

ภาคผนวก ฎ

เอกสารแสดงสัดส่วนความเข้มข้นของฝุ่นละออง

**EPA Contract No. 68-D7-0068
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ERG No. 0101-01-009**

ESTIMATING PARTICULATE MATTER EMISSIONS FROM CONSTRUCTION OPERATIONS

FINAL REPORT

Prepared for:

**Emission Factor and Inventory Group
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711**

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EASTERN RESEARCH GROUP, INC.

Section 4.

Existing Methodologies for Estimating Construction Emissions

Many methodologies have been developed to calculate PM emissions from construction activity. The basic limitations to developing a construction emissions methodology are how to estimate the level of activity that occurs at a construction site and what emission factor is appropriate to use to calculate PM emissions.

Two basic approaches are used in collecting data for the development of emission inventories: (a) “top down” methodology; and (b) “bottom up” methodology. The “top down” method uses national and state data resources to estimate activity levels that are multiplied by general emission factors to calculate emissions for a large region. The calculated emissions are then apportioned to more resolved areas, such as county and sub-county levels using surrogate activity level data, such as population or affected land area. The “top down” method for estimating construction operation emissions uses a single-valued, composite emission factor of 1.2 tons TSP/acre/month, multiplied by estimated acres of construction (derived from construction cost data) and an average duration for construction. The “top down” method is cost-effective, but does not usually provide an accurate reflection of emissions when broken down into the county and subcounty levels.

The “bottom up” methodology may use multiple emission factors (for specific construction phases and activities) and local activity data to calculate emissions. Local data includes equipment population levels, construction permit information, and specific factors that affect construction activity for that area, including construction equipment usage. “Bottom up” methods more accurately reflect the actual construction emissions than is represented using a “top down” method, but are labor-intensive and costly. A “bottom up” emission inventory is preferred for spatial and temporal allocation needed by modeling applications.

Existing methodologies for estimating PM emissions from construction activities are described below and are mostly “top down” methods. Their advantages and limitations are also explained.

4.1 Methodology 1: General “Top-Down” Emission Inventory

Most “top down” emission inventories of PM emissions from construction activities have utilized the current composite AP-42 emission factor as follows:

$$EF_{PM-k} = k \times EF_{TSP}$$

where: k = fraction of TSP that is PM-k
EF = emission factor, 1.2 tons TSP/acre/month

This emission factor requires only that the activity level (acres of construction and duration of the construction activity) be known for each type of construction. If construction activities are controlled, a fractional control efficiency is utilized:

$$\text{PM-k emissions} = \text{EF}_{\text{PM-k}} \times \text{acres of construction} \times \text{months of activity} \times (1 - \text{CE})$$

where: CE = fractional control efficiency

The acres of construction are determined, usually from a published relationship of construction cost to acres disturbed. PM-k emissions are calculated by multiplying the TSP emission factor of 1.2 tons/acre/month by the PM-k/TSP ratio, the total acres disturbed by the construction activity and the months of activity. A control efficiency may be applied to reduce emissions.

For example, the PM₁₀ emissions inventory for the Southern California Air Quality Management District's (SCAQMD) 1991 and subsequent 1994 Air Quality Management Plan used a PM₁₀ emission factor of 0.31 tons/acre/month. This factor was based on the TSP emission factor of 1.2 tons/acre/month, a PM₁₀/TSP ratio of 0.52 (SCAQMD, 1991 and 1994), and a 50% emission reduction to account for watering as a dust control measure.²

The ratios of PM₁₀/TSP and PM_{2.5}/PM₁₀ are important because of their use to project PM₁₀ and PM_{2.5} emissions from TSP estimates. A typical ratio of 0.30 is used for PM₁₀/TSP. The *Criteria Document for Particulate Matter* (USEPA, 1996)³ indicates a ratio for PM_{2.5}/PM₁₀ of approximately 0.15 for construction sites in Fresno, California. Other laboratory and field tests have indicated ratios of crustal PM_{2.5} to PM₁₀ in the range of 0.05 to 0.20, and are documented by Cowherd and Kuykendal.⁴ They recommended a PM_{2.5}/PM₁₀ ratio of 0.15 for construction operations because of the typical dominance of unpaved road emissions.

The information on the acres of land disturbed by construction activity can be obtained from local government agencies and regional planning councils. Building permits usually specify the area of land and/or the cost of the construction. Permits are typically issued by city or county governments and require different levels of activity information.

The duration for an individual construction activity is likely to be identified in the building permit. An average duration can also be estimated using the MRI-developed values of 6 months for residential, 11 months for nonresidential, and 18 months for non-building construction.⁵ Construction activity information can also be obtained from two major national sources, the U.S. Bureau of Census and from the McGraw-Hill Construction Information Group's *Dodge Construction Analysis System*, an on-line service that provides monthly-updated construction data for a fee.

The disturbed area can be determined by using the cost of the construction activity and published conversion factors for several construction types. This simple method uses the aggregated cost of construction in an area which is available from the U.S. Bureau of Census, Construction Statistics Division or from the U.S. Census Bureau's annual publication, *Privately Owned Construction Authorized by Building Permits*. The dollars-to-acres conversion factors are presented in Table 4-1 and are from the MRI report, *Emissions Inventory of Agricultural Tilling, Unpaved Roads and Airstrips, and Construction Sites*.⁵

Table 4-1. Construction Dollars-To-Acres Conversion Factors