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### Study on Analysis for Working Environmental Measurement Results of Automobile Industries

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The aims of this study are to confirm the improvement by comparison with the excess-rate for exposure level of the harmful factors for working environmental measurement results of 1995~2003 year of automobile factories and to suggest direction for working environmental measurement in future.

1st, the harmful factor continuously issued at A(B ; same factory) and C factories during 1995~2003 year was the noise. The total excess-rate of harmful factors for overall processes was 19.4% during 1995~1997 year, 2000~2001 year 9.4% in A(B) factory and C factory was 1.96% during 2001~2003 year. The results of improvement for harmful factors are as follows.

1. Noise ; The total excess-rate for overall processes of A(B) factory was av. 24.9% during 1995~1997 and av. 19.7% during 2000~2001 and especially at 2001(13.6%) was very improved. The mainly improved process was the press-process. The excess-rate of C factory during 2001~2003 year was av. 6.1% for overall processes.

2. Manual material handling(MMH) and repeated works ; The RWL excess-rate for MMH of A(B) factory was very high during 1995~1997 but during 1999~2001(61.5% 7.1%) was very improved. The ANSI excess-rate for repeated works during 1995~1997 was 77.2%. The MMH for C

factory have been automated and not issued.

3. Dusts(welding fume, Fe<sub>2</sub>O<sub>3</sub> dust, and etc.) and heavy metals ; During 1995~2003 the excess-rate for dusts and heavy metals was zero in A(B) and C factories.

4. Organic solvents ; During 1995~1997 the excess-rate for organic solvents of A factory was 5.3% and during 1999~2001(zero%) was very improved. During 1995~2001 benzenes(A2) have been detected but not exceed exposure level. The excess-rate for C factory was zero% and benzenes were not detected.

5. The others(specific chemical materials, toxic gases, oil mists, asbestos, electromagnetic wave, vibration, heat, etc.) not exceed the exposure levels except the oil mist and the a few physical factors.

2nd, Until now as the chemical factors have been very improved, the direction of working environmental measurement in future will manage the chemical factors as the basis and enforce the physical factors(noise, vibration, electromagnetic wave etc. and the ergonomic factors(MMH and repeated work related with the CTDs).

**Key Words** : Excess-ratio, manual material handling(MMH), cumulated trauma disorders(CTDs)

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Table 1. The excess-rate of exposure level for harmful factors in overall processes of A automobile manufacturing factory during 1995 ~ 1973 years)

Harmful factor	Number of measurement	Excess number(%)	Excess number/ Total excess number,%
Noise	898	224(24.9)	72.3
Welding fume	232	0	0
Organic solvent	284	15(5.3%)	4.8
Oil mist	37	0	0
Toxic gas	54	0	0
MMH*	/	mostly excess	-
Repeated work	92	71(77.2%)	22.9
Vibration	/	not mostly excess	-
Total	1597	310(19.4)	100

\* MMH ; manual material handling

Table 2. Wavelength analysis of noise for the important processes ; dB(A)

Process	Detail work	Frequency(Hz)						
		125	250	500	1000	2000	4000	8000
Press	Press	77.8	84.8	89.1	90.2	90.0	87.9	82.2
	Grinding	78.0	78.9	90.0	107.0	104.5	104.0	101.0
Coating	Dust elimination	64.6	68.7	74.2	85.2	92.4	95.2	90.6

가 3 , 0~13.5% , 가 , 13.5% 가 , 58.0~99.6dB , CO<sub>2</sub> / , , 82.5± 2.69dB , 100~1000 μW/cm<sup>2</sup> 가 , 344 1 (2001 ) , 2001 , 2001 , 2003

3. C자동차의 작업환경측정 결과 분석 (2001~2003년도)

가 1000 Lux (輝度)가 가 , C 2001~2003 769 , 2000 Lux 4. , 4 C 98, TWA, mg/m<sup>3</sup> ; Fe ; 5, Mn ; 1, Cr ; 0.5( ) , Cu ; 0.1, Zn ; 5, Pb ; 0.05 6.1%

