field sampling and analysis (Enclosure No. 6).
3. Screen the medical records on operating, maintenance, shipping and other personnel working with TDI who have pre-existing physical conditions or limitations and initiate, through the usual channels, the recommendations for restricting these employees from working with TDI or TDI contaminated equipment (Enclosures No. 7 and 8).

The illustrations* on the next several pages will indicate to the reader the lengths to which the management of the Institute plant has gone to protect employees from exposure to this chemical. The captions included with each illustration describe the use of the particular piece of equipment shown.

Submitted by:


 R. U. Sexton, M.D.
 Plant Medical Director

RJS:hl

*Photographs by Mr. B. F. Allen of the plant 512 maintenance department engineering staff.

Figure 1

TOLYLENE DIISOCYANATE (TDI) PRODUCTION

RAW MATERIALS AND CATALYST

	<u>ORAL</u>	<u>SKIN IRR.</u>	<u>SKIN PEN.</u>	<u>BREATHING</u>	<u>EYE</u>
DINITROTOLUENE	2	2	2	1	2
METHANOL	1	1	1	3	2
o-DICHLOROBENZENE	3	2	3	3R	3
PHOSGENE (CARBONYL CHLORIDE)	-	-	3*	5*	4*
CALCIUM CARBONATE (LIMESTONE)	1	1	1	1	2
SODIUM HYDROXIDE (20%)	4	5	1	3	5
HYDROGEN	-	-	-	3	-
RANEY NICKEL	3*	4*	1*	1*	4*

* = APPROXIMATIONS AND NOT CONFIRMED BY ANIMAL WORK

R = REPEATED BREATHING IS MORE DANGEROUS THAN THE ENTRY SUGGESTS

Figure 2

TOLYLENE DIISOCYANATE (TDI) PRODUCTION

INTERMEDIATES AND END PRODUCTS

	<u>ORAL</u>	<u>SKIN IRR.</u>	<u>SKIN PEN.</u>	<u>BREATHING</u>	<u>EYE</u>
TOLYLENE DIAMINE	3	2S	2	1	2
TOLYLENE DIAMINE RESIDUES	-	2	-	-	3
TOLYLENE DIISOCYANATE	2	3S	2	5S	3
HYDROGEN CHLORIDE (GAS)	3	5	3	5	4
CARBON DIOXIDE	-	-	-	3	-
CARBON MONOXIDE	-	-	-	5	-
HYDROGEN SULFIDE	-	-	3	5	4

S = SENSITIZATION MAY RESULT FROM REPEATED EXPOSURE

REPORT ILLUSTRATIONS

Figure 3

The decontamination station, built on skids, is shown located in the TDI unit area. This view shows the open entranceway into the laboratory hood with the chain hoist attached to the monorail. The window on the right is open for ventilation so that when the doors of the building are shut, makeup air can enter the decontamination station to feed the ventilating fan of the hood. The contaminated air is blown out the top of the 15 foot high stack, roughly 26 feet above ground level.



Figure 4

Close-up view of the entranceway into the decontamination station showing a canned pump being hoisted by the chain hoist on the monorail. The chain hoist slides along the monorail into the inside of the decontamination station so that the pump then can be disassembled on the workbench (see Figures 5 and 6). The disassembled parts are placed in the neutralization bath to decontaminate liquid and solid TDI (shown in Figures 5 and 6).



Figure 5

Looking down on the workbench where pumps are disassembled. On the right is the tank containing the neutralizing solution to decontaminate pump parts. Note drainage hole in workbench under which is a collecting pan and the material draining off the equipment being disassembled is collected and neutralized. This decontaminated solution is then flushed to the sewer. On the far left is shown the small diameter pipe which contains water and is sprayed on the collecting pan.



Figure 6

Another view of the inside of the decontamination station showing the workbench on the left and the bath on the right. Behind and above is shown the hood to exhaust the contaminated air.

