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Statement of

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16. Abstract (Limit: 200 words)

Testimony was presented concerning the establishment of an occupational exposure standard for acrylonitrile (107131) (AN) to which an estimated 125,000 workers were potentially exposed. Two year feeding and inhalation studies with animals indicated the chemical to be carcinogenic, producing tumors of the central nervous system (CNS), cerebral tumors, squamous cell neoplasms of the Zymbal gland, adenocarcinoma of the small intestine and large intestine, along with numerous benign tumors. Other findings included papillomata in the stomach, hemangioma of the kidney, fibroadenomas of the mammary gland, benign tumors of the uterus, and tumors of the ear canal. These animal studies have reinforced the findings of the Du Pont mortality study of workers exposed to AN which, though incomplete, strongly suggested that AN has carcinogenic properties for humans. Teratogenicity studies indicated increased incidence of fetal malformation. Concentrations of 0.05 milligrams/liter (the Soviet standard for exposure to AN) have demonstrated an inhibitory effect on CNS function, specifically in relation to the learning process. Cases of AN as an allergen causing contact dermatitis and ulcers have been widely documented. It was recommended that drugs essential to the treatment of acute intoxication from AN be kept in the medical facility of all facilities using AN, and that employers institute a respiratory protection program in accordance with requirements.

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INTRODUCTION

I am appearing here today to discuss the proposed standard on Occupational Exposure to Acrylonitrile. Appearing with me are the following:

Jane Brown, B.S., M.S. Industrial Hygienist

James Gideon, B.S., Research Chemical Engineer, Control Technical Branch

Nelson Leidel, B.S., M.S., Chief, Technical Evaluation and Review Branch

Harold Plotnick, M.S., Ph.D., J.D., Chief, Mech. of Industrial Disease Section, Experimental Toxicology Branch

Jud Posner, B.S., M.S., Chemist, Measurements Research Branch

Cynthia Robinson, B.A., M.S., Biostatistician, Industry-Wide Studies Branch, Biometry Section

Richard Ronk, B.S., Supervisory Safety Engineer, Testing & Certification Branch, Respirator Section

Our resumes are provided in the appendix of this statement.

DISCUSSION

Acrylonitrile (vinyl cyanide) is an explosive flammable liquid with a chemical structure CH_2 = CHCN which resembles vinyl chloride, a known carcinogen. Approximately 1.5 billion tons of acrylonitrile (AN) are manufactured each year in the United States mainly for the

production of acrylic and modacrylic fibers. NIOSH estimates 125,000 people are potentially exposed to AN in the workplace.

OSHA's proposal to limit the exposure to the minimal feasible limit is appropriate and timely.

AN has been shown to be a chemical carcinogen on the basis of animal experiments. The interim results which we have reviewed are significant. The experiments involved a two-year feeding and inhalation study of AN by laboratory rats. In the ingestion study, AN was incorporated into the drinking water at concentrations of 0, 35, 100, or 300 ppm (corresponding to doses of approximately 0, 4, 10, or 30 mg/kg body weight/day). At twelve months, an interim sacrifice (10 males and 10 females) was carried out. At that time 9 of the experimental animals had developed central nervous system tumors (6 of 20 animals at 100 ppm and 3 of 20 animals at 300 ppm). In a second report, 4 months later, the company identified 2 further cerebral tumors in rats ingesting the lower dose of 35 ppm AN. These tumors were histologically diagnosed as infiltrating gliomas. In addition to this, 4 malignant squamous cell neoplasms of the Zymbal (cerumus) gland were found (2 of 20 animals at 100 ppm and 2 of 20 animals st 300 ppm). One adenocarcinoma occurred in the small intestine (100 ppm) and 1 in the large intestine (300 ppm). Furthermore, numerous benign tumors were noted in the exposed group of animals. Thirteen papillomata were present in the non-secretory part of the stomach only among the AN-treated animals. One animal on AN had a hemangioma of the kidney. Among the female animals, 2 controls and 4 AN animals developed fibroadenomas of the mammary gland. Seven

benign tumors of the uterus occurred in AN animals, 2 in controls. (The tables are attached to this testimony.)

In the inhalation study, male and female rats were exposed to 0, 20, or 80 ppm AN for 6 hours a day, 5 days per week. At the 1-year interval, 13 animals of each sex of each dose level were sacrificed and 3 of those exposed to 80 ppm AN were found to have developed CNS tumors histologically comparable to those reported in the ingestion study.