2. B자동차의 작업환경측정결과 분석 (2000~2001년도)

B 2000 2001 , 2003 7.8% , Fe 0.0024~0.3586 mg/m<sup>3</sup> , Mn 0.0012~0.0032 mg/m<sup>3</sup> , Cr 0.0003~0.0046 mg/m<sup>3</sup> , Cu 0.0002~0.0009 mg/m<sup>3</sup> , Zn 0.0009~0.0086 mg/m<sup>3</sup> , Pb N.D~0.0098 mg/m<sup>3</sup> , 8.7%, 6.2%, 4.3%, 3.8%

(3 )

Table 3. No. of measurement and excess rate for harmful factors in B factory

Harmful factor	1999 lhy*		2000 uhy <sup>†</sup>		2000 lhy		2001 uhy		Total(2000~2001)	
	No. of meas.	Excess No.(%)	No. of meas.	Excess No.(%)	No. of meas.	Excess No.(%)	No. of meas.	Excess No.(%)	No. of meas.	Excess No.(%)
Noise	452	78(17.3)	512	117(22.8)	573	133(23.2)	583	79(13.6)	1668	329(19.7)
Dust	198	17(8.6)	228	5(2.2)	263	2(0.8)	286	5(1.7)	777	12(1.5)
Organic solvent	88	0	85	0	104	0	118	0	307	0
Oil mist	104	1(1.0)	108	1(0.9)	101	0	112	1(0.9)	321	2(0.6)
Heavy metal	80	0	104	0	122	0	116	0	342	0
MMH	78	48(61.5)	48	28(58.3)	79	42(53.2)	98	7(7.1)	225	77(34.2)
Toxic gas	193	0	206	0	210	0	276	0	692	0
Acid/alkali	12	0	8	0	7	0	24	0	39	0
Radiation	6	0	9	0	34	0	47	0	90	0
Asbestos	2	0	7	0	6	0	8	0	21	0
Etc.	-	-	55	0	13	0	39	12(30.8)	107	12(11.2)
Total	1213	144(11.9)	1370	151(11.0)	1512	177(11.7)	1707	104(6.1)	4589	432(9.4)

\* lhy(lower half year), <sup>†</sup>uhf(upper half year)

Table 4. No. of measurement and excess rate for harmful factors of 8 processes in C factory.

Harmful factor	2001 uhy		2001 lhy		2002 uhy		2002 lhy		2003 uhy		Total	
	No. of meas.	Excess No.(%)										
Noise	129	10(7.8)	126	11(6.9)	161	10(6.2)	138	6(4.3)	130	5(3.8)	684	42(6.1)
Dust	75	0	73	1(1.4)	76	0	59	0	61	0	344	1(0.3)
Heavy metal	171	0	156	0	191	0	124	0	127	0	769	0
organic solvent	30	0	31	0	47	0	40	0	41	0	189	0
SCS*	8	0	10	0	20	0	20	0	14	0	72	0
Toxic gas	18	0	21	0	26	0	34	0	29	0	128	0
Asbestos	0	0	3	0	1	0	1	0	3	0	8	0
Total	431	10(2.3)	420	12(2.9)	522	10(1.9)	416	6(1.4)	405	5(1.2)	2194	43(1.96)

\* SCS ; Specific chemical substance

Table 5. The excess-rate of exposure level for harmful factors in manufacturing processes of the automobile.