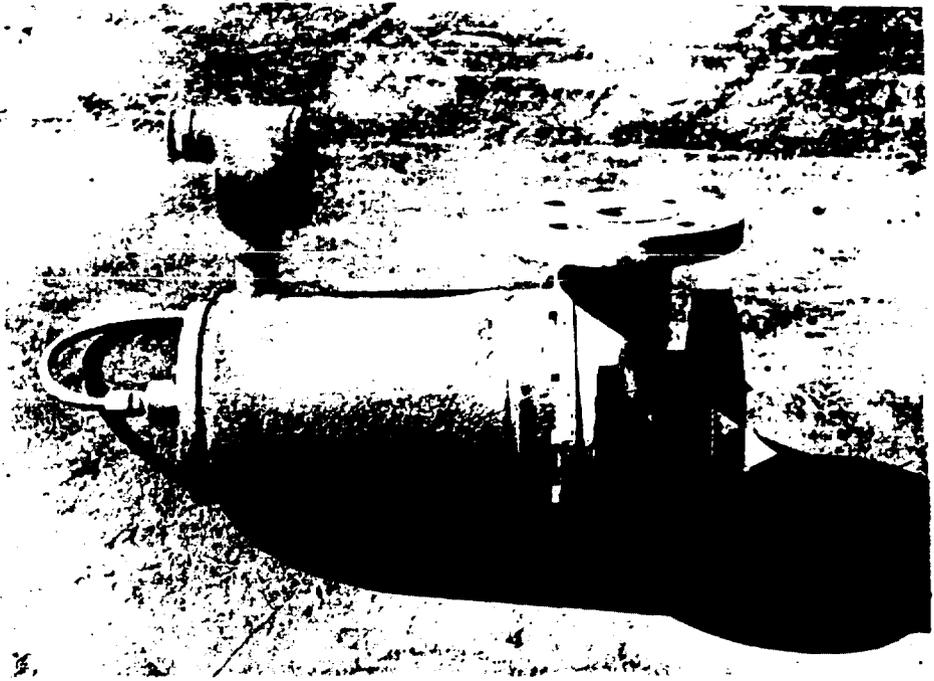


Figure 7

A canned pump, still intact, is shown lying on the tank pad. The pump, removed from TDI service, will be disassembled in the decontamination station.



Figure 8

A canned pump, partially disassembled, shows the stack containing the stator from which the can has been removed. On the left is a flange which has been removed from one end of the pump.



Figure 9

Shows the 30 foot trough in the TDI unit area containing neutralizing solution and in the end of the trough nearest the viewer are three valves soaking in the neutralizing solution. The trough is of sufficient length so that larger pipe sections can be decontaminated.



Figure 10

Shows the decontamination vat, measuring ten feet in diameter and ten feet in height. This vat will be partially buried in the ground (shown on Figure 11).



Figure 11

Shows the decontamination vat of which seven feet of the height of the vat is under ground and three feet above ground. This vat is useful to decontaminate large pieces of equipment such as still sections, heat exchangers, etc.



Figure 12

Shown on the left is the green drum containing clean Speedi-dri® and on the right the red drum where the contaminated Speedi-dri® is placed. If liquid TDI is spilled on the ground or tank pad, clean Speedi-dri® is immediately thrown on the spill. Neutralizing solution (shown in Figure 13) is then sprinkled on the Speedi-dri®. The neutralized TDI-Speedi-dri® mixture is swept together and shoveled into the red drum.

Figure 13

Shows one of the drums located in the TDI unit containing TDI neutralizing solution and shown also is an ordinary sprinkling can used to disperse the neutralizing solution on the Speedi-dri® covering a spill.



A meeting was held at the Maintenance Office Tuesday, September 8, to discuss the problems of handling equipment and piping which has been in TDI service, spills at the unit, and other housekeeping problems. Those in attendance at the meeting were: Mr. J. Slaughter, Mr. Jim Nichols, Mr. R. Schafer, Mr. A. F. Booth, Mr. W. J. Dugan, Mr. C. C. Miller, Mr. S. B. Hammonds, Dr. Sexton, and Mr. B. F. Allen.

The following decisions were made to reduce the exposure of maintenance personnel to TDI:

- I. A metal building, preferably one on skids, will be placed in the unit. This building will contain:
 - A. A laboratory-type hood with provisions to place small pieces of equipment, i.e., pumps, motor valves, etc., into the hood from the outside of the building.
 - B. Necessary tools for disassembly.
 - C. A neutralizing bath of ammonia and isopropanol installed under the hood.The equipment will be disassembled and decontaminated under the hood before being sent to the shop for repair.
- II. It shall be mandatory that maintenance personnel wear fresh air equipment when opening any pipe or equipment where TDI is suspected.
- III. All TDI piping being removed from the unit shall be blind flanged and taken to an area in the unit (to be designated) where it shall be cleaned with water and steam. The area for cleaning of pipe and large pieces of equipment shall be north of the TDI Unit.
- IV. A trough or open top tank, containing ammonia and isopropanol, will be placed in the unit to allow the submersion of large pieces of equipment for decontamination.
- V. Still sections, when removed, shall be flooded with water at the unit.
- VI. A shop order will be written to install trenches at the unit to permit better clean-up and eliminate sewer plugging.

