which are not simple occupational hazards, it will be necessary to know not only about the direct connexions between occupations and the particular disease, but also about the connexions between work and the other putative factors which are currently being studied. In the present instance, this involves, first, the connexions between occupation and various relevant habits of living. Thus, there is every reason to suppose that obesity is not equally distributed amongst various occupations; it is a reasonable proposition that men in different jobs have different smoking and, possibly, food habits; and that they enjoy leisure activities of different kinds. There are wide fields here on the margins of industrial medicine waiting to be tilled; and the situation today is rich with opportunity for the student who wishes to learn something about the causes of health and ill-health in middle age.

I am grateful to my colleagues in the Social Medicine Research Unit for their help.

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Exposure to Trichloro-ethylene during an Industrial Degreasing Operation

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The effect of trichloro-ethylene vapour upon workers exposed to it has been the subject of several detailed studies in recent years (Ahlmarm and Forssman, 1951; Frant and Westendorp, 1950; Grandjean, Münchinger, Turrian, Haas, Knoepfel, and Rosenmund, 1955). We are reporting the results of a routine industrial hygiene survey in order to emphasize the importance of such surveys in detecting undesirable contamination of the workshop air.

Description of the Process

The degreasing plant concerned consisted of a single gas-heated tank, approximately 2 ft. 6 in. × 3 ft. 6 in., and divided laterally to provide liquid and vapour phase degreasing sections. The work to be cleaned was mainly small machined components, which were packed into wire baskets fitted with long handles, and then placed in the tank. In some cases where the baskets were tightly packed with very small components, such as nuts and bolts, manual agitation in the liquid degreaser was necessary in order to facilitate the penetration of the solvent. The volume of the regular output from the machine shop involved a considerable quantity of degreasing, and the degreaser unit was heavily loaded.

Covers were not provided on the tank, but vapour-cooling coils were fitted near the upper edges of the tank. Two propeller fans in the outer wall of the shop extracted air at high level, and a further fan extracted air via a draining grid fitted in the floor of the shop near to the tank. The general layout is shown in Fig. 1. Three men were involved in the operation of the plant.

Air Sampling and Analysis

Air sampling was carried out on a day when the normal volume of work was being handled. Air was drawn through two U-tubes in series, each limb containing approximately 5 g. of dried 20- to 60-mesh silica gel. The rate of flow was controlled at approximately 1 litre per minute by the insertion of a critical orifice in the suction line between the U-tubes and the vacuum pump. Analysis of the air samples was carried out by the method described by Elkins (1950), the final titration being performed in a blackened box illuminated by a photographic darkroom lamp with an Ilford yellow safelight No. VS901.

The efficiency of collection and recovery had previously been checked in the laboratory at a concentration of 100 p.p.m. Using stock gel, two U-tubes in series gave recoveries of 65.9 p.p.m. and 27.4 p.p.m. respectively, whereas overnight drying of the gel at 105 to 110° C. improved the recoveries to 90.7 p.p.m. and 3.6 p.p.m. Drying of the gel is thus advisable if a single U-tube is to be used for collection.

The air samples were collected simultaneously at three positions in the workshop, indicated as A, B, and C in Fig. 1. Positions A and B were selected as corresponding as closely as practicable to the main working positions D and E. Position C was representative of the general conditions in the shop away from the immediate vicinity of the tank. Samples were taken for two periods, one of 50 minutes and one of 53 minutes; less work was handled during the second period owing to the approach of the lunch break. The results of the air analyses are shown in Table 1.

TABLE 1
CONCENTRATIONS OF TRICHLORO-ETHYLENE IN AIR OF WORKSHOP

Sample No.	Position	Concentration (p.p.m.)
1	A	637
2	B	423
3	C	73
4	A	494
5	B	372
6	C	62

Urine Sampling and Analysis

The absorption of trichloro-ethylene vapour is indicated by the presence in the urine of trichloro-acetic acid. Urine samples were obtained from each of the three operatives engaged on the degreasing process for a period of 24 hours from noon on the day on which the air samples were collected, and analysed by the method described by Powell (1945). The results are shown in Table 2. A spot urine sample obtained from a laboratory technician who had not been exposed to trichloro-ethylene vapour when analysed by the same procedure indicated an excretion of only 2.5 mg. per litre.

Maximum Allowable Concentrations

Air Concentrations.—Divergence of opinion exists regarding the maximum allowable concentration of trichloro-ethylene vapour. On the basis of exposure for 40 hours a week, I.C.I. Ltd. recommend 400 p.p.m. The American Conference of Governmental Industrial

FIG. 1.

TABLE 2
ANALYSIS OF URINE SAMPLES FOR TRICHLORO-ACETIC ACID

Sample	24-Hour Excretion	
	Total (mg.)	(mg./litre)
Res.	264	175
Bid.	255	204
Rig.	416	258

Hygienists recommends 200 p.p.m. for a similar length of exposure, although for some time previously it gave the figure of 100 p.p.m., while Elkins (1950) suggests 150 p.p.m. More recently Grandjean *et al.* (1955) postulated that the maximum allowable concentration should not exceed 40 p.p.m. for continuous exposure for eight hours a day, and they quote a Russian value of 9 p.p.m.

The operatives in this case were exposed for 45 to 50 hours a week; the concentrations measured near to the tank exceeded the highest maximum allowable concentration quoted above when corrected approximately for the increased exposure time. The senior operative (Bid.) spent a considerable portion of his time in very close proximity to the tank, and the other two operatives were engaged in the movement of material to and from the region of the tank.