The Dow Chemical investigators also stated that gross examination of other animals exposed to 80 ppm AN revealed an "increased incidence" of ear canal tumors and the tumors of the mammary region. In animals exposed to 20 ppm, an "apparent increase in the subcutaneous masses of the mammary region" was noted as well. A subsequent report sent to us by the Manufacturing Chemists Association on February 22nd this year (copy of letter attached) stated that at the conclusion of the experiment in animals exposed to 80 ppm, an "increased incidence" of brain tumors diagnosed microscopically; an increase in ear canal gland tumors; an "increase in incidence" of mammary gland tumors among females and gastrointestinal tract tumors among males were found. Specific details were not given, however. Among the 20 ppm male and female animal groups, an "increase in the incidence" of brain tumors was diagnosed histologically. The female rats exhibited an increase in mammary gland tumors.

The purpose in presenting the details of Dow Chemical's reports is

to underline the broad range of tumors that occurred in the experimental group as opposed to the control animals. Spontaneous central nervous system tumors are very rare among laboratory rodents. For example, Gilbert and Gillman examined 1,345 rats over their entire life span and found only 2 intracranial tumors (1). Guerin found only 4 central nervous system tumors in a population of 16,500 rat autopsies (2). Thompson and Hunt found 4 intracranial tumors among a population of 177 rats (3). A review of these findings have been reported by Jänisch and Schreiber (4). Although we do not have the final reports from Dow Chemical yet, the interim study on the AN-fed animals alone, shows that 11 histopathologically diagnosed gliomata occurred among 60 animals - an incidence of 15.02% compared to an average of 0.77% of spontaneous tumors in the studies mentioned above. Therefore, there can be no doubt that AN has a carcinogenic effect with a special affinity for the central nervous system. Nor can the presence of an excessive number of benign tumors among the AN-exposed animals be dismissed. For example, benign mammary gland tumors in rodents frequently give rise to malignant tumors at the same site (5).

There are three further brief points. Firstly, many of the benign tumors and all but 2 of the malignant types, occurred at sites distal to the point of absorption. Secondly, the propensity for AN to attack the central nervous system is in keeping with its long observed neurotoxic effects both in experimental animals and clinically reported cases among humans. Thirdly, several other nitrogenous compounds have also demonstrated

this particular biological effect including 1,2-diethylhydrazine, azo-ethane, N-methyl-N-nitrosourea and N-ethyl-N-nitrosourea (6). These nitrogenous compounds not only have the ability to induce brain cancer in the animals into which they were injected, but they also induce brain cancer in the offspring when the pregnant female is exposed by various routes including inhalation. Acrylonitrile has not been tested for its transplacental carcinogenic effects, but in view of the evidence existing for related compounds, this is a study which obviously needs to be carried out.

The results from the experimental animal studies have been reinforced by the Du Pont mortality study of workers exposed to AN (the details are attached). Even though incomplete, the results strongly suggest that AN is carcinogenic in man.

One major problem with interpreting the increased incidence of cancer among the Du Pont employees is that although 16 cases of cancer occurred (compared to 5.8 expected cases based on Du Pont Company rates or 6.9 based on National rates were expected), Du Pont does not have follow-up data on approximately 1/3 of the cohort (484 of 1,343 workers). They are currently in the process of tracing these cases in order to complete the study.

We have also noted that work histories are incomplete and that, as is commonly the case, workers may have been exposed to a number of chemicals possibly acting on the biological system synergistically. We would like to point out, that if it is determined that the predominant

exposure was to AN, then that chemical should be considered the primary carcinogenic agent. In a similar situation, Mabuchi, Lilienfeld and Snell (7) recently found that arsenic was the predominant carcinogenic agent among a number of substances to which workers were exposed.

The findings of carcinogenicity have been complimented by the mutagenicity studies reviewed by OSHA in the preamble as the Emergency Temporary Standard statement. I wish to stress the significance of the positive results obtained by investigators such as Milvey and Wolff (8) using an exposure chamber. As OSHA stated, the wide variety of results for mutagenicity are probably related to differences in techniques as well as the high volatility and toxicity of AN. Because of its high vapor pressure and, therefore, volatility, AN tends to evaporate from the petri dish, probably resulting in unstable conditions and fluctuating concentrations when tests are conducted outside an exposure chamber. It appears, therefore, that the use of AN vapor in an exposure chamber is the method of choice.