Other items discussed were:

1. Contact Mr. Bob Peele concerning the new type fresh air hood being used on "C" Shift. (This contact has been made.)
2. A point was made that greater care should be taken by Polyols personnel in the handling of TDI.
3. The Shipping Department is using personnel not instructed in the proper handling of TDI.
4. Shipping and laboratory personnel will be invited to the safety lectures scheduled for the Maintenance Department later this month. These lectures will be conducted by Dr. Sexton.
5. The Trucking Department will be instructed to give priority to the handling of TDI resid

Submitted by: B. F. Allen
B. F. Allen

TO: Mr. S. B. Hammonds

9-11-64

Copy to: Mr. G. F. Morris
Mr. R. W. Mundy
Mr. C. Sturgeon

Subject: Neutralization of TDI spills in the unit and the necessary assistance that will be required by Maintenance.

Dear Mr. Hammonds;

Attached is a copy of the procedure we are going to follow within the TDI operating areas in order to minimize TDI exposure.

This procedure will require some assistance from your Dept. to make effective and we are requesting that you take appropriate action to provide the following service:

1. Daily empty the contaminated barrels (Red drums).
2. Daily see that the new speedi-dry drums are filled (Green drums).
3. In the case of major spills, provide necessary labor force to clean up the contaminate and neutralized speedi-dry. (Depending on particular case, this will be done either on unit clean-up charge or a specific shop order.).

We would also like to make it clear that any equipment or tools painted red or green is intended to be used for TDI spill neutralization ONLY. We will have to insist on this and would appreciate your help in being sure all your personnel know this.

Very truly yours,


J. M. Ernst

TO: All TDI Unit Personnel

Sept. 11, 1964

SUBJECT: Procedure for handling any TDI spill in order to minimize personnel exposure.

Gentlemen:

Starting today, all TDI spills will be handled as outlined below. This is requested in order that we minimize the possibility of TDI sensitization. As of today, you will find placed in strategic locations, a set of three drums.

A set of these drums will consist of the following;

- 1 green drum - this is to store new "speedi-dry" for use on a spill.
- 1 red drum - this is for contaminated speedi-dry cleaned up from the spill.
- 1 drum - containing "TDI neutralization solution" with a 10 qt. sprinkling can for applying the solution.¹

These sets of drums will be located initially as follows (Experience may indicate that relocation will be necessary):

- a. West of the TDI forecolumn under the mezzanine.
- b. North east of the TDI refining column.
- c. Centrally located to all TDI storage tanks in unit tank farm.
- d. At tanks 5078 and 5079 (At foot of east stile.).
- e. Tank car and truck loading rack

Effective immediately, we all will be responsible as follows for any TDI spill we may encounter:

- a. Immediately cover the spill thoroughly with speedi-dry.
- b. Immediately upon completion of covering with speedi-dry, the spill area will be thorough saturated with "TDI neutralization solution"¹
- c. Within 5 minutes of saturating the spill with solution, the contaminated material will be swept or shovelled up and placed in the red drums. These drums will be maintained daily so as to insure having room for material in them at all times.

It will be the responsibility of the man causing the spill to see that the above procedure is carried out to completion either as an individual or with adequate assistance. If the spill is of major proportions, it will be his responsibility to see that adequate coverage with speedi-dry and neutralization solution is carried out and then immediate report the spill so that additional labor can be acquired to clean up the neutralized area.

Strict adherence to this procedure is a must if we are minimize TDI exposure and resultant sensitisation. The maintenance dept. is installing adequate equipment to permit complete de-contamination of all of our equipment SUSPECTED of containing TDI prior to its removal from the unit area.



¹ TDI neutralization solution is a mixture of water-ammonia-isopropanol and will be stored in the UCAR shipping building.

LOADING PROCEDURE FOR TDI TRUCKSInstitute Plant

Exposure to TDI liquid and vapor must be avoided. Use air mover to keep vapors out of working area. Fresh air equipment is available and must be used whenever a TDI truck or car is being loaded or unloaded. Any contaminated clothing must be removed at once. Be sure to use coverall goggles when disconnecting hose from the truck.

Care must be taken to avoid leakage and spillage of TDI. It will be the responsibility of the man causing the spill to see that the exposed liquid is reacted and removed from the work area. Exposed liquid must be covered with "Speedi-Dri" from the green drum and sprinkled with ammonia-isopropanol mixture. Shovel the "Speedi-Dri" into the red drum and cover with water after absorption is complete.

1. Check the trailer and lines to be sure there is no moisture or dirt present.
2. Connect ground wire, and pressure trailer to 20 psig with "high purity" nitrogen. Check for leaks. (All except Carpenter trucks)
3. Connect vent line to top vent outlet on trailer and turn on blower at tank car shelter.
4. Connect loading hose to bottom outlet. Be sure loading hose is equipped with shut-off valve at the end toward trailer. Use stainless hose only.
5. Set valves to use filter and meter. Set meter for desired load and call unit for material. Extreme care must be taken when starting flow through the meter to avoid liquid hammer. If the line is empty, open the shut-off valve very slowly before the meter and ease the flow on the line. Do not use quick-acting valve to stop flow on downstream side of meter. Use "emergency stop" on meter if necessary.