Harmful factor	A automobile			B automobile			C automobile		
	1995~1997(3 years)		Excess-rate, %	2000~2001(3 times)		Excess-rate, %	2001~2003(5 times)		Excess-rate, %
	No. of meas.A	Excess No.B (%)	A/B. %	No. of meas.	Excess No. (%)	A/B. %	No. of meas.	Excess No. (%)	A/B. %
Noise	898	224(72.3)	24.9	1668	329(76.2)	19.7	684	42(97.7)	6.1
Dust	232	0	0	777	12(2.8)	1.5	344	1(2.3)	0.3
MMH	92	71(22.9)	77.2	225	77(17.8)	34.2	-	-	-
Heavy metal	/	/	/	342	0	0	769	0	0
Organic solvent	284	15(4.8)	5.3	307	0	0	189	0	0
SSC	/	/	/	/	/	/	72	0	0
Acid/alkali	/	/	/	39	0	0	/	/	/
Toxic gas	54	0	0	692	0	0	128	0	0
Oil mist	37	0	0	321	2(0.5)	0.6	/	/	/
Asbestos	/	/	/	21	0	0	8	0	0
Electromagnetic wave	/	/	/	90	0	0	-	-	-
Etc.	/	/	/	107	12(2.8)	11.2	-	-	-
	1597	310(100)	19.4	4589	432(100)	9.4	2194	43(100)	1.96

Table 6. The excess-ratio for noise exposure level for overall processes.

Factory, year	A, B automobile(same factory)					C automobile	
	95~97(3 years) Excess-rate, %	2000~2001(3 times) Excess-rate, %				2001~2003(5 times) Average	Excess-rate, % Range
		Average	2000 uhy	2000 lhy	2001uhy		
Average excess-ratio(range)	24.9 (0~73.4)	19.7 (0.7~47.1)	22.8 (2.5~46.9)	23.2 (0~47.1)	13.6 (0~24.5)	6.1 (0~13.5)	0~20
Exposure range	64.5~105.5		78.0~99.9			58.0~99.6	
Level(process)	GM : 88.4dB, GSD : 0.59dB (press)					GM : 82.5 GSD : 2.69 dB(overall)	

Table 7. Noise level and frequency range of ship manufacturing works.

Kind of work	Noise level, dB	Frequency, kHz
Hammering	97~102	2~4
Welding	80~88	0.25~0.5
Grinding	94~100	2~8
Cutting	86	8
Crane siren	92	0.5
Crane operation	88	0.25
Ventilation Fan(large)	85~96	0.25~0.5
Engine room	88~101	0.032~1
Air nozzle	84~105	4~16
Dust collector(Bag filter)	88	0.25
Iron handling	94	2~4
Airless coating	95~115	3~6
Shortening	105~110	4~6
Curving	100~105	2~16

Table 8. No. of the occurred and the guessed CTDs in Korea.

Year	No. of occupational decease	No. of recuperation	No. of CTDs (%)	Total No. of manufacturer, thousand*	No. of the guessed CTDs	
					Total No. of manufacturer <sup>†</sup>	Only automobile
1993	1,613	1,413	2(0.1)	4,740	47,400	7,110
1994	1,116	918	20(2.2)	4,812	48,120	7,218
1995	1,351	1,120	128(11.4)	4,765	47,650	7,147
1996	1,927	1,435	345(24.0)	4,698	46,980	7,047
1997	2,119	1,424	133(9.3)	4,477	44,770	6,716
1998	1,838	1,288	410(31.8)	3,891	38,910	5,837
1999	2,732	1,897	345(18.2)	4,282	42,820	6,423
2000	4,051	2,459	815(33.1)	4,348	43,480	6,522
2001	5,653	4,456	1,457(32.7)	4,296	42,920	6,438
2002	5,417	4,190	1,827(43.6)	4,240	42,400	6,360
2003.9	-	6,171	2,801(45.4)	4,225(2003.6)	42,250	6,338

: 1) 2002, 2) 2002.6, 3) , , / , 2003.11.5

\* (KOSIS, , 2003.11) 12 ( ; 1982.7 3,016 , 86.6 4,015 1990.12 5,040 )

† 1995 (10.0 /1000 )

- 1995 18,886,000 184,800 ( 1 %)

- 1992 14.4 % (40,600/281,800), 193 14.1 % (42,600/302,400), 1994 15.8 % (52,500/332,100), 1995 16.1 % (49,500/308,200) ;  
1992~1995 (4 ) , % = (14.4 +14.1+15.8 +16.1)/4 15 %