The teratogenicity of AN was tested by Murray et al. (9) and resulted in an increased incidence of fetal malformation. The acrylonitrile was administered in doses of 65 mg/kg per day and this produced significant maternal toxicity. At lower levels of 25 mg/kg/day, the maternal toxicity was reduced and the incidence of malformation was lower. Chemicals tested in this fashion exert their toxicity either on the mother or directly on the developing embryo. In this case, the authors believe that because the malformations were not seen at "an increased incidence among fetuses

of pregnant rats stressed to a similar degree" that there was no correlation between the toxicity and the occurrence of malformation. In this particular experiment, the lowest dose of 10 mg/kg/day did not result in fetal malformation, but attention is drawn to the possibility that intrauterine insults to the developing embryo may only manifest clinically in the offspring long after birth. Synthetic estrogens given to human pregnant females is a case in point. Mandybur et al. (10) demonstrated that ethylnitrosourea (ENU) injected in a sufficiently high dose in pregnant animals produced mammary tumors in the offspring of his experimental animals. In their paper recently submitted for publication, they point out that more mammary tumors developed in animals treated with low doses than those treated with high doses. Swenberg et al. (11) have shown that small doses of ENU tends to produce non-neural tumors while higher doses are neuro-oncogenic. These experiments highlight the fact that chemicals related to AN can cross the placental barrier and produce tumors in the offspring of the treated animals.

It is not my intention to deal with the effects of acute intoxication by AN in any detail. There is considerable literature on this subject which covers the human experience and that of experimental animals. The effects range from transient symptoms to death. However, as mentioned above, one theme recurs throughout the literature and that is the neurological sequelae of acute intoxication. More specifically, these range from transient tremors to convulsions and have been recorded throughout the literature on AN, both in this country and in foreign

journals. Brewer (12) noted the reactions in test animals prior to death - ataxia, ptosis, clonic convulsions among others. Krysiak and Knobloch (13) carried out an elegant experiment on the effects of AN on the central nervous system. They presented their animal group with AN by the intraperitoneal subcutaneous route and by inhalation, noting the acute effects on animal learning ability. They found that AN has a definite inhibiting effect on CNS function, specifically in relation to the learning process. This effect was observed at concentrations of 0.05 mg/L (The Soviet standard for acrylonitrile is 0.05 mg/m^3 of air.) (14)

AN is an allergen producing contact dermatitis (15, 16). It is also ulcergenic (17). In other words, its acute toxic effects are widespread and well publicized in the scientific literature. Although the early workers regarded the symptoms of AN toxicity as mainly due to hydrocyanic acid, some difference of opinion exists. It is appropriate to note that in 1966, Paulet et al. (18) observed that the symptoms of AN poisoning differed from those of hydrocyanic acid poisoning. The latter is dominated by anoxic disorders, he stated, while the AN intoxication is characterized by nervous disorders in the form of tremors, tetanic attacks, epileptoid attacks and paralysis. Several cases of fatal AN poisoning have been observed. Luijt (19) noted that the liquid can penetrate the skin along with the possibility of oral ingestion. Even in the vapor form, AN can be absorbed through the skin as well as by inhalation, again in contrast to hydrogencyanide. NIOSH draws

attention to this article not only because it deals with a case of fatal poisoning but because the author goes into considerable detail concerning the treatment of an acute case of poisoning, and points out that if the man who died had been correctly treated, he probably could have been saved.

Therefore, NIOSH strongly recommends that the drugs essential to the treatment of acute intoxication be kept in the medical facility of all plants concerned with the manufacture of AN. In addition to this, a schedule of the best known method of treatment for acute intoxication should be kept with the drug because the acute treatment is often a complicated procedure and delay may have fatal consequences. We also draw attention to a paper by Sustov et al. (20) conducted concerning the examination of 390 workers at a synthetic fiber plant. This group of Russian investigators observed subtle changes in the central nervous system, gastrointestinal tract, cardiovascular and hematopoietic systems. The authors draw attention to long-term exposures to varying concentrations of AN and related chemicals. Manifestations such as nystagmus, a decrease in corneal and pharyngeal reflexes and other clinical signs relating to central nervous system function, may be subtle and undetected consequences of long-term exposure. This paper underscores some of the long-term exposure effects of AN and related chemicals that may scope detection because the subjective symptoms and objective signs are modest. The need for physician awareness in this respect is covered under Medical Surveillance.

In summary, experimental evidence shows that AN is a potent toxin with long-term effects. In addition, experiments have shown it to be carcinogenic, mutagenic, and teratogenic, and any exposure in excess of the proposed standards represents a hazard to the worker.

METHODS OF COMPLIANCE IN REGULATED AREAS

This proposal requires that the employer institute a respiratory protection program in accordance with 29 CFR 1910.134(e). However, 29 CFR 1910.134(e)(5) allows the use of qualitative fit tests to meet the requirements for having the respirator "fitted properly."

NIOSH recommends the use of quantitative fit tests in all respirator programs, especially those used for protection against occupational carcinogens such as acrylonitrile. Test equipment for this type of quantitative testing is commercially available, and NIOSH will work with OSHA to develop uniform guidelines for this type of testing. Respiratory protection plays a role both during the retrofit of controls and after controls are installed. Respirators are <u>not</u> a substitute for engineering control because their use has no effect on the concentration of contaminants in the workplace. After engineering controls are installed, respiratory protection becomes a major backup measure in case of equipment malfunction, abnormal operation, or emergency. During maintenance, respiratory protection is a main source of control of exposre to AN, and should be a mandatory requirement.

PERMISSIBLE EXPOSURE LIMITS

NIOSH method number S156 with slight modifications was recommended in 1977 for sampling and analysis of acrylonitrile in air for the purpose of establishing the standard for occupational exposure to acrylonitrile. Based on the best available data at that time, the Institute determined that 4ppm of acrylonitrile was the lowest concentration measurable with any acceptable degree of accuracy and precision. Currently NIOSH is in the process of further modifying this method, originally developed by White (19), to achieve an accuracy of 2ppm or less. NIOSH has for some time recognized the difficulty of sampling and the fact that other methods of collection such as the porous polymer tube and aluminized gas bags are available and in use by some industrial plants. NIOSH believes that it is possible to establish reliable methods of collection and analysis at a level of 2ppm and hopes to shortly describe a method compatible with the standards that OSHA will set.

In May 1977, NIOSH requested certain information from users and producers and acrylonitrile. A part of this request concerned worker exposure levels. Several companies responded with summaries of their industrial hygiene sampling data (Table I). In addition, NIOSH

personnel visited five plants and obtained the sampling data that was available. This has also been included in the Table. Observations by NIOSH personnel during these visits indicates that polymerization areas generally have the highest potential for acrylonitrile exposure. Other areas are lower due to the low levels of residual monomer following polymerization. Operations in the polymerization area with high exposure potentials include any procedure where the equipment is open to the working atmosphere, such as process sampling, reactor and filter cleaning and maintenance work. Monomer transfer operations, such as occur in tank farm operations, are another area of concern.

TABLE I

Company	Product	Sampling Results	No. of People
Goodyear	Nitrile Rubber ABS Resins Urethane Foam	<1 — 150 ppm Typically <10 ppm	2430
Uniroyal		No levels	
Borg Warner	ABS Resins	Est. <20 back to 1957	65-570
Tennessee Eastman	Acrylic Fibers	Avg. 14 ppm in 1968 after enclosure TWA - 1 ppm in 1974 Since 1976-continuous GC monitoring TWA 1 ppm or less	-48
Gulf	Research	No levels	4
Firestone	Nitrile Rubber	No records before 1974 but levels were 1-4 ppm by detector tube Since 1975 see attached	18-260
Dow		See copy attached	
B. F. Goodrich	Nitrile Rubber Akron	1949-75 — 0 - 10.7 ppm 1975 TWA - 8.2 ppm 1977 TWA - 9.8 ppm	12
*	Nitrile Rubber Louisville ABS	1976 TWA - 1.4 ppm poly area TWA - 2.5 ppm drying area 1976 TWA - 2.2 ppm poly area TWA - 0.6 ppm ABS compounding	277
	Nitrile Rubber	1977 TWA - <1 ppm except 5 poly cleaners 4 of them 3-6 ppm and 1 of them 15 ppm (used AL resp)	32
*Monsanto		See Table	
Union Carbide	Urethane foam	1 ppm Avg. 0-20 ppm Range - 1 plant	37
	Intermediate	<1 Avg. 0-25 Range	
	Amine Prod.	<1 Avg. 0-30 Range	
	SAN	2 Avg. 0-25 Range	50-100
	Silicone Inter.	5 Avg. 0-20 Range	70
	Paint Latex Prod.	<1 Avg. 0-20 Range	150

TABLE I (continued)

Company	Product	Sampling Results	No. of People
Reichold	Nitrile Rubber	See Table	
Dow Badishe	Acrylic Fiber	1960 0.2 ppm, 1.1 & 16 source samples 1963 - 56 samples spinning area 18-90 ppm 1972 - TWA - 3 ppm B plant TWA - 9 ppm - thread-up Overall TWA 5 ppm - wet end opr. Overall TWA - 20 ppm Z plant 11-32 ppm range	41-89
Copolymer	Nitrile Rubber	0.91 ppm SD - 1.32 ppm Range <0.2 ppm - 5.6	650
W. R. Grace		No levels	20-25
American Cyanamid	Total	<0.05 — 7.8 ppm TWA	209
	*Acrylic Fiber Santa Rosa, Fla.	Chemical Area 1977 - 150 samples Avg. TWA - 6.5 ppm Chemical Lab 128 samples Avg. TWA - 0.5 ppm	
DuPont	*Acrylic Fiber Camden, South Carolina	1977 - 1240 TWA samples 18.6% >2.0 ppm 34.4% >1.0 ppm 52.2% >0.5 ppm	650

*Plants visited by NIOSH personnel.

EXPOSURE MONITORING

It must be recongized that the OSHA wording and intent differ from the NIOSH sampling strategy used for over 400 draft technical standards transmitted to OSHA under the Joint NIOSH/OSHA Standards Completion Program. The NIOSH philosophy is detailed in the NIOSH Occupational Exposure Sampling Strategy Manual, by Leidel, Busch, and Lynch, #77-173. OSHA feels that each employer must "monitor each workplace and work operation to accurately determine the airborne concentrations to AN to which employees may be exposed." Interpreted from a statistical standpoint, this translates to determining the distribution of employee exposures for each workplace and work operation. This, very easily, may be an unnecessary employer burden and waste of exposure monitoring resources if the entire distribution lies substantially below the PEL.

It appears that the OSHA concept of "representative" sampling can greatly reduce the health protection afforded under the NIOSH sampling strategy, while increasing the employer's sampling burden in some cases. OSHA does add the proviso that the employer must "demonstrate that the determinations are representative of employee exposures." However, OSHA has never provided any technical guidance on what constitutes adequately "representative" exposure measures. NIOSH would be pleased to work with OSHA to develop such guidelines.

The sampling strategy given in the Manual, which was developed for substances not suspected of human carcinogenicity, can easily be adapted to the suspected carcinogen, acrylonitrile. Primarily, I would recommend combining the written determination step with the maximum risk employee measurement step (p. 11 of the Manual). That is, each employer would be charged with making a written initial determination that included maximum risk employee(s) measurement(s). Note that this modified NIOSH sampling strategy would also eliminate possibly unnecessary employer burden created by section (e)(4) of the OSHA proposal. Strictly interpreted (i.e. legally!), this section requires re-monitoring every time there is a minor process change (a few pounds of pressure or a few degrees of temperature on a reaction system) that may cause no significant increase in exposures. The written determination can include anticipated ranges of production operating variables. Then, re-monitoring of a maximum risk worker would only be required if the new operating conditions did not fall within the range of operating conditions considered in the original written determination.

CONTROL TECHNOLOGY

NIOSH has recently completed a 16 month study entitled "Engineering Control Technology Assessment for the Plastics Resins Industry." The study was carried out by the Enviro Control, Inc. (ECI), Rockville, Md. under contract 210-76-0122. ECI studied 13 polymerization processes as follows: 2 polyvinyl chloride (PVC) bulk processes: 2 PVC suspension processes: 2 PVC dispersion processes: 1 acrylonitrile-butadiene-styrene (ABS) - styrene-acrylonitrile (SAN) process: 1 polystyrene process: 1 styrene-butadiene-rubber (SBR) process: 1 phenolic process: 1 acetile phenol process: 1 epoxy process. Based on the technical input provided by ECI to NIOSH through this contract and on the first hand knowledge gained from participation in a number of process studies as well as on our professional experience in chemical process and industrial hygiene engineering, NIOSH offers the following comments concerning control technology for the proposed acrylonitrile standard.

PRINCIPLES OF CONTROL

Occupational exposure to acrylonitrile can be controlled through the application of a number of well known principles which are given in Table II. These principles may be applied at or near the hazard source, to the general workplace environment, or at the point of occasional exposure by individual workers. Controls applied at the source of the hazard (including material substitution, process/equipment modification, isolation and local ventilation) are generally

the preferred and the most effective means of control. Other controls such as general dilution ventilation and work practices, are applied to hazards which have escaped into the general workplace environment.

The third type of control measures are applied at or near individual workers (such as isolation booths, some work practices, and personal protective equipment) to prevent contact of workers with workplace hazards not controlled at the source. In general, a combination of types of controls to form a system providing worker protection under normal operating conditions as well as under conditions of process upset or maintainence, is required. Process or workplace monitoring/ warning systems, the education of both workers and management concerning occupational health, and surveillance of controls to insure proper use in operating conditions are very important ingredients of a complete control system.

The general principles of control apply to all facets of AN production, polymerization and use. However, the specific application of these principles to particular processes (such as ABS-SAN polymerization) depends on the nature of the process and on the physical properties of the materials which are being processed. In general, similar processes involving similar materials will require similar controls. For example, controls for ABS-SAN polymerization processes will in general be similar to controls for analogous vinyl chloride polymerization processes. In both cases the primary method of control

involves containment of the monomer within enclosed equipment to the greatest extent possible and worker/process isolation through the use of automated process control and maintenance procedures. Typical intermittent exposure sources which can occur in PVC plants in spite of efforts at process enclosure are given in Table III (attached). Similar types of exposure sources would also occur in ABS-SAN plants. The application of a variety of other control methods from Table II is necessary to control these intermittent sources. As discussed, these controls must function together as an integrated, coordinated system.

Although the application of control technology for ABS-SAN and PVC polymerization processes is similar in many respects, it is not identical. For example, the lower vapor pressure and greater solubility of AN coupled with the lower thermal stability of AN polymers (compared to vinyl chloride monomer (VCM) and PVC) makes stripping of unreacted AN from the product polymer more difficult than with VCM/PVC. Thus, although PVC can apparently be stripped so as to avoid any significant occupational exposures to VCM in subsequent PVC processing, this method of control may not be as effective with AN/AN polymers. Other control methods (such as local exhaust ventilation) could be necessary in further processing of AN polymers.

In general an optimum control strategy should be determined for each plant or process based on the principles listed in Table II. The particular set of constraints and operating conditions found in each plant will usually result in a number of plant-to-plant differences in the implementation of these principles, particularly in retrofit situations.

CONCLUSIONS

The state of the art in retrofit controls for PVC polymerization plants surveyed in the recent NIOSH sponsored ECI study can usually meet the current 1 ppm TWA/5 ppm ceiling standard for VCM. ABS-SAN polymerization processes are similar enough to PVC polymerization processes that the same level of technology applied to the ABS-SAN processes should meet the proposed 2 ppm standard and might possibly meet the proposed 1 ppm standard. AN production processes should not be substantially more difficult to retrofit for either the 2 ppm or 1 ppm standards than the ABS-SAN polymerization processes.

Based on the observed effectiveness of control technology in PVC plants, it is probable that AN polymerization plants would require substantial redesign and extensive modification/rebuilding in order to meet the 0.2 ppm TWA standard. The same conclusion is probably true of AN production facilities.

The control of AN in fiber spinning processes is somewhat complicated by the difficulty in stripping AN from AN polymers or copolymers. Further controls in fiber processing operations and/or advances in AN stripping technology may be necessary in order to meet the proposed standards.

Certain general guidelines should be used in the application of control technology for AN. These guidelines include the use of sealed

equipment and processes to contain the AN as the primary control method. Local exhaust ventilation should be provided as an adjunct in cases when equipment failure may occur. General ventilation, work practices, area monitoring systems and protective equipment should also be used as adjuncts to enclosed processes.

Specific regulatory requirements for particular controls or types of equipment should be avoided. The technical competence of the chemical industry (as indicated by the innovative technology which has been developed to meet VCM standards) should function most effectively within the framework of the general guidelines given above.

TABLE II -- PRINCIPLES OF CONTROL

POINT OF APPLICATION OF THE CONTROL MEASURE	CONTROL MEASURE
At or near the hazard source	1. Substitution or non-hazardous or less hazardous material.
	2. Process modification.
	3. Equipment modification.
	4. Isolation of the source.
	5. Local exhaust ventilation.
	6. Work practices.
To the general workplace environment.	1. General dilution ventilat
	2. Local room air cleaning devices
	3. Work practices.
At or near the worker	1. Isolation of workers.
	2. Work practices.
	3. Personal protective equipment.

TABLE III -- TYPICAL SOURCES OF OCCUPATIONAL EXPOSURE TO VINYL CHLORIDE MONOMER IN PVC POLYMERIZATION PLANTS

OPERATION	EXPOSURE SOURCE
Reactor charging	- Opening reactors for adding batch (solid) ingredients
Polymerization	- Failure of gaskets around reactor mainways - Agitator seal failure
Post-polymerization slurry handling	- Pump seal failure - Maintenance required on plugged lines and filters - Failure at flanged or other connections - Material sampling for quality control
Post-polymerization maintenance on reactor	- Cleaning PVC crust from reactor internal surfaces
VCM Recovery System	- Equipment (compressor) failure - Failure of seals on compressors
Handling of Contaminated Process Waste	- Scrap PVC from reactor cleaning - Process wastewater
Handling of Contaminated Exhaust Air	- Inadvertent recirculation of VCM-laden exhaust air from ventilation systems

MEDICAL SURVEILLANCE

NIOSH recommends the following additions and deletions to the OSHA proposed Medical Surveillance:

1. Initial Examination: The work history shall specifically include record of all previous exposures to chemical or other occupational environments of one month or longer. The exposure data, past, present and future should identify all chemicals used in each job classification. The medical history should include smoking, drinking, and other relevant social activities such as travel and places of residence. In addition, the employee should be asked about reading and relevant learning skills. A complete history of body systems as well as a detailed history of past illnesses, drugs and family history should be recorded.

   NIOSH does not contribute to the idea that histories of specific systems should be given special attention as this may encourage the physician or allied health personnel to dwell on symptoms related to these symptoms and ignore others that may equally be important.

2. The Physical Examination: Unlike the history-taking, NIOSH agrees that special attention should be paid to the peripheral as well as the central nervous system, and that eye signs should be carefully assessed. The reason for stressing this aspect of the medical examination is because of the tendency of AN to affect the nervous

system and experience indicates that this part of the medical examination is frequently less detailed than desirable. However, NIOSH strongly recommends that physicians examine all systems and not limit this consideration to those that tend to be affected by AN.

NIOSH does not subscribe to the view that a highly specialized procedure such as proctosigmoidoscopy should be singled out as special examination. However, where appropriate, the workers should be sent to specialists or special centers for more detailed system analysis whether that be a brain scan, a liver scan, proctosigmoidoscopy or bronchoscopy.

NIOSH agrees that a stool examination particularly for occult blood should be carried out. In addition a routine test of urine should include blood cells, albumen, and whatever other urine analysis the physician deems appropriate. An initial urinary thiocyanate level should be established.

Blood tests should include a liver profile and a serum thiocyanate. The object of these minimal laboratory investigations is to establish baseline data for renal and liver function.

Chest X-ray as detailed is appropriate.

3. Emergency Procedures: NIOSH suggests that instructions for emergency procedures for eye and skin contact; inhalation and ingestion should be accessible and kept in a known place at the plant so that these instructions can be readily retrieved. This is important because acute intoxication with large amounts of acrylonitrile may cause permanent damage or death while the emergency procedure may be lifesaving.

The physician and/or nurse should be familiar with all first aid procedures and ampoules of amyl nitrite, sodium thiosulphate and sodium nitrite should be kept in locked cupboards at the appropriate facility. Oxygen and potassium permanganate (for gastric lavage) should also be available.

Physician and allied health personnal training and education:

NIOSH subscribes to the view that the physician(s) in charge of plant employee health as well as nurse(s) and/or other health personnel should be afforded the opportunity and encouraged to attend centers for update courses relevant to occupational safety and health.

This concludes my testimony on the subject of acrylonitrile. I trust that I have managed to make it clear that NIOSH regards this chemical as a carcinogen and therefore a hazard in the workplac We believe that it is possible to control emmisions of this chemical and that it is desirable to limit exposure to the proposed OSHA standards. My colleagues and I will answer any questions related to this testimony.

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