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Investigation and analysis of occupational disease hazard factors of a precision tool manufacturing enterprise in Shaanxi Province

Zhang Ningning[1,a], Qi Baoning[1,b,*], Liang Kai[1,c], Shi Hanwen[1,d], Meng Yuan[1,e]

[1]Shaanxi University of Chinese Medicine, Xianyang, Shaanxi, 712046, China
[a]znn13335302870@163.com, [b]281958527@qq.com, [c]964081408@qq.com, [d]491143954@qq.com, [e]1255467410@qq.com
[*]Corresponding author

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Abstract: In order to test and analyze the occupational disease hazard factors of a precision tool manufacturing enterprise in Shaanxi Province, and provide protective measures for protecting the health of workers. We tested and analyzed the occupational disease hazard factors of the precision tool manufacturing enterprise in Shaanxi Province by occupational health field investigation method and detection method in August 2022. Resultly, the main occupational disease hazard factors in the enterprise are dust and noise, and the time-weighted average concentration of dust contact point is less than 0.3 mg / m^3, meet the requirements of occupational contact limit; There are 21 noise working points, the equivalent sound level strength of fitter in fitter area is 86.1dB (A), exceeding the occupational contact limit, and the other noise points meet the requirements of occupational contact limit. Thus, the noise in the workplace exceeds the standard, so it is recommended to take reasonable protective measures.

1. Introduction

With the rapid development of economy and society, the number of industrial enterprises with occupational diseases is large and the number of hazards is large. In recent years, through the joint efforts of all government departments, occupational disease prevention agencies and enterprises, the occupational disease prevention work has made positive progress, but the situation of occupational disease prevention is still grim [1]. At present, a precision tool manufacturing enterprise in Shaanxi Province has the production capacity of high efficiency, high performance and high precision aviation parts, and its processing capacity occupies a place in the field of parts processing.

In order to fully grasp the occupational disease hazard factors exposure situation, exposure level, occupational disease hazard factors protection measures and use effect of the workers of the precision tool manufacturing enterprise, and to master the main occupational disease hazard factors types and links produced in the production process. In this study, the field occupational health survey was conducted in August 2022, and the occupational disease hazard factors were detected and analyzed in the production unit workplace, so as to provide a scientific basis for reasonably protecting the

health of workers.

2. Object and methods

2.1. Object

The object of the study is a precision tool manufacturing enterprise in Shaanxi Province.

2.2. Methods

2.2.1. Detection methods

The occupational health field investigation method and the occupational-disease-inductive factor detection method are applied to identify and test the occupational-disease-inductive factors in the workplace of the enterprise.

2.2.2. Detection and evaluation basis

Detection and evaluation shall be based on the Provisions on Management of Occupational Hygiene in Workplaces [2], GBZ159-2004 Specification of Air Sampling for Hazardous Substances Monitoring in the Workplaces [3], GBZ2.2-2007 Occupational Exposure Limits for Hazardous agents in the Workplace Part 2:Physical agents [4], GBZ/T192.1-2007 Determination of Dust in the Air of Workplaces Part 1: Total Dust Concentration [5], GBZ/T189.8-2007 Measurement of Physical agents in Workplaces Part 8: Noise [6], Occupational Exposure Limits for Hazardous agents in the Workplaces Part 1: Chemical Hazardous agents [7], GBZ1-2010 Hygienic Standards for the Design of Industrial Enterprises [8] and GB/T18204.1-2013 Examination Methods for Public Places Part 1: Physical Parameters [9].

2.2.3. Detection Scope

There are four area in the production workshop of the precision tool manufacturing enterprise in Shaanxi Province, including numerical control area, five-axis workshop, electric spark room and fitter area. The detection scope include all of them.

2.2.4 Sampling, determination, and measurement methods

Under the normal operation of production equipment and production process, this study conduct field sampling and measurement according to the requirements of standard specifications. The sampling, measuring instruments and laboratory analysis instruments used in on-site testing have been verified by corresponding qualified metrological verification units and used within the validity period. Chemical harmful factors were sampled at fixed point and short time, and the sampling frequency was sampled once for two different periods of the day, see Table 1 and Table 2.

Table 1: Sampling and determination method of chemical harmful factors in workplace air

Detection items	Sampling device	Sampling method	Measuring method	Analytical device	Quantitative lower limit
Other dust	AKFC-92A mining dust sampler	At the sampling point, a 15-min air sample is collected at a flow rate of 20.0 L/min at the height of the respiratory zone using a sampler fitted with a gravimetric dust filter membrane.	GBZ/T192.1-2007-Filter membrane quality method	CP225D Electronic Balance	0.1mg

Table 2: Methods of measuring physical factors in the workplace

Detection items	Measuring Method	Measuring Device
noise	GBZ/T189.8-2007 Measurement of Physical agents in Workplaces Part 8: Noise [6].	TES-1352 sound level meter
meteorologic condition	GB/T18204.1-2013 Examination Methods for Public Places Part 1: Physical Parameters[9].	YWSD60/100 Temperature and humidity meter QDF-6 Digital anemometer DYM 3 empty box pressure gauge

2.2.5. Sampling point setting

Chemical harmful factors: (1) the sampling point is set in the place where the workers are exposed to toxic substances, and it is as close to the workers as possible, but it can not affect the work of the workers.(2) The selection of sampling points must include the points with the highest concentration of toxic substances in the air and the longest contact time.(3) The sampler is set in the breathing belt of the worker, 1.5m away from the ground.