### IV. 고 찰

#### 1. 유해인자별 노출기준 초과 비율

2000 2001

( 2000, 2001, 2000~2001 )

8.3% , 57.4~73.4% 가 , 12.5~ 19.4%

2. 소음

6 . A, B ( 1995~1997 )

24.9%( 73.4%, (double-hammer type impact wrenches, DHIW) - (oil-pulse type impact wrenches, OPIW) ( , 1995) DHIW가 95.95± 4.56, OPIW가 87.52±2.87 )

5 ) 2000 ~2001 2000

A 19.7% , B 9.4%, C 1.96%

A, B 2000

. A(B), C

72.3~97.7%, 0~2.8%, 17.8~22.9%

, 가 2001 ~ 2003 ( 5 )

6.1% 2001 2003 ( 7.)

7.8, 8.7, 가

, 6.2, 4.3, 3.8%( 4)

1KHz~4KHz

가

1m 90dB 2 m

84dB, 4 m 78dB

가 2 가 6dB

6dB (反響) (平松幸三外 5人, 1992).

A, B ( , 1995) DHIW가 95.95± 4.56, OPIW가 87.52±2.87

가 OPIW가 DHIW 가 8dB(A)

Table 9. The excess-rate(%) of exposure level for dust.

Item	1999 lhy	2000 uhy	2000 lhy	2001uhy	2001 lhy	2002 uhy	2002 lhy	2003 uhy	Total	
									No. of meas.	No. of excess(%)
B automobile	8.5	2.2	0.8	1.7	/	/	/	/	975	29(3.0)
C automobile	/	/	0	0	3.6	0	0	0	344	1(0.3)

Table 10. The excess-rate(%) of exposure level for organic solvent.

Item	1995~1997(3 years)	199~2001(4 times)	2001~2003(5 times)	Total	
				No. of meas.	No. of excess(%)
A automobile	5.3	-	-	284	15(5.3)
B automobile	-	0	-	395	0
C automobile	-	-	0	189	0

3. 중량물 및 반복작업

(10, 2001). A 1995~  
 1) (1997(3 ) ( (RWL) 2002,  
 ), 2) ( (2002.6, /  
 ), 3) ( ), ( , 2000 2003.11.5 )  
 ) ( ; 1999 61.5%,  
 1) / ( , ). 2000 58.3%, 2000 53.2%, 2001 8  
 2) , ( ), 3) 7.1%) ( . 1993 2  
 , 4) , 5) 3). A(B) 가 , 1997 IMF  
 , 6) 가 2000  
 / , ( ), 가  
 ( 1KHz ), 가  
 ( ( 2002 1,827  
 가 ; , , / ( 43.4%),  
 , , / ) 2003.9 2,801 .  
 , , , 2000  
 , , A 1995~1997 (3 ) 가  
 (kg/m<sup>2</sup>)가 가  
 , 1) ( / (ANSI) 가  
 ) , 2) , 3) 83.3%, 100%,  
 , 4) , 5) 74.3%

Table 11. The detection-rate of benzene in mixed organic solvents.

Item	1995~1997 (3 years)	2000 uhy	2000 lhy	2001 uhy	2001~2003 (5 times)	Exposure conc.(av.), ppm	Exposure range, ppm	Total	
								No. of detection/ No. of meas.	Detection- rate(%)
A automobile	22.6	-	-	-	-	0.54	0.04~2.67	38/168	22.6
B automobile	-	3.5	7.7	8.5	-	0.1	t~1.1786	21/307	6.8
C automobile	-	-	-	-	0	0	0	0/189	0

Table 12. The excess-rate for the other harmful factors.

Harmful factor	B automobile		C automobile		Total	
	2000~2001(3 times) excess-rate, %		2001~2003(5 times) excess-rate, %			
	No. of meas.	No. of excess, %	No. of meas.	No. of excess, %	No. of meas.	No. of excess, %
SCS. etc.	51	0	72	0	123	0
Toxic gas	885	0	128	0	1013	0
Oil mist	425	3(0.5)	/	/	425	3(0.5)
Asbestos	23	0	8	0	31	0
Electromagnetic wave	96	0	-	-	96	0
Etc.	107	12(11.2)	-	-	107	12(11.2)
Total	1587	15(0.9)	208	0	1795	15(0.8)

### 4. 분진

5%

60% , 1981 23,000  
1995 1981 13,4  
, 1994  
(OSHA, BLS 2001,  
1996-1998,  
1999, U.S.  
Department of Labor, Bureau of Labor  
Statistics, 1997.3)

B  
1999 ~2001 (4 )  
2000  
2.2, 0.8, 1.7%  
C  
2001 ~2003 (5 )  
2001  
1 (0.3%)  
2001

Fe~Pb

3.0%

(2002.5.24, )  
(2003.6.18,  
)가  
2003.5 “

### 5. 중금속

. 1990  
(humanization of work)  
(  
, 2001).  
(ANSI/HFS 100, 1998 ; ANSI  
B11.TR, 1993 ; ANSI Z-365, 1996 ; OSHA  
Ergonomics Program, 2000)

A  
. 1990  
Pb, Ni, Mn, Zn, Fe  
( 11), B (A )  
1999 ~2001 (4 )  
422  
( 3),  
C 2001  
~2003 (5 ) 769  
( 4),  
A(B), C 1995 ~2003  
1,191  
(  
~2001 (3 )  
1998, TWA, mg/m<sup>3</sup> ; Fe ;5. Mn ; 1, Cr  
; 0.5( ), Cu ; 0.1, Zn ; 5, Pb ; 0.05)  
Fe(0.0024 ~ 0.3586), Mn(N.D ~  
0.0408), Cr(N.D ~ 0.0053), Cu(N.D ~ 0.036),  
Zn(N.D ~ 0.6595), Pb(N.D ~ 0.0134)

### 6. 유기용제

가  
MIBK,  
MEK, IPA, , n-  
10 A(B )  
1995~1997  
5.3%  
, 1999  
0  
C  
2001 ~2003 (5 )  
0  
(  
, 1991 ;  
, 1992 ; , 1995 ;  
, 1996 ; ,  
1998). A (B ) 95~97  
22.6% 2000  
~2001 (3 )  
6.8%  
0.04~2.67 ppm  
t( )~1.1786 ppm

C

189 . C 2001 . C 3. ( , , ) A(B), C  
 ~2003 (5 )  
 가 가 ,  
 가 가 A(B)  
 (ACGIH, 1998) 0.5 ppm 2000 가 가 4. ( , , , / ; Fe, Cd, Ni, Zn, Mn, Cr, Pb, Al) 1995~2003 A(B), C  
 , 1ppm( , 1998) . 1995~1997 A  
 19.4%(310 /1597 ) , 2000 B  
 가 9.4%(432 /4592 ) , C 가 ( , )  
 1.96%(43 /2194 ) . ( )  
 가 1. A(B) 가  
 1995~1997  
 24.9% 2000 ~2001 (3 ) 5. 1995~1997 A  
 19.7% , 2001 5.3% 1999 ~2001  
 13.6%  
 1995~1997 A(B)  
 73.4% 2001 1995~2001  
 16.7% ( , A2)  
 12 . 1995~1997 2000  
 B, C 2000 2003 ~2001 . 1995~1997 22.6% , 2000 ~2001  
 C 6.8%  
 6.1% ,  
 13.5% B (35.0%)  
 . C 2001 ~  
 58~99.6dB( 82.5dB, 2003  
 2.69dB) B  
 가  
 1KHz~4KHz  
 2. A(B) 가  
 (RWL) 1995~  
 1997 2000  
 ~2001 58.3%, 53.2%, 7.1% 가 ( ) B  
 0.9%) A(B), C

V. 결론

1995~1997 가 ANSI  
 , A, B, C (A B ) 77.2% ,  
 1995 ~2003  
 , B 가