If meter is by-passed or inoperable, try to get quantity from unit storage tank or load as you do Carpenter trucks and build pressure on truck to 20 psig after loading.

6. When trailer is loaded, blow hose from loading platform into the truck. Do not blow through the meter to the tank or from the tank. Material may be left in the line normally. Electrical tracers set for 30°C. will keep material from freezing. Tracers should be controlled by Operating Department. Use only "high purity" nitrogen for blowing.
7. Disconnect hose from truck. Use five-gallon bucket to collect spillage. Dispose of spillage by using "Speedi-Dri" and ammonia-isopropanol solution. Discard the residue into the red drum. Cover the reacted product with water.

Loading Procedure for TDI Trucks - contd.

8. Reset meter, sample, and set valves at meter and filter. Clean truck and hose connections with "Chlorethene," cap and cover with plastic bags.
9. Build truck to 20 psig and check for leaks using "high purity" nitrogen. Disconnect ground wire and send to scales after tagging and sealing.
10. Do not pressurize Carpenter trucks, but be sure dome lids are closed and sealed and tagged.
11. Notify unit when truck is loaded so they can shut off pump and set field storage valves.



P. W. Pontius

G. M. Robinson

PWP-GMR:va

9/17/64

TO: All Maintenance Foremen in Area VII
Maintenance Weekend Log Book
TDI Unit (5)

DATE: October 13, 1964

SUBJECT: Facilities And Procedures For Handling TDI Equipment

FROM: G. F. Morris

FACILITIES FOR HANDLING TDI EQUIPMENT

The following facilities are provided at the TDI Unit to help minimize personnel exposure:

1. Stations within the unit and at the shipping rack to neutralize spills. These stations each contain the following:
 - a. A green 55-gallon drum containing clean SPEEDI-DRY to cover spill.
 - b. A 55-gallon drum of TDI neutralizing solution with a 10-quart sprinkle can to saturate area of spill.
 - c. A red 55-gallon drum to hold contaminated material.

These stations are to be used in the event of a TDI spill as follows:

- a. Immediately cover spill with clean speedi-dry from green drum.
- b. Saturate area of spill with TDI neutralizing solution.
- c. After approximately five (5) minutes shovel contaminated material into red drum.

FACILITIES (Continued)

2. A building on the east end of the unit containing a fresh air station, ventilating fan, work bench, monorail for handling equipment and a neutralizing bath.

This building is to be used for dismantling small equipment containing TDI and neutralizing it before removal from the area.

3. A 30-foot trough made of large diameter pipe containing TDI neutralizing solution.

This trough is for neutralization of piping and tubing containing TDI.

4. A large open-top tank approximately ten feet deep containing TDI neutralizing solution for submersing large items of equipment containing TDI.

PROCEDURES FOR HANDLING TDI EQUIPMENT

1. When removing any TDI equipment, fresh air masks must be worn. If there is doubt as to whether the equipment contains TDI, be sure to ask the operating foreman or responsible technical assistant.
2. If a spill occurs while removing or installing equipment, cover the spill immediately with SPEEDI-DRY and saturate with TDI neutralization solution. After approximately five (5) minutes

PROCEDURES (Continued)

shovel material into one of the red drums provided in the unit for contaminated material. The man creating the spill will be responsible for the cleanup.

3. Blind flanges must be installed on all open piping remaining when equipment is removed. The proper blind flanges should be available before removing equipment to avoid delay in preventing a spill. The equipment being removed should also be blind flanged if it is not going to be neutralized immediately.
4. All equipment containing TDI must be neutralized before leaving the immediate area of the unit.
5. All TDI equipment leaving area must be tagged with fluorescent caution tag, even though equipment has been neutralized.
6. Above all, avoid breathing TDI vapors.

PROCEDURE FOR HANDLING SPECIFIC ITEMS

A. Pumps - General

1. Suction and discharge piping must be blind flanged immediately upon removing pump.
2. Cover pump suction and discharge with plastic to avoid escaping vapor.

PROCEDURE FOR HANDLING SPECIFIC ITEMS (Continued)

A. Pumps - General (Continued)

2. Continued

a. Chempumps

First check stator for ground, then remove to ventilated building, place under hood from outside building, using monorail. Enter building, turn on fan and completely disassemble pump. If the stator is grounded, rupture can on each end with tool provided and completely submerge stator until neutralized. If stator is not grounded, remove vent, plug opening and submerge in neutralizing solution until neutralized. Submerge all other parts in neutralizing solution until neutralized. Place parts in metal pan provided and send to Shop.