Physical harmful factors: Noise measurement point setting: if the sound level difference of the worker is less than 3dB, select 1~ 3 measurement points; if the sound level difference is greater than 3dB, the production site is divided into several areas according to the sound level; place the ear position of the operator.

3. Results

3.1. Enterprise Overview

The precision tool manufacturing enterprise in Shaanxi Province is mainly engaged in processing of aerospace parts, research and development, design, manufacturing, assembly and sales of industrial automation equipment, processing of mechanical parts, tool design, manufacturing and sales, pattern design, manufacturing and sales.

3.2. Main equipment

2 CNC105 CNC lathe, 1 gantry machining center, 1 horizontal CNC machining center, 5 QX 850 CNC milling machines, 5 LST-508 servo turret lathe, 1 LX-1580 vertical machining center, 1 CNC wire cutting machine tool.1 bench drilling bed, 1 tapping machine, 1 handheld grinder, 2 XXC-002 discharge processing center.

3.3. Production process

(1) The operators in the CNC workshop will put the workpiece to the processing position, close the door, start the equipment, the equipment processing according to the preset procedures to complete the processing operation, the processing process will automatically spray the coolant, manually remove the workpiece, the compressed air purge and sent to the next process. The operation process of five-axis workshop and electric spark workshop is the same as that of CNC workshop. (2) The workers in the fitter area shall operate the hand-held grinding machine to hand-polish the steel parts.

3.4. Exposure to occupational disease hazards

This study focus on the labor staffing, identification of occupational-disease-inductive factors, personal protective equipment and protective facilities of the enterprise. The post setting and exposure to occupational-disease-inductive factors are shown in Table 3.

Table 3: Post setting and exposure to occupational-disease-inductive factors

operational site	working place	kind of work	Operation mode / day contact time	Occupational disease hazards	Personal protective articles and its use status	Occupational disease prevention facilities
producing departments	Numerical control area	Lathe worker	Workpiece processing 6h, purging 5min	noise	Type 3M1270 earplugs	—
		Milling worker	Workpiece processing 6h, purging 5min	noise	Type 3M1270 earplugs	
		Milling worker	Workpiece processing 6h, purging 5min	noise	Type 3M1270 earplugs	
		Milling worker	Workpiece processing 6h, purging 5min	noise	Type 3M1270 earplugs	
		Milling worker	Workpiece processing 6h, purging 5min	noise	Type 3M1270 earplugs	
		Lathe worker	Workpiece processing 6h, purging 5min	noise	Type 3M1270 earplugs	
		Lathe worker	Workpiece processing 6h, purging 5min	noise	Type 3M1270 earplugs	
		operator	Workpiece processing 4h	noise	Type 3M1270 earplugs	
	Five axis workshop	Milling worker	Workpiece processing 6h, purging 5min	noise	Type 3M1270 earplugs	
	electric spark room	operator	Workpiece processing 1h, purging 2min	noise	Type 3M1270 earplugs	
	Fitter area	benchworker	Deburring 2h	Other dust and noise	KN95 self-priming filtered particulate respirator, splash goggles, earplugs type 3M1270	GJSF-090 type polished dust collector

3.5. Detection results and analysis

3.5.1. Dust

There is a dust operation point in this test, and the weighted average concentration of the fitter in the production workshop is less than 0.3 mg / m^3, meet the occupational contact limits. The test results

of dust concentration in the workplace of the enterprise are shown in Table 4.

Table 4: Test results of dust concentration in the air in the workplace

Operational site	Kind of work	Sample point / equipment	Detection items	Test result	C_{TWA}	Exposure limit (mg / m3)		Judgment result
				(mg/m^3)	(mg/m^3)	PC-TWA	PE	
manufacturing shop	benchworker	Fitter area /Handheld sander	Other dust	0.3	<0.3	8	24	√

Notes: C_{TWA}-Time-weighted average concentration; PC-TWA-Time-weighted average allowable concentration; PE-Exposure Concentration; √-comply with requirements.

3.5.2. Noise

Table 5: Test results of noise level of workers in main positions

sample points	type of work	Equipment/Operation mode		Detection result [dB(A)]	Contact time (h/d)	$L_{EX, 8h}$ [dB(A)]	Exposure limit [dB(A)]	Judgment results
Numerical control area	lathe worker	CNC-105 CNC Lathe	processing	78.1	6	78.2	85	√
			purging	92.3	1/12			
	Milling worker	QX-850 CNC Router	processing	78.5	6	77.5	85	√
			purging	85.2	1/12			
	Milling worker	ZMC-850 CNC Router	processing	84.8	6	83.7	85	√
			purging	88.2	1/12			
	Milling worker	K-4025 Gantry Machining Center	processing	83.6	6	82.5	85	√
			purging	87.6	1/12			
	Milling worker	VMC-1270 Horizontal CNC Machining Center	processing	78.6	6	77.7	85	√
			purging	86.4	1/12			
	Lathe worker	LX-1580 Vertical Machining Center	processing	79.5	6	78.7	85	√
			purging	88.5	1/12			
	Lathe worker	LST-508 Servo Turret Lathe	processing	79.4	6	78.5	85	√
			purging	87.2	1/12			
	operator	CNC wire-cut machine	purging	78.6	4	75.6	85	√
Five axis workshop	Milling worker	VC5A3020 Five-axis machining center	processing	80.1	6	79.3	85	√
			purging	89.5	1/12			
electric spark room	operator	XXC-002 EDM center	processing	75.5	1	68.6	85	√
			purging	88.2	1/30			
Bench work area	Benchwork	Handheld sander	deburring	92.1	2	86.1	85	×

Notes: $L_{EX, 8h}$- 8-hour equivalent sound level; √-comply with requirements; ×-incomply with requirements.

There are 21 noise working points in this test. The equivalent sound level intensity of the fitter in

the fitter area is 86.1, which exceeds the limit of occupational exposure, and the other noise posts meet the requirements of occupational exposure limit. The detection results of noise level of the main workers in the manufacturing shop of the enterprise are shown in Table 5.

4. Discussion

Enterprises should master the raw materials and auxiliary materials, workplace layout and the types of occupational-disease-inductive factors required by the production process, so as to protect the occupational health of workers [10]. In the investigation and testing of a precision tool manufacturing enterprise in Shaanxi Province, it was found that the raw materials were aluminum and steel, and the occupational-disease-inductive factors in the workplace were dust and noise. The noise of the working point of the fitter in the fitter area exceeds the standard. The reason for the exceeding point is the noise of the handheld grinder when in contact with the workpiece, and the daily working time of the operators is long, despite noise reduction measures, it is still above the occupational exposure limit.The exceeding point is the key control point for the prevention and control of the occupational disease hazards of the enterprise.

Studies have shown that noise not only specifically causes human ear hearing loss, and eventually leads to occupational noise deafness [11], but also has adverse effects on the neurological, digestive and reproductive systems, and increases the risk of hypertension and the risk of electrocardiogram abnormalities [12-14]. The person in high intensity noise environment for a long time, can produce headache, dizziness, tinnitus and other neurasthenia symptoms, and can be accompanied by heart rate, blood pressure, loss of appetite, gastric dysfunction and other symptoms, female workers can also have menstrual disorders [15].

5. Suggestions

According to the investigation and evaluation of the current situation of the occupational disease hazards of the enterprise, the following suggestions are put forward to protect the health of the workers.

(1) For excessive noise, the unit of choose and employ persons can gradually reduce the level of high noise in the workplace according to the development of industry control noise technology, such as improving process level, using low noise equipment instead of high noise equipment; noise equipment should set vibration reduction base, equipped with sound insulation cover; workshop wall, ceiling and other position should deploy sound insulation sound absorbing material. At the same time, enterprises should reduce the working time of workers as far as possible, and workers should wear hearing guards at work.

(2) Enterprise should strengthen vocational education, usually organize regular preaching, speech, operation, skills competition and other forms of occupational health education activities, strengthen the known of occupational-disease-inductive factors of human damage. And it should strengthen personal protective equipment use training, especially training on occupational disease hazard factors identification and knowledge of occupational disease diagnosis, and improve the cognition of occupational disease hazards to enhance the personal protection consciousness.

(3) Enterprise should also perfect the warning signs for occupational disease hazards in the workplace. In order to make workers correctly understand of the harmful factors of the existence of the workplace, the management department should strengthen the supervision and management of field operation personnel occupational disease prevention articles wear, and ensure that the individual protective equipment correct wear rate reached 100%.

(4) According to the requirements of the GBZ188-2014 Technical specifications for Occupational Health Surveillance[16], in accordance with the hazard factors of the relevant personnel do before the

post, the post, and leaving the post occupational health examination, the health examination found disease or patients diagnosed with occupational disease and occupational contraindications personnel to take treatment, recuperation or change jobs, make dynamic observation, and for each contact occupational disease hazard factors workers establish personal occupational health monitoring file [17].

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