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CINCINNATI, OHIO 45226

HAZARD EVALUATION AND TECHNICAL ASSISTANCE
REPORT NO. TA 79-16

JOHNSON MEMORIAL HOSPITAL
STAFFORD SPRINGS, CONNECTICUT
JULY 1979

Study Requested By:
Hospital Administrator
Johnson Memorial Hospital
Stafford Springs, Connecticut

Report Prepared By:
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Study Dates:
February 15-16, 1979
March 29-30, 1979

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16. Abstracts ABSTRACT: Levels of airborne substances in concentrations sufficient to cause symptoms of discomfort were investigated in the Administration and Central Sterile System areas on February 15, 16, and March 29, 1979, at Johnson Memorial Hospital, Stafford Springs, Connecticut. The evaluation was requested by the hospital administrator. Analysis of ambient air samples did not reveal the presence of fibrous glass. Analysis of bulk samples subjected to thermal decomposition analysis at 302 degrees Fahrenheit showed small amounts of methylene chloride (75092), carbon disulfide (75150), furan (110009), furfural (98011), and methyl furfural (620020), and lesser amounts of acetone (67641), methyl ethyl ketone (78933), pentanone (27154672) and furfuryl methyl ketone (6975606). At 100 degrees Fahrenheit, no volatile compounds were identified. It is concluded that concentrations of chemicals and airborne fibers were well within OSHA limits, and that reported symptoms of irritation were due to high temperatures, cigarette smoke, and poor air flow. Recommendations resulting from the evaluation include increasing air handling capability, improving ventilation systems, reducing the amount of solar radiation in administrative areas, increasing humidity, scrutinizing work safety practices to prevent ethylene oxide (75218) exposure during sterilizer operations, modifying the handling and storage of formaldehyde (50000), and prohibiting smoking.			
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I. SUMMARY

The presence of airborne chemicals in sufficient quantities likely to cause the symptoms (itchy skin, burning eyes, dry mouth, rashes, headaches, scratchy throat, bad taste in mouth, etc.) reported by employees of the Administration and Central Sterile System (CSS) Areas could not be documented during the days the NIOSH study was conducted. It is believed that no such hazard exists in these areas sufficient to endanger the health of the subject employees and that returning these employees to their normal work areas is appropriate.

Although one ambient air sample for formaldehyde taken in the CSS showed a concentration below recommended exposure criteria but in the range of concentrations documented in the literature to cause irritation symptoms in some individuals, there is no clearly identifiable source for formaldehyde in CSS other than that brought in by soiled equipment from the morgue/autopsy area. With careful handling of such equipment, no health problems due to formaldehyde in CSS are expected. However, it is believed that the predominate symptoms reported by most of the employees were due to uncomfortable combinations of temperature, humidity, and air exchange. Other symptoms which were reported are considered to be unrelated to this particular problem and probably represent, in general, background levels in a normal population.

Recommendations are presented to help alleviate these sensations of discomfort.

II. EVALUATION

A. BACKGROUND INFORMATION

In October, 1975, the administrative and health care functions of Johnson Memorial Hospital moved into a new facility. Four months after the move, some employees in the administrative section and the central sterile supply area of the hospital began complaining of a myriad of symptoms which they felt were work associated. Symptoms included difficulty breathing, skin and eye irritation and difficulty swallowing. Various investigators - State and Federal Occupational Safety and Health Administrations, State Health Department and three private consulting firms - had visited the facility in an effort to resolve the problem. Although they were unsuccessful in determining the cause of the reported symptomatology, they were able to eliminate certain potential agents. The hospital administrator, in an effort to isolate the administrative area from its occupants, moved the administrative functions out of the building into temporary trailers and sealed off the area from the rest of the hospital. Due to the hospital depending on the services of central sterile supply, this area was not similarly isolated.

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II. EVALUATION

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Suggestions as to the cause of the problem had been advanced by various previous investigators; among them being insulation containing fibrous glass in the ventilation system, fungal growth in the ventilation system, poor ventilation and excessive heat from solar radiation causing employee discomfort, and concomitant heightened awareness of sensations not normally noticed.

The administration was not satisfied with the conclusions and recommendations presented by these investigators and felt an additional appraisal was in order. Accordingly, a request for technical assistance from NIOSH was received by the Hazard Evaluations and Technical Assistance Branch on January 25, 1979.

On February 15-16, 1979 and March 29-30, 1979, a NIOSH industrial hygienist visited Johnson Memorial Hospital to study the problem.

B. STUDY DESIGN

After a walk-through orientation of the facilities and conversations with the hospital administrator and facilities engineer, it was decided that there were two similar, yet perhaps separate, problems in the hospital as determined by location.

1. Administration Area

The Administration Area had no other source of airborne physical or chemical agents except what might somehow make its way into the ventilation system and be distributed throughout the subject area. The primary etiologic agent disseminated by this means was believed to be fibrous glass. The source of fibrous glass was hypothesized to be the fireproofing coating material which was being abraded by air movement in the false ceiling being used as a return air plenum. Another possible source of contamination was considered to be the uptake of soil microorganisms by the intake plenum reportedly located too near the ground. However, this latter hypothesis was discounted because of the actual location of the plenum (at least 6 feet from the ground), the condition of the soil immediately below the plenum (grassy, sloping area, little likelihood of growth conditions optimal for microorganisms) and the reported symptomatology (symptom patterns not generally suggestive of infectious diseases).

2. Central Sterile System (CSS)

It had been previously determined that the fireproofing material in the false ceiling in the Administration Area contained fibrous glass, and one investigator was able to document the presence of airborne fibrous glass at one time during the initial stages of the investigation. The volume of air flow within the plenum observed by the NIOSH industrial

hygienist was judged insufficient to cause abrading of the material; however, general area sampling for fibrous glass was performed to determine if fibrous glass was present. Also, general area sampling for any unknown organic chemicals was performed. This sampling was done in part to determine if any chemicals from the autopsy area located directly below the Administration Area were present in the Administration Area. This presence would be indicative of a cross-connection in the ventilation system or a passage through the floor.

A bulk sample of the fireproofing material was obtained for qualitative analysis. This material was also subjected to thermal decomposition analysis since it was reported that high ambient temperatures could be reached in the plenum under certain conditions and that gaseous contaminants could diffuse from the material. This sampling and analytical methodology was also extended to the CSS and the 3rd floor ward area where no similar health problems in employees had been reported.

The Central Sterile System uses ethylene oxide as a sterilant when steam cannot be used. The literature¹ contains documentation of health effects of chronic and/or acute exposures to ethylene oxide similar to those reported by the employees. Ethylene oxide, therefore, was considered to be a possible cause of the symptomology in CSS employees.

The CSS employees were monitored for ethylene oxide during their work procedure. Due to the intermittent but lengthy work procedure, the normal work procedure was shortened; however, the relevant steps in ETO sterilization (loading, charging and unloading of the sterilizer) were retained for sampling. An area sample for aldehydes was also taken in CSS.

The CSS employees expressed concern over the amount of fine material that settled out in the linen supply area. Accordingly, a bulk sample of this material was obtained for fibrous glass and asbestos analysis.

The only characteristic common to both areas was the quality of the ventilation system and the operational temperature and humidity. The air handling unit serving the Administration Area was 25% fresh/75% recirculated air and that serving the Central Sterile System was 50% fresh/50% recirculated. Relative humidity was reportedly kept at 45% and temperature at 77°F. The sterilizers in the CSS are ventilated to the roof.

In order to more closely define the frequency and range of reported symptoms and obtain further information concerning the onset of employees' symptoms, a questionnaire was developed and distributed to as many present and past employees of the Administration and CSS Areas as could be contacted.

In addition, the NIOSH industrial hygienist inspected the roof exhaust stacks, intake plenums and the layout of the hospital in general. Although the air intake plenum was observed to be of adequate distance away from the ground to prevent the entrainment of soil microorganisms, due to the location of the vehicle loading dock adjacent to the plenum (a tractor-trailer exhaust could conceivably be 20 feet away) there is the potential for exhaust odors to be drawn into the ventilation system. The chance for carbon monoxide (CO) contamination in excess of recommended criteria (NIOSH - 35 parts per million²) is judged to be minimal. However, in order to determine if CO levels could be detected in the Administration Area, the facilities engineer for Johnson Memorial Hospital was loaned a sampling pump and length-of-stain CO detector tubes, and instructed on its use. It was suggested to him that he sample under the following set of conditions:

- 1) When no vehicles are present at the loading dock;
- 2) When vehicles are present at the loading dock, and the wind direction is from the dock to the plenum; and
- 3) When the Administration Area is full of smokers.

C. ENVIRONMENTAL FINDINGS

Bulk samples of the fireproofing material were analyzed for fibrous glass. The sample from the Administration Area contained less than 1% fibrous glass while the sample from the CSS and the third floor control area did not contain fibrous glass.

Ambient air samples did not contain fibrous glass.

The three bulk samples were subjected to thermal decomposition analysis at 302° and 100° Fahrenheit. At the higher temperature the following compounds were detected in all three samples: small amounts of methylene chloride, water, carbon disulfide, furan, methyl furan, furfural and methyl furfural. There were also ketones in lesser amounts: acetone, methyl ethyl ketone, pentanone, and furfuryl methyl ketone. At 100°F, no volatile compounds were detected.

Long term (greater than 8-hour) samples for volatile organic compounds in the Administration Area were negative, i.e. no compounds were detected.

The results of personal monitoring for ethylene oxide in the CSS is reported in Table I. NIOSH³ recommends that no employee be exposed to a concentration greater than 135 milligrams ethylene oxide per cubic meter of air (mg/m³) determined during a 15-minute sampling period, as

a ceiling occupational exposure limit, and in addition, with the provision that the time-weighted average (TWA) concentration of 90 mg/m³ for a workday not be exceeded. All values were below these recommended criteria.

The results of area samples for aldehydes taken in the Administration and CSS Areas are presented in Table II. Two compounds were identified-- formaldehyde and furfural. Recommended personal exposure levels are 1.2 mg/m³ (NIOSH, 15 minute ceiling exposure limit) and 20 mg/m³ (ACGIH, TWA Limit)⁴, respectively. Inspection of Table II indicates all values were below these criteria.

The analysis of the bulk samples of settled material in the linen supply area of CSS was negative for fibrous glass and asbestos. The material was determined to be primarily processed or refined cotton fibers (lint).

Of a total of 40 questionnaires distributed, 27 were returned, representing a 68% response rate. Table III reports the frequency of each symptom and the percentage of respondents who reported the symptom. Table IV reports the chronology of symptom onset. This information was taken from the returned questionnaires. Other pertinent information gathered from the questionnaires included the majority (23/27) of employees indicated symptoms gradually disappeared after taking corrective measures such as showering or leaving the building.

D. CONCLUSIONS

During the NIOSH study dates, the presence of airborne substances under consideration--fibrous glass, organic chemicals, volatile chemicals from fireproofing material, ethylene oxide, and CO in concentrations sufficient to cause the reported health problems, could not be documented. One exception is formaldehyde, which will be discussed later. Thermal decomposition of the fireproofing material at a temperature (100°F - which could reasonably be expected to be reached in the Administration Area under the worst conditions) failed to reveal any volatile components.

In the opinion of the NIOSH investigator, and supported by the hospital administrator and facilities engineer, the environmental conditions under which the sampling was performed represented normal working conditions and therefore the results should be indicative of concentrations of toxic substances present when the symptoms were first reported. This is generally in agreement with the findings of previous investigators. One exception is the fibrous glass result. Although one initial investigator was able to document the presence of airborne fibrous glass and NIOSH was not, it is believed that airborne fibrous glass may have been present for a period of time after the new facility opened and may have accounted for some of the irritative symptoms experienced by the employees. However, the ventilation system's filters presumably removed any residual

fibrous glass left from installation of the fireproofing material, and airborne fibrous glass thus would be no longer a health problem.

It was postulated at one time that chemicals from the autopsy area beneath the Administration Area were the cause of the reported symptoms. The most likely chemical is formaldehyde. Environmental sampling in the Administration Area indicated a concentration of 0.26 mg/m^3 (one sample). Formaldehyde was also detected in CSS at 0.61 mg/m^3 . Although these values are less than the NIOSH exposure criteria of 1.2 mg/m^3 for a 15-minute exposure period⁵, the literature contains documentation of health effects caused by formaldehyde at concentrations in the range measured. These values are not believed to be indicative of a chronically significant problem with formaldehyde in these areas because 1) there is no clear source of formaldehyde in either area, 2) area samples were taken and cannot reliably be compared to personal exposures, 3) past investigators were not able to detect the presence of formaldehyde and 4) only one sample in each area was taken (sampling or analytical error could account for the values). Rather, the Administration Area value probably represents normal background level in the hospital and may be indicative of poor handling or storage of formaldehyde in areas where it is normally used. The CSS value may be due to residual formaldehyde on incoming soiled equipment.

The hospital facilities engineer, on two separate occasions, measured the CO concentration in the Administration Area. Results indicated trace (less than 5 parts CO per million parts air) amounts of CO. From this it is concluded that reentrainment of CO from outside sources is not excessive.

It was reported that the Administration Area was a very uncomfortable place to work on certain days, in terms of climate. There are a number of factors which would contribute to employee discomfort.

- 1) A minimum design indoor temperature of 75°F ;
- 2) A southern exposure and large windows allowing significant solar radiation;
- 3) A ventilation system possessing 90% efficient filters rather than 25% efficient filters, the net effect of which is reduced air flow;
- 4) A supply register and a passive exhaust register both located in the ceiling which can cause channeling of ventilation air at the ceiling level and stale air conditions at working level;
- 5) A majority of the Administration workforce who smoke cigarettes (questionnaire data).

The chronology of symptom onset (Table IV) indicates that most symptoms were experienced by Administration employees during the heating session, at least during 1977. An already high ambient temperature, little air movement, and the accumulation of cigarette smoke, are suspected to have caused most of the symptoms reported by the Administration employees. The presence of fibrous glass at one time may have been a contributing factor in employee irritation.

The predominance of irritative symptoms in Table I tend to bear out the conclusion that high temperature and other factors such as cigarette smoking and deficient air movement, were likely to have been responsible for some of the employees' complaints.

With the exception of less solar load and a lesser percentage of smokers versus non-smokers, the factors listed previously are present in the CSS and may have contributed to the problems there also.

III. RECOMMENDATIONS

In order to improve working conditions in the Administration and CSS Areas, the following recommendations are offered:

- 1) Increase the air handling capabilities of the ventilation systems.
- 2) Raise roof exhaust stacks to prevent recapture of exhausted contaminants by adjacent intake plenums. The ventilation engineering group consulted for other modifications will be able to advise you on the correct height. References 8, 9, and 10 can provide further detail on determination of proper height.
- 3) Install the proper filters so that the ventilation system meets its design criteria.
- 4) Reduce the amount of incident solar radiation to the Administration Area.
- 5) Increase the relative humidity, if necessary, to eliminate drying of skin and mucous membranes.
- 6) Ascertain that sterilizer operations have no leaks and that the vacuum exhaust does not connect to any recirculating air system. Work practices should be scrutinized closely to prevent lapses in safety that could result in ethylene oxide exposure.

- 7) Improve housekeeping in the linen supply area to reduce the accumulation of lint.
- 8) Stop smoking, or segregate smokers from nonsmokers.
- 9) Since the presence of formaldehyde has been documented, it is recommended that the handling and storage of this chemical be reviewed and modified, if necessary, to reduce unnecessary airborne concentrations.

IV. REFERENCES

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Table I

PERSONAL SAMPLING DATA FOR ETHYLENE OXIDE
JOHNSON MEMORIAL HOSPITAL
STAFFORD SPRINGS, CONNECTICUT
TA 79-16

<u>Type of Sample¹/Location or Duty</u>	<u>Sample Duration (Min.)</u>	<u>Concentration (mg/M³)</u>
Personal/Supervisor, After Charging	60	16
Personal/CSS Tech, After Charging	65	16
Personal/CSS Aide, After Charging	85	8
Personal/Supervisor, Opening Sterilizer	24	32
Personal/CSS Tech, Opening Sterilizer	24	8
Area/In Sterilizer Tank Room	27	4
Area/Opposite Sterilizer On Wall	90	10
Limit of Detection of Analytical Method		0.08 mg
NIOSH Recommended Exposure Criteria		135 (C-15 min.) 90 (TWA)

¹Samples taken with personal sampling pumps, 200 cc per minute flow rate; sampling media-activated charcoal.

²Maximum concentrations are listed. Due to analytical method and sensitivity (detection limit), actual value falls somewhere between zero and the value indicated.

Table II

AREA SAMPLES FOR ALDEHYDES
JOHNSON MEMORIAL HOSPITAL
STAFFORD SPRINGS, CONNECTICUT
TA 79-16

<u>Area</u>	<u>Sample Volume (m³)*</u>	<u>Formaldehyde (mg/m³)</u>	<u>Furfural (mg/m³)</u>
Administration	.11	.26	< .98
CSS	.02	.61	<5.33
NIOSH Personal Exposure Criteria		1.2	--
ACGIH Personal Exposure Criteria		3	20

*Samples Taken By Impinger Using 0.1 Normal Sodium Bisulfite;
Flow Rate: 1.5 liters per minute.

Table III
Frequency and Percent of Sample (N=26) Reporting Each Symptom
Johnson Memorial Hospital
Stafford Springs, CT
TA 79-16

<u>Symptom</u>	<u># Reporting Symptom</u>	<u>% of Sample</u>
itchy skin	21	78
burning eyes	19	70
dry mouth	16	59
rashes	14	52
headaches	12	44
scratchy throat	12	44
bad taste in mouth	11	41
sleepiness	10	37
watery eyes	9	33
chest pains	8	30
nose bleeds	7	26
dizziness	7	26
blurred vision	6	22
difficulty swallowing	6	22
hives	6	22
earaches	5	19
boils	4	15
sneezing	3	11
nausea	3	11
tingling feeling	3	11
ringing in ears	2	7
difficulty breathing	2	7
18 other symptoms reported once each		4

Table IV
 Chronology of Symptom Onset
 Johnson Memorial Hospital
 Stafford Springs, CT
 TA 79-16

Number Employees Reporting Onset of Symptoms
 6
 5
 4
 3
 2
 1

Moved to New Facility

• Administration Employees
 x Central Sterile Supply Employees

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