Note: If these pumps are submersed without disassembly the urea remaining in the pump after neutralizing will cause difficulty in removing rotor and bearings due to the close tolerances of all parts.

b. Seal pumps

Loosen seal flange, remove plastic from suction and discharge of pump, then submerge head in neutralizing tank making sure seal is covered with solution. When material is neutralized, remove pump and send to Pump Shop.

Note: Deposits on pump may require further attention by chemical cleaning before being sent to the Pump Shop.

PROCEDURE FOR HANDLING SPECIFIC ITEMS (Continued)

A. Pumps - General (Continued)

2. Continued)

c. Packed Pumps

Remove packing, remove plastic from suction and discharge of pump, then submerge head in neutralizing tank making sure packing gland is covered with solution. When material is neutralized, remove pump and send to Shop.

Note: Deposits on pump may require further attention by chemical cleaning before being sent to the Pump Shop.

B. Piping

All piping being removed from TDI service should have plastic on open ends during removal to the neutralizing trough to avoid vapor escaping in the area. The piping should be immediately placed in the neutralizing trough or tank. Some large crooked sections of piping may require a blind flange or plug on one end and the pipe filled with solution rather than being submersed. Upon neutralization, the piping should be removed to Salvage or to Chemical Cleaning for removal of urea, depending upon whether it is going to be discarded or revised.

If piping is going to be reused without revision, it should be blind flanged upon removal and contact with water avoided to prevent formation of ureas in the piping.

PROCEDURE FOR HANDLING SPECIFIC ITEMS (Continued)

C. Miscellaneous Equipment

Valves, safety valves, motor valves and other miscellaneous equipment must be neutralized before leaving the area. However, before submersing the equipment, it should be determined whether or not the equipment should be disassembled before submersion. Solids formed during neutralization could make disassembly more difficult.

It should be noted that this procedure does not cover the handling of all equipment and occasion will arise when additional information is required before working on equipment.

CFMorris:jcb



INTERNAL CORRESPONDENCE

UNION CARBIDE CHEMICALS COMPANY • INSTITUTE PLANT P. O. BOX 2931, CHARLESTON, WEST VIRGINIA

To (Name) Mr. L. B. Weddell

Date 24 September 1964

Company

Location Bldg. 2, Room 132

Originating Dept. Medical Department - Plant 512

Mr. L. N. Dickinson

Answering letter date

Mr. N. S. Eastman

Copy to Mr. A. W. Cole

Subject

Mr. B. F. King

Mr. A. F. Booth

TOLYLENE DIISOCYANATE - HEALTH EDUCATION
SUMMARY REPORT

Mr. W. J. Dugan

Report No. 3

Mr. R. B. Frincke

Mr. N. H. Ketcham

Dr. H. F. Smyth - Dr. C. P. Carpenter

Dr. C. U. Dernehl

Dr. J. J. Welsh

During January of this year, the TDI Unit began producing a finished product and in the cold winter weather evidently exposures to TDI, if any occurred, were slight and did not result in illness. In late spring and early summer, more and more exposures were reported resulting in considerable percentage of illness in those exposed. Production personnel had received health education sessions¹ prior to start-up of the unit. On special request, because of exposures, the four groups of shift utility personnel were offered similar health education sessions² during May and June. The sessions were not offered to Field Maintenance personnel or Maintenance Shop personnel and up until this time there was no reason to believe that the latter group would be exposed to TDI or would have illness resulting thereof.

However, Maintenance Shop personnel experienced, during warm weather months, a considerable number of exposures to TDI resulting in illnesses and sensitization. This was reported³ and efforts were taken by the Maintenance Department to eliminate or at least reduce the number of exposures in the shops. This also was reported⁴. Shipping personnel also began reporting exposures while loading tank cars, tank

1. TDI - Health Education Summary Report No. 1 dated 30 Sep 63

2. TDI - Health Education Summary Report No. 2 dated 9 Jun 64

3. TDI Toxicity Report No. 1 dated 22 Jun 64

4. TDI Toxicity Report No. 2 dated 12 Aug 64

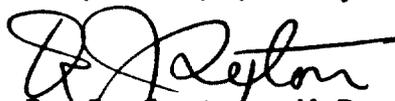
Mr. L. B. Weddell
24 September 1964
Page 2

trucks, etc. Therefore, on request of the Maintenance Department, early in September, health education sessions were conducted for Maintenance and Shipping personnel.

The health education presentations of one and one-half hours each were given over a seven-day period to twelve groups of about 35 or 40 men each from 10 Sep 64 to 18 Sep 64 inclusive, with a total of 407 Maintenance and Shipping Departments' hourly and supervisory personnel attending. The sessions were either preceded or followed by explanatory comments from staff engineers of the Maintenance Department on the necessity of eliminating TDI exposures as well as a detailed explanation of the measures that would be taken to accomplish this.

Each session was followed by the usual question-and-answer period and many of the questions that were asked were actually comments on work procedures or methods that needed to be revised to eliminate exposures. Through these pertinent questions, a number of work procedures and practices were revealed which were extremely hazardous, thus enabling the Maintenance and Shipping Departments to extend their preventive measures even further than they originally had intended. The object of the sessions, which were well received, is to eliminate exposures and, if the same cooperation is extended by personnel in their daily plant work habits as was shown by their interest in this subject, TDI illnesses and sensitization should no longer be a problem in this plant.

Very truly yours,



R. J. Sexton, M.D.
Plant Medical Director

RJS:gh

**INTERNAL CORRESPONDENCE****CHEMICALS DIVISION • INSTITUTE PLANT P. O. BOX 2831, CHARLESTON, WEST VIRG**

To (Name) R. J. Sexton, M.D.
Division
Location Medical Department

Date 29 September 1964
Originating Dept. Industrial Hygiene - Plant 512
Answering letter date

Copy to

Subject TDI FIELD SAMPLING & ANALYSIS EQUIPMENT

A brief resumé on the status of sampling equipment for the TDI Unit has been compiled as requested on Friday, 18 Sep 64.

On 1 Sep 64, Mr. J. R. Nichols, Production Supervisor of the TDI Unit, stated that the duPont Corporation uses a field sampling and analysis kit that is very effective in the field for identifying TDI concentrations in air. He requested that information be obtained on such equipment, and stated that he would like to start a sampling program for his unit as soon as equipment is available.

Reaction to this request revealed that there are two companies, i.e., Mine Safety Appliance Company and Union Industrial Equipment Company, which offer such equipment for sale. Descriptive literature on the kits available from both companies and a report of an evaluation of the Union Industrial Equipment Company, i.e., "UNICO", equipment as compiled by the Technical Center Industrial Hygiene Laboratory, was investigated. It was determined that both kits are equally effective and sensitive, however, the "UNICO" kit is cheaper (\$190.00 versus \$225.00), easier to handle, easier to adapt for other purposes and is the only one actually evaluated by our Industrial Hygiene Laboratory.

One portion of the "UNICO" kit, i.e., the field color standard, was ordered on 10 Sep 64, with the idea that it could be used with our existing TDI sampling equipment and thereby save money. Delivery on this order was received on 22 Sep 64.

A complete "UNICO" kit was ordered on 21 Sep 64, with delivery expected by 24 Sep 64. This was in response to both your request and the evident need for such equipment. Upon receipt of this kit, it will be taken to the TDI Unit where it can be used by the unit personnel (following a short period of instruction) in evaluating suspected releases of TDI.

R. J. Sexton, M.D.
29 September 1964
Page 2

This equipment will not replace but will supplement sampling and analysis done by the Industrial Hygiene Department. There are several advantages associated with such an approach. These can be enumerated as follows: (1) the ability to evaluate a specific TDI problem immediately, (2) the psychological and educational effect of being able to demonstrate the presence or absence of detrimental quantities of TDI in the air and (3) a recorded evidence of actual concentrations for comparison with reported exposures.

Very truly yours,



R. E. Peele
Industrial Hygienist

REP:hl



INTERNAL CORRESPONDENCE

U.C.C.C.
RECEIVED
SEP 18 1964
R. B. FRINCKE

INSTITUTE PLANT P. O. BOX 2831, CHARLESTON, WEST VIRGINIA

CHEMICALS DIVISION

To (Name) Mr. R. B. Frincke

Division
Location Building 2

Date 17 September 1964

Originating Dept. Medical Department

Answering letter date

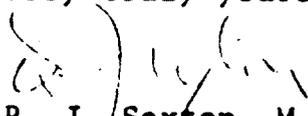
Copy to

Subject TDI - Shipping Personnel

I have gone over the list of 129 names which you submitted and as far as I can determine the only one who should have no contact with TDI is Number 86, This man has been sensitized to TDI and supposedly is assigned to permanent restricted work. All others on the list at the present time are cleared for working with TDI. At the moment, I believe that no Shipping Department employee has been assigned to temporary restricted work because of TDI illness.

If you have further questions, please contact me.

Very truly yours,


R. J. Sexton, M.D.
Plant Medical Director

RJS:gh



INTERNAL CORRESPONDENCE

Enclosure No. 8

CHEMICALS DIVISION

INSTITUTE PLANT P. O. BOX 2831, CHARLESTON, WEST VIRGINIA

To (Name) Mr. Cecil C. Miller

Date 4 September 1964

Division
Location Building 23

Originating Dept. Medical Department - Plant 512

Answering letter date

Copy to Subject TDI - Maintenance Personnel
Areas V, VI and VII.

I have gone over the list of 362 names of maintenance personnel in areas V, VI and VII and as far as I can determine, the employees who should have no contact with TDI are as follows:

In area V -- and
all have a history of bronchial asthma although none of these men have had difficulties with TDI. In addition, there are three men who are either now permanently restricted or permanent restricted work will be requested -- and

In area VI -- have
a history of asthma and it should be pointed out neither of these men have had difficulty with TDI.

In area VII -- have
a history of bronchial asthma. In addition, there are three men, two insulators, --, for whom permanent restriction to TDI will be requested and -- who has been granted a permanent restricted assignment and is now transferred to maintenance area IV; and a pipefitter, --, who has been granted permanent restricted work and is now assigned to maintenance area IV.

Very truly yours,

R. J. Sekton, M.D.
Plant Medical Director

RJS:gh



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

William C. Kuryla, Ph.D.
Assistant Director, Product Safety
Union Carbide Chemicals and Plastics Company Inc.
Health, Safety and Environmental Affairs
39 Old Ridgebury Road
Danbury, Connecticut 06817-0001

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

MAR 06 1995

EPA acknowledges the receipt of information submitted by your organization under Section 8(e) of the Toxic Substances Control Act (TSCA). For your reference, copies of the first page(s) of your submission(s) are enclosed and display the TSCA §8(e) Document Control Number (e.g., 8EHQ-00-0000) assigned by EPA to your submission(s). Please cite the assigned 8(e) number when submitting follow-up or supplemental information and refer to the reverse side of this page for "EPA Information Requests".

All TSCA 8(e) submissions are placed in the public files unless confidentiality is claimed according to the procedures outlined in Part X of EPA's TSCA §8(e) policy statement (43 FR 11110, March 16, 1978). Confidential submissions received pursuant to the TSCA §8(e) Compliance Audit Program (CAP) should already contain information supporting confidentiality claims. This information is required and should be submitted if not done so previously. To substantiate claims, submit responses to the questions in the enclosure "Support Information for Confidentiality Claims". This same enclosure is used to support confidentiality claims for non-CAP submissions.

Please address any further correspondence with the Agency related to this TSCA 8(e) submission to:

Document Processing Center (7407)
Attn: TSCA Section 8(e) Coordinator
Office of Pollution Prevention and Toxics
U.S. Environmental Protection Agency
Washington, D.C. 20460-0001

EPA looks forward to continued cooperation with your organization in its ongoing efforts to evaluate and manage potential risks posed by chemicals to health and the environment.

Sincerely,

Terry R. O'Bryan

Terry R. O'Bryan
Risk Analysis Branch

Enclosure

12248A



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contains at least 50% recycled fiber

Triage of 8(e) Submissions

Date sent to triage: MAY 05

NON-CAP

CAP

Submission number: 12248A

TSCA Inventory: Y N D

Study type (circle appropriate):

Group 1 - Dick Clements (1 copy total)

ECO AQUATO

Group 2 - Ernie Falke (1 copy total)

ATOX SBTOX ~~SEN~~ w/NEUR

Group 3 - Elizabeth Margosches (1 copy each)

STOX CTOX EPI RTOX GTOX
STOX/ONCO CTOX/ONCO IMMUNO CYTO NEUR

Other (FATE, EXPO, MET, etc.): _____

Notes:

THIS IS THE ORIGINAL 8(e) SUBMISSION; PLEASE REFILE AFTER TRIAGE DATABASE ENTRY

For Contractor Use Only	
entire document: 0 <u>(1)</u> 2	pages <u>1, 2</u> pages <u>1, 2, 4-6</u>
Notes:	
Contractor reviewer: <u>LPS</u>	Date: <u>12/30/94</u>

CECATS/TRIAGE TRACKING DBASE ENTRY FORM

CECATS DATA:

Submission # REHQ-1092-12248 SEQ. A

TYPE: (INT) SUPP FLWP

SUBMITTER NAME: Union Carbide Corporation

INFORMATION REQUESTED: FLWP DATE:

- 0501 NO INFO REQUESTED
- 0502 INFO REQUESTED (TECH)
- 0503 INFO REQUESTED (VOL. ACTIONS)
- 0504 INFO REQUESTED (REPORTING RATIONALE)

DISPOSITION:

- 0639 REFER TO CHEMICAL SCREENING
- 0678 CAP NOTICE

VOLUNTARY ACTIONS:

- 0401 NO ACTION REPORTED
- 0402 STUDIES PLANNED/IN PROGRESS
- 0403 NOTIFICATION OF WORKERS
- 0404 LABEL/MSDS CHANGES
- 0405 PROCESS/HANDLING CHANGES
- 0406 APP/USE DISCONTINUED
- 0407 PRODUCTION DISCONTINUED
- 0408 CONFIDENTIAL

SUB. DATE: 10/15/92 OTS DATE: 10/21/92 CSRAD DATE: 08/19/94

CHEMICAL NAME:

Toluene Diisocyanate

CAS#

26471-62-5

INFORMATION TYPE:	P F C	INFORMATION TYPE:	P F C	INFORMATION TYPE:	P F C
0201 ONCO (HUMAN)	01 02 04	<u>0216</u> EPI/CLIN	01 <u>0204</u>	0241 IMMUNO (ANIMAL)	01 02 04
0202 ONCO (ANIMAL)	01 02 04	0217 HUMAN EXPOS (PROD CONTAM)	01 02 04	<u>0242</u> IMMUNO (HUMAN)	01 02 04
0203 CELL TRANS (IN VITRO)	01 02 04	0218 HUMAN EXPOS (ACCIDENTAL)	01 02 04	<u>0243</u> CHEM/PHYS PROP	01 02 04
0204 MUTA (IN VITRO)	01 02 04	0219 HUMAN EXPOS (MONITORING)	01 02 04	0244 CLASTO (IN VITRO)	01 02 04
0205 MUTA (IN VIVO)	01 02 04	0220 ECO/AQUA TOX	01 02 04	0245 CLASTO (ANIMAL)	01 02 04
0206 REPRO/TERATO (HUMAN)	01 02 04	0221 ENV. OCC/REL/FATE	01 02 04	0246 CLASTO (HUMAN)	01 02 04
0207 REPRO/TERATO (ANIMAL)	01 02 04	0222 EMER INCI OF ENV CONTAM	01 02 04	0247 DNA DAM/REPAIR	01 02 04
0208 NEURO (HUMAN)	01 02 04	0223 RESPONSE REQUEST DELAY	01 02 04	0248 PROD/USE/PROC	01 02 04
0209 NEURO (ANIMAL)	01 02 04	0224 PROD/COMP/CHEM ID	01 02 04	0251 MSDS	01 02 04
0210 ACUTE TOX. (HUMAN)	01 02 04	0225 REPORTING RATIONALE	01 02 04	0299 OTHER	01 02 04
0211 CHR. TOX. (HUMAN)	01 02 04	<u>0226</u> CONFIDENTIAL	01 02 04		
0212 ACUTE TOX. (ANIMAL)	01 02 04	<u>0227</u> ALLERG (HUMAN)	01 <u>0204</u>		
0213 SUB ACUTE TOX (ANIMAL)	01 02 04	0228 ALLERG (ANIMAL)	01 02 04		
0214 SUB CHRONIC TOX (ANIMAL)	01 02 04	0239 METAB/PHARMACO (ANIMAL)	01 02 04		
0215 CHRONIC TOX (ANIMAL)	01 02 04	0240 METAB/PHARMACO (HUMAN)	01 02 04		

Sen

TRIAGE DATA:	NON-CBI INVENTORY	ONGOING REVIEW	SPECIES	TOXICOLOGICAL CONCERN:	USE:	PRODUCTION:
<u>YES</u>		YES (DROP/REFER)	<u>Hmn</u>	LOW		
CAS SR	NO	NO (CONTINUE)		MED		
	DETERMINE	REFER:		HIGH		

COMMENTS:

> <ID NUMBER>
8(e)-12248A

> <TOX CONCERN>
H

> <COMMENT>
THIS SUBMISSION CONTAINS INFORMATION CONCERNING WORK-PLACE EXPOSURES TO TDI. DURING A SIX MONTH PERIOD, 56 MEN REPORTED HAVING A TOTAL OF 74 EXPOSURES TO TDI. ACUTELY ILL FROM TDI TOXICITY WERE 35 MEN OF WHOM EIGHT MEN LOST TIME FROM THE JOB. EIGHT MEN ALSO ACQUIRED PULMONARY SENSITIZATION TO THE CHEMICAL. OTHER CLINICAL SIGNS INCLUDED INTERSTITIAL PNEUMONITIS, UTICARIAL LESIONS, INSOMNIA, WHEEZING, AND SPASMODIC COUGHING. DURING THE NEXT THREE MONTHS, 23 MEN REPORTED 26 EXPOSURES TO TDI. THE COMPANY IS PRESENTLY INITIATING MEASURES TO REDUCE THE NUMBER OF EXPOSURES.

Tox Concern

ID

12248A

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EPI

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COMMENT

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EPI: A 1964 PLANT INDUSTRIAL HYGIENE REPORT RELATED TO SEVERAL CASE HISTORIES SHOWS THE PARENT COMPANY WAS AWARE THAT TDI CAN INDUCE RESPIRATORY SENSITIZATION LEADING TO PERMANENT INDUSTRIAL ASTHMA. THE ADVERSE EFFECTS OF TDI ARE NOW ESTABLISHED.