Urinary Concentrations of Trichloro-acetic Acid.—Ahlmark and Forssman (1951) found symptoms of exposure to trichloro-ethylene in about half of persons who excreted 40 to 75 mg. of trichloro-acetic acid per litre of urine, and in almost all those who excreted 100 mg. per litre or more. With exposures which caused regular excretion of 200 mg. per litre or more, symptoms were often so pronounced as to cause absence through sickness.

FIG. 2.—Drawing of the lateral hood for open tanks.

On the basis of these findings Ahlmark and Forssman suggested that a concentration of 20 mg. per litre of urine should be the upper limit allowed. Frant and Westendorp (1950), however, found little correlation between urinary concentrations and complaints from workers.

Grandjean *et al.* (1955) considered that determinations

of trichloro-acetic acid in urine are an insufficient index, and that they should be accompanied by air analyses. They recommended a double standard, namely that the concentration of trichloro-ethylene in air should be kept below 40 p.p.m., and that the concentration of trichloro-acetic acid in urine should be less than 96 mg. per litre.

Clinical Examinations

The three employees seen in this investigation were aged 32, 30, and 37; one (Bid.) had been exposed to trichloro-ethylene for 10 years, and the other two for nine months. All three reported vague symptoms of fatigue, headaches, and dryness of the lips and mouth. Two were subject to periods of loss of appetite and of flatulence, and the operator with the longest exposure stated that he was subject to occasional feelings of vertigo. No organic defects were discovered on clinical examination. The haemoglobin values (determined by the cyan-haematin method) were somewhat low (Bid. 84%, Res. 89%, Rig. 89%); no abnormality was found in red or white cell count, differential white count, and packed cell volume.

Discussion

This study is presented to emphasize that unless adequate precautions are taken during industrial degreasing operations there may be considerable contamination of the air by trichloro-ethylene.

The primary cause of the high concentrations recorded appeared to be the use of a tank which was too small for the volume of work handled. This resulted in two major operating errors. First, not enough time was allowed for the draining of liquid trichloro-ethylene from the material before withdrawal from the tank, so that quantities of liquid solvent were withdrawn; but for the presence of the draining grid, even higher concentrations would have occurred. Secondly, the rapid removal of material induced a surge of vapour, which at times was almost overpowering to an observer standing near the tank. It will be noticed from Fig. 1 that the exhaust fans extract such vapour across the breathing zone of a worker at position E. The use of a mechanical hoist, limiting speed of withdrawal to 11 feet per minute or less, is strongly to be recommended (Horowitz, 1955).

When properly designed and efficiently operated, degreasers may often be used quite safely without exhaust ventilation. In circumstances where exhaust ventilation is necessary, the most efficient method of application is by means of lateral slots placed along the edges of the tank. Fig. 2 shows a typical design for such a slot exhaust system. To prevent excessive vapour loss through the exhaust system, there must be adequate free-board between the vapour line and the slots. Experience suggests that excessive loss of solvent when it occurs is due mainly to the carry-out of liquid on improperly racked work, and not to ventilation.

We are indebted to the management of the factory and the workers concerned for their ready cooperation, and to Professor G. P. Crowden and Dr. P. J. R. Challen for helpful criticism and advice.

Fig. 2 is reproduced by permission of the Division of Industrial Hygiene, New York Department of Labor.

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The British Occupational Hygiene Society

The first provincial meeting of the Society was held at University Hall, Liverpool, in April, 1956. During the afternoon of April 19 three papers were read by members of the staff of the General Chemicals Division, Imperial Chemical Industries Ltd.; they dealt respectively with chlorine, dust sampling and analysis, and fluorine. A film illustrating the work of the General Chemicals Division was also shown. The new President of the Society, Dr. C. G. Warner, presided over the meeting and delivered an address after dinner that evening.

On the next day members were entertained by the General Chemicals Division of Imperial Chemical Industries and conducted round the Castner-Kellner and Rocksavage works.

Presidential Address: The Pneumoconiosis Problem in Coal-mines

C. G. WARNER

Divisional Dust Suppression Scientist, National Coal Board, South Western Division

The Society is now starting its fourth year of existence, but during our brief life we have indeed achieved considerable measures of success in many directions. The reports of the conferences of the Society make interesting reading. At the inaugural meeting of the Society the then Minister of Labour and National Service, Sir Walter Monckton, in his opening address remarked:

"The prominence now being given in Government and other quarters to the development of provision for occupational health in its widest sense shows that occupational hygiene is a subject which will receive increasing attention.

"It is particularly opportune that the foundation of this Society should come at a time when efforts are being made to establish and develop this important service to industry. The application of knowledge of practice of many kinds is necessary to achieve these objects. The medical profession, physiologist and the psychologist must work hand in hand with the engineer, the chemist and the physicist and a vital factor must be the closest collaboration between industrial research and industrial health research."

Sir Walter continued:

"During the last decade there has been a marked increase in the interest shown in health matters by industry. But it cannot be said that the facilities for studying occupational risks to health have kept pace with the growing awareness of the importance of this subject. This Society is following this principle and I am glad to say that its membership is not limited to scientists, but includes others with interests and responsibilities in the wide field of occupational health."

Dr. Bedford, the first President of the Society, to whom is due much of the credit for its inception and constitution, reinforced Sir Walter Monckton's comments by referring to the importance of team work. Dr. Bedford, in fact, put it in these words: