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Document Processing Center (7407)
Attention: 8(e) Coordinator
Office of Pollution Prevention and Toxics
U. S. Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

MR35172

Dear 8(e) Coordinator;

This letter is being submitted on behalf of the Acrylonitrile (AN) Group, Inc., a trade association representing producers and users of acrylonitrile. The Acrylonitrile Group was formed in the late 1970's to facilitate the protection of human health and the environment through all stages of the acrylonitrile product lifecycle. We conduct health, safety and environment studies; analyze these and other information and communicate the results to the scientific community. We also advocate appropriate regulation of acrylonitrile based on sound science.

Recently scientists from AN Group member companies obtained copies of English translations of four unpublished surveys of the Chinese chemical industry which examined workers with potential exposure to acrylonitrile. The information in these translated surveys is inadequate to make a proper scientific evaluation of the methods used to collect the data. Further, limitations in the design of these studies make it difficult to determine if the findings from the surveys are valid. Nevertheless the information may meet EPA's published guidance for reporting under TSCA 8(e) and accordingly the AN Group is submitting as enclosures to this letter, copies of the four English translations. This submission is on behalf of the members of the AN Group engaged in the manufacture of acrylonitrile, namely BP Chemicals Inc., Cytec Industries Inc., E. I. DuPont de Nemours, Inc., Solutia Inc. and Sterling Chemicals Inc. The AN Group has made no determination as to whether a significant risk of injury to human health or the environment is actually presented by the findings.

We are not aware of similar reports of effects reported herein among acrylonitrile workers outside of China. Given the uncertainties with the description of these studies, the methods employed, and the potential for exposure to other chemicals in the workplace, it is difficult to establish a causal association for acrylonitrile exposure with the observed outcomes.



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The U.S. acrylonitrile producers are committed to pursuing a better understanding of the quality and meaning of these surveys and to incorporating any scientifically sound information into management of acrylonitrile health risks. Please contact me if you have questions or comments about these reports.

Sincerely,

A handwritten signature in cursive script, appearing to read "John F. Murray". The signature is written in black ink and is positioned above the printed name and title.

John F. Murray, CAE
Executive Director

**HEALTH CONDITIONS OF WORKERS EXPOSED TO ACRYLONITRILE
PRELIMINARY CONCLUSION BASED ON INVESTIGATION
(ABSTRACT)**

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OCT 21 1984
OCCUPATIONAL MEDICINE

The slow toxicity of Acrylonitrile (AN) is not confirmed yet. In order to explore AN's slow toxicity, this article reports the results of health investigations completed on 177 workers exposed to AN in a Shanghai chemical plant. The investigation items included: test of AN density in the working environment, regular physical examination, blood test, test of GSH and ICDH.

Investigation results: (1) AN density in the environmental air almost reached the State maximum allowable range (2mg/m³). (2) Among 177 workers exposed, the rates of dizziness (22.3%), insomnia (18.6%), memory failure (25.4%), as well as throat hyperemia (58.2%) and reduced knee jerk (16.3%) were higher. These symptoms were greater in the group workers with longer service years (≥5 years) than that those in the group of shorter service years (<5 years). (3) Among 177 workers, 80 were chosen who had complete physical examination information for self comparison. We compared 1984 physical exam information, which was the year the plant started to operate, with that obtained in 1997. The rate of memory failure, insomnia and throat hyperemia had an obvious increase (P<0.05). (4) Test of GSH on 177 workers exposed did not find obvious reduction of GSH, nor any difference between longer and shorter service years (P>0.05).

(5) Test serum ICDH and GPT of 85 workers exposed to AN and 40 workers with no exposure to AN. The result was whether exposed or not exposed, GPT of serum was not found to have any increase. But the positive rate of serum ICDH increase in the exposure group was higher than the non-exposure group (12.8%) ($P < 0.05$). Besides, as the exposure years increased, the positive rate of ICDH increased too.

Based on the above investigation results, this article is an analytical discussion. Points are: (1) AN might be a slow toxicant to human body. It has some effects on the central nervous system of human beings. If exposed to a low density AN for a long time, it might cause toxic neurasthenia symptoms. But the rate of throat hyperemia was high. In the factories with no exposure to AN there were similar results, therefore it is hard to decide completely that this was caused by AN. (2) Long time exposure to low density of AN will not cause GSH to obviously decrease or interfere with normal metabolism. (3) Based on the high positive rate of ICDH increase in the AN exposure group, the rate will increase as the service years increase. This means AN is slowly and lightly toxic to human liver. At the same time, it also means ICDH can be a useful sensitive index when doing research on AN's toxicity to liver.

STUDY ON REPRODUCTIVE ORGANS IN FEMALE WORKERS EXPOSED TO ACRYLONITRILE

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Acrylonitrile is a common toxicant in the organic synthetic industry. People are very much concerned with its toxicity research. But there are only a few reports on its damages to human reproductive organs. Therefore, from March to April in 1991, we did a review of surveys on reproductive organs of female workers exposed to AN. Our purpose was to protect and control occupational hazards, and to provide scientific evidence to protect the health of workers and their children.

1. Survey Target and Method

We chose 379 female workers as the exposed group from Lanzhou Chemical Industry Company. They were exposed to AN manufacturing, and all were married more than one year. Their average age was 33.95 years old (22.75-54.83). Average length of service was 14.10 years (3.25-34.42). In addition, we chose 511 female married workers as the control group from a Bed Sheet Factory and a Biological Research Institute. They had no exposure to AN and were all married more than one year. The two groups had similar ages and lengths of service.

1.2 Method

Survey forms were filled out by professionals. Review of the surveys was done in accordance with the "Judgment Standards of Observation Data of Child-Bearing Workers" and "Explanation of Filling the Survey Form" written by the Labor Health & Occupational Disease Research Institute of China, Protective Medical Scientific College.

1.3 Statistic Analysis

The statistics did not include people who had a history of marriage between close relatives, family genetic disease, deformity and sterility. When counting times of pregnancy, situations involving abortion, illness, drugs, drinking, and X-ray exposure during the pregnancy were all excluded.

2. Survey Results

2.1 AN Density in the Shop Air

Monthly test data for 1989 and 1990 was provided by the factory. Among the 155 test data, average AN density was 16.35mg/m³ (0-152.88mg/m³). Meaning 92.90% exceeded State health standards. (2mg/m³)

2.2 Result of Reproductive Organs of Female Workers Exposed

Based on statistical analysis in the exposed group, there were pregnancy complications (20.80%) and premature deliveries (11.62%). Deficiency rates were much higher than the control group (25.4%) ($P < 0.01$). In the exposed group, sterility was 2.64% and overdue delivery was 3.87% which were higher than the control group ($p < 0.05$). Although the difference of mortality of new-borns vs. pregnancy had no statistic meaning, the relative data was 4.11 and 2.26 and had a tendency to increase. See Table 1.

Table 1. Comparison of results of reproductive organs of female between exposed group and control

	Exposed			Control			X ²	RR
	Number of cases	positive	Rate of positive	Number of cases	positive	Rate of positive		
Sterility %	379	10	2.64*	511	4	0.78	4.84	3.38
Gestation Complications %	476	99	20.80**	770	55	7.14	50.64	2.91
Spontaneous abortion %	476	37	7.77	770	50	6.49	0.74	1.2
Premature delivery %	439	51	11.62**	720	34	4.72	19.08	2.46
Overdue delivery %	439	17	3.87*	720	13	1.81	4.62	2.14
Stillborn fetus %	439	6	1.37	720	6	0.83	0.76	1.65
Congenital defects ‰	433	11	25.4**	714	3	4.2	10.05	6.05
Mortality of newborn ‰	433	5	11.5	714	2	2.8	3.4	4.11
Mortality of pregnancy ‰	439	11	25.1	720	8	11.1	3.29	2.26

* P<0.05; ** P<0.01.

In order to discuss the results of reproductive organs of both male and female exposed to AN and female only exposed to AN, we further divided the exposed group into 2 groups; one was for couple exposure, and the other was for female exposure. We found that except for mortality of new-born in the couple exposure group, all other data was higher than the female group. For details, see Table 2.

Table 2. Comparison of results of reproductive organs of female between couple and female workers exposed to AN

	Couple exposure			Female exposure			R/Ra	R/Rb	Ra
	Number of cases	Positive	Rate of positive	Number of cases	Positive	Rate of positive			
Sterility %	104	3	2.88	275	7	2.55*	1.13	3.69	3.
Gestation Complications %	133	28	21.05**	343	71	20.70**	1.02	2.95	2
Spontaneous abortion %	133	13	9.77	343	24	7	1.4	1.51	1.
Immature delivery %	120	19	15.83**	319	32	10.03**	1.58	3.35	2.
Later born %	120	7	5.83**	319	10	3.13	1.86	3.22	1.
Stillborn fetus %	120	4	3.33*	319	2	0.63	5.29	4.01	0.
Congenital defects ‰	116	4	34.5**	317	7	22.1**	1.56	8.21	5.
Mortality of newborn ‰	116	1	8.62	317	4	12.6	0.68	3.08	4
Mortality of pregnancy ‰	120	5	41.7**	319	6	18.8	2.22	3.76	1.

R—rate of couple exposure group; Ra—rate of female exposure group; Rb—rate of control group

When comparing the rate of stillborn fetus (3.33%) in the couple exposure group and 0.63% in the female exposure group, their difference was obvious (P<0.05). The

rates of complication, premature delivery, overdue delivery and deficiency were higher in the couple exposure group than that of the control group ($P < 0.01$). Besides, stillborn fetus, mortality of pregnancy in the couple exposure group was also higher than that of the control group. The rates of complication, premature delivery and deficiency in the female exposure group were also higher than that of the control group. Plus sterility was higher than that of the control group.

3. Discussion and Analysis

It is reported that AN has embryo toxicity and a deformative effect to animals. We found in our survey that the rates of sterility, complication of pregnancy, premature delivery, overdue delivery and deficiency were all higher than those of the control group ($P < 0.05$). Especially when the couple both were exposed to AN, the rates of sterility, complication of pregnancy, natural miscarriage, premature delivery, overdue delivery, stillborn fetus, deficiency and mortality of pregnancy were all higher than those of the female exposure group. So we think AN damages female reproductive organs. We need to further study AN toxicity to male reproductive organs. The causes of unusual child-bearing dangers should be explored further.

Since shop air has a higher density of AN than the standards allow, and workers work under that condition, the rate of unusual child-bearing dangers to the female worker increases. In order to insure the health of the workers and their children, it is recommended the density of AN in shop air be reduced.

PAPER RECEIVED: 1994—06—30; REVISED 1995—06—20

ACRYLONITRILE EFFECT ON WORKERS' REPRODUCTIVE SYSTEM**By Dong Dinglong and Pan Jinglong**

Abstract: Acrylonitrile is a highly toxic substance. Animal experiments have proved already it causes embryo toxicity and is a carcinogen. But in China, there are no reports on its effects of reproductive system to workers exposed. Based on previous research, this article will talk about the survey results of the reproductive systems of 256 married workers exposed to AN and whose years of service were over 2 years, as well as 231 workers in a control group. The result shows that when the average density of AN was 0.53-15.5mg/m³, there were 6 fetus stillborn, giving a ratio of 4.46%, yet the control group had none ($p < 0.05$). For the wives of male workers exposed to AN, their premature delivery, natural miscarriage, threatened abortion, stillborn fetus, sterility, and the rates of premature delivery, mortality of newborn and sterility of female workers exposed were all higher than the control group, even though the two groups had no obvious differences. This suggests AN exposure might cause reproductive system injuries.

Keywords: Acrylonitrile; Production Workers; Mixing; Density; Reproductive System Injuries

Acrylonitrile, also known as AN, is a highly toxic chemical substance. Murray et al. reported that AN is embryo toxicant and deformative⁽¹⁾. But in China, there are no reports of its effects on the reproductive systems of exposed workers. Based on our previous surveys, we initially find it has some effects on the male reproductive system. In order to further explore this issue, in 1993, we expanded our survey by developing an occupational epidemiological study on the reproductive system of workers exposed to AN. We are reporting the results in the following.

1. Survey Target and Method

(1) **Survey Target:** 256 workers exposed in an acrylic fiber plant, a chemical fiber plant and a chemical plant. They were in the exposure group. Among them, there were 150 male workers whose exposure was more than 2 years and they were all married. The female exposure group had 106 workers whose exposure was more than 2 years. There were 110 male and 121 female workers chosen in the control group. Their ages, length of service, working conditions and life styles were pretty similar to the first group, but their working environment had no AN and or other elements which were toxic to their reproductive systems.

(2) **Survey method:** The same survey form was used and completed by professional people, one by one. Survey data was based on the "Reproductive Occupational Epidemiological Study Requirements Written by the National Women Labor Health Group"⁽²⁾.

(3) **Test method of AN density in the shop air:** The method used was a gas like coloring method.

2. Survey Results

(1) **AN density in the shop air:** The chemical plant, acrylic fiber plant and chemical fiber plant, all tested AN density in the shop air periodically. For a recent three year period, the yearly average of AN density in the shop air of each plant is listed in Table 1. One can see from the data, except for the control room and drawing room, all other rooms exceeded the maximum allowable density of AN ($2\text{mg}/\text{m}^3$). Among them, the pump room for finished products, the room for raw material and polymerization had the highest densities.

Table 1. Average acrylonitrile concentration in air at workshop (mg/m^3)

	1991		1992		1993	
	number of samples	Average concentration	number of samples	Average concentration	number of samples	Average concentration
Room						
Control	12	0.96	-	-	-	-
Pump room for reaction	30	1.11	80	2.51	20	2.75
Pump room for purification	115	10.22	46	11.41	40	3.29
Pump room for finished products	12	2.06	12	4.11	12	10.35
Workplace						
raw materials	35	15.52	26	8.79	22	6.56
polymerization	183	11.2	24	10.78	82	8.4
filtering	90	3.73	24	4.86	22	3
Spinning	100	2.52	80	3.16	54	2.7
washing	76	2.21	36	2.52	34	1.98
drawing	108	0.53	42	1.21	46	1.92

(2) **Results of tests on the reproductive system of male workers:** The statistical analysis results of reproductive system information for the wives of the male workers in the exposure group, and the wives of the male workers in the control group are listed in

Table 2. The numbers of pregnancies for the wives of male workers in the exposure group were 168, and the control group had 113. The rates of premature delivery, spontaneous abortion, threatened abortion, stillborn fetus and sterility were all higher than that of in the control group.

Table 2. Comparison of reproductive results between exposed males and control males

	exposure	control
Number	150	110
Average age	20.97 ± 6.85	30.04 ± 3.37
Average working years	3.19 ± 5.35	8.53 ± 3.89
Times of pregnancy	168	113
Alive newborn	159	113
Normal born	141	104
Premature delivery (%)	18(7.74)	4(3.54)
Overdue delivery (%)	6(3.57)	4(3.54)
Spontaneous abortion (%)	8(4.76)	1(0.88)
Threatened abortion (%)	5(2.98)	1(0.88)
Stillborn fetus (%)	4(2.38)	0(0)
Sterility (%)	9(5.00)	2(1.82)
Body weight	5(3.14)	4(3.64)

(3) Results of the reproductive system of female workers: The statistical analysis results of reproductive system information for the female workers in the exposure group and the female workers in the control group are listed in Table 3. The numbers of pregnancies of the female workers in the exposure group were 11, and the control group had 124. There were 5 stillborn fetus which was 4.46%. There were obvious differences, $P < 0.05$. Rates of premature delivery, stillborn fetus and sterility were all higher than that of in the control group.

Table 3. Comparison of reproductive result between exposed females and control females

	exposure	control
Number	105	151
Average age	29.36 ± 5.12	20.68 ± 4.05
Average working years	10.19 ± 8.22	10.12 ± 4.34
Times of pregnancy	112	124
Alive newborn	105	125
Normal born	101	113
Immature delivery (%)	8 (7.14)	5 (4.03)
Later born (%)	8 (1.73)	6 (4.84)
Spontaneous abortion (%)	1 (0.89)	0 (0)
Threatened abortion (%)	3 (2.68)	5 (4.03)
Stillborn fetus (%)	5 (4.46) (P<0.05)	0 (0)
Mortality of newborn (% _{mb})	3 (23.30)	0 (0)
Sterility (%)	3 (8.83)	1 (0.83)

3 Discussion

In recent years, the issue of occupational effects on the reproductive system is becoming an increasing concern to people. Murray et al. reported that AN is an embryo toxicant and deformative⁽¹⁾. But in China, there are no reports on its effects on the reproductive systems of workers exposed. We did surveys of the reproductive systems on 256 workers exposed from a mineral plant, an acrylic fiber plant and a chemical fiber plant, and 231 workers in a control group. The results showed when AN density in the air was 0.53-15.52mg/m³, the rate of stillborn fetus in the female exposure group was obviously much higher than the control group, P<0.05. The rates of premature delivery, spontaneous abortion, threatened abortion, mortality of new-born and sterility of

the wives of the male workers exposed, as well as premature delivery, mortality of newborn and sterility of female workers exposed, were all higher than the control group. This points out AN does damage to the reproductive system, but the channels of effect will be researched further.

This study had an initial search parameter of effects on the reproductive system of the workers exposed to AN. It provides a significant base for future research and protection against occupational effects on the reproductive system.

IV. REFERENCE

1. Fu GL and et al. Chemical Effects to Female Workers' Next Generation. Published by Huadong Regional Labor Health Prevention Center. Shanghai, 1987:189
2. Tung Dinglong and et al. Survey of Sex Ability and Reproductive Organ Effect of Male Workers Exposed to AN. Health and Toxicology, 1993. 7 (Supplementary Issue):37
3. Bao Mingshu and et al. Commonly Used Analytical Data and Statistic Method in Reproductive Organ Occupational Epidemiological Study. Labor Medicine. 1989.6(3):50

4.

**PAPER PUBLISHED IN PETROCHEMICAL SAFETY TECHNOLOGY MAGAZINE 1995 Vol 5;
Section 11; Pages 30 - 31**

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1. Fu GL and et al. **Chemical Effects to Female Workers' Next Generation.** Published by Huadong Regional Labor Health Prevention Center. Shanghai, 1987:189
2. Tung Dinglong and et al. **Survey of Sex Ability and Reproductive Organ Effect of Male Workers Exposed to AN.** *Health and Toxicology*, 1993. 7 (Supplementary Issue):37
3. Bao Mingshu and et al. **Commonly Used Analytical Data and Statistic Method in Reproductive Organ Occupational Epidemiological Study.** *Labor Medicine*. 1989.6(3):50
- 4.

**PAPER PUBLISHED IN PETROCHEMICAL SAFETY TECHNOLOGY MAGAZINE 1995 Vol 5;
Section 11; Pages 30 - 31**

**MICRONUCLEI IN PERIPHERAL BLOOD LYMPHOCYTES FROM THE
OCCUPATIONAL WORKERS EXPOSED TO ACRYLONITRILE AT VARIOUS
TIMES**

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Abstract: 90 occupational workers exposed to acrylonitrile (AN) are categorized into five groups whose service length is between 0-20 years. The frequency of micronuclei (MN) in peripheral lymphocytes is increasing steadily and dependent on the service length. $r=0.95$, $P<0.05$. Among the workers whose service length is over 20 years, frequency of micronuclei has a steady tendency. For those workers whose service length is under 10 years, their micronuclei cells do not increase obviously. But for those whose service length is over 10 years, their micronuclei increase very clearly. Therefore, obviously, there are differences in MN when comparing the workers exposed to AN less than 10 years and more than 10 years. This is meaningful for statistic purposes ($P<0.05$)

Keywords: Acrylonitrile; Micronuclei

Acrylonitrile or AN is a highly toxic chemical substance. Lab experiment proves that it is a mutant agent and animal carcinogen, as well as a potential human carcinogen(1). We reported before that workers exposed to AN have a higher frequency of micronuclei in peripheral blood lymphocytes than the comparison group. This research will talk mainly about the impact of MN in peripheral blood lymphocytes of workers with different service lengths of exposure.

Material and Method

1. Target

This research included 90 occupational workers of the Shanghai Petrochemical Limited Company who were exposed to AN. Their ages were from 21 to 56. Average ages were 34.06 ± 7.74 . There were 9 female and 81 male workers, among which 29 were non-smokers and the rest were smokers. These 90 workers were from the same shop, but different shifts.

2. Method

The test method used to determine MN in peripheral blood lymphocytes was as follows. Draw blood from the vein. Remove fiber protein and add 3% gelatin for free settle. Get clear liquid lan. Use methanol to firm the precipitate and use Giemsa for coloring. Under microscope, count 1000 complete lymphocytes and calculate the molecular rate for every thousand.

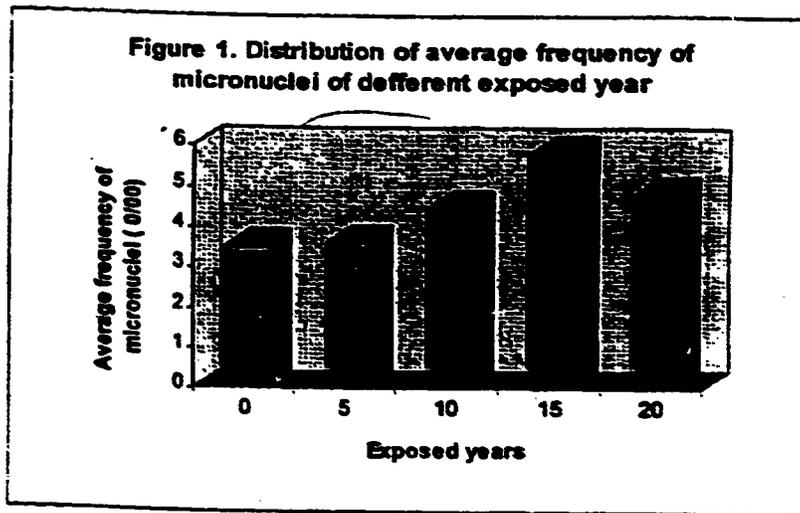
In order to observe the impact of the length of service to the micronuclei rate, divide 90 workers exposed into 5 groups, and calculate average micronuclei rate for each group.

Result

90 workers exposed to AN were categorized into 5 groups. See Table 1 for the average frequency of micronuclei of each group.

Table 1. Average frequency of micronuclei of workers exposed to acrylonitrile

Years of exposed to AN	Number	Average frequency of micronuclei (‰) $\bar{x} \pm s$
0-	14	3.50 ± 1.87
5-	21	3.62 ± 1.90
10-	23	4.48 ± 2.12
15-	16	5.81 ± 2.41
20-	16	4.81 ± 2.19



One can see from Figure I and the Diagram, for workers exposed to AN between 0 to 20 years, as their service length increased, their micronuclei increased as well. The related coefficient $r=0.95$. It obviously has a statistic meaning ($P<0.05$).

From Figure I, we can see from workers exposed to AN under 10 years, their micronuclei rate had no obvious change, but over 10 years, their MN rate had clearly

increased. If 90 people are divided into 2 groups based on 10 years of service, their average micronuclei rates can be seen in Figure II.

Figure II Comparison of two groups with different service length

YEARS OF SERVICE (YEARS)	NUMBER OF PEOPLE	AVERAGE FREQUENCY OF MICRONUCLEI (%)	P
LESS THAN 10	35	3.57 +/- 1.89	< 0.01
GREATER AND EQUAL THAN 10	55	4.96 +/- 2.23	< 0.01

Among 90 workers exposed to AN, 29 of them were non-smokers. Their average age was 33.48+/-9.34. Their average years of service was 10.03+/-6.74. Their average rate of micronuclei in peripheral blood lymphocytes was 4.00+/-2.00. Average age of 61 smokers was 34.32+/-6.92. Their average years of service was 12.08+/-5.69. And average micronuclei rate was 4.48+/-2.12. The comparison between these two groups had no statistical meaning.

In order to eliminate the disturbance of external elements, such as smoking, we used Epi Info software to analyze each layer. The result was: Analysis For Linear Trend in Proportions Chi Square for Linear Trend: 0.016 p Value: 0.90072. This states that smoking and length of service in groups caused no disturbance to micronuclei in this experiment.

Discussion

We did research on the workers exposed to AN for their micronuclei in peripheral blood lymphocytes. We found the workers exposed to AN for 13 years (8 years was the minimum years of service) had the higher rate than the comparison group (P<0.005) (2).

In this survey, we did research of micronuclei in lymphocytes on 90 workers exposed to AN with various service length, in order to understand the relationship between the length of exposure and amount of micronuclei. The result was that workers exposed to AN less than 10 years had no clear increase of micronuclei, but those with over 10 years had a higher increase. The comparison of the two groups has statistic meaning ($P < 0.001$). This means that exposure to AN for more than 10 years may cause higher micronuclei in peripheral blood lymphocytes. This conclusion is the same as obtained from previous research.

Domestic researchers, such as Li Laiyu, think within the range of workers' service length, the age usually shouldn't be considered as having impact on micronuclei. In our research, for workers between 0-20 years of service, the frequency of micronuclei increases as the service years increase. It is shown as $r < 0.05$ and $P < 0.005$. Therefore it is considered that the genetic toxicity effect of occupational exposure to AN may be from long time accumulation. Among workers whose service length was over 20 years, the frequency of micronuclei did not increase further which meant if their exposure was over 20 years, their frequency of micronuclei was in a stable condition.

Smoking can cause an increase of micronuclei in peripheral blood lymphocytes. We divided 90 workers into 2 groups, one is smoking, the other is non-smoking. The result was there was no obvious change in terms of micronuclei. These two groups had similar average ages and lengths of exposure. This result might be because these 90

workers were all in the AN manufacturing environment. Of the two known causes of micronuclei, AN is a highly toxic chemical substance and its capability is more than smoking coagulate. But since this research is based on exposure to AN itself, therefore AN plays the most important role among the causes of micronuclei.

REFERENCES

1. Xia Yanxun, Chemical Substance Toxicity Encyclopedia, Shanghai Scientific Technological Publication, 1991; 604
2. Jin Fusheng and Zhu Ruijuan. Experiment of Micronuclei in Peripheral Blood Lymphocytes on workers Exposed to AN, Health and Toxicity Magazine, 1993; 7(1):54
3. Li Laiyu, Liang Liyan, and Zheng Qiaoling. Using Culture to test Micronuclei Value in Peripheral Blood Lymphocytes Among 120 Healthy Adults in Guangzhou Area. Occupational Medicine, 1992; 19(4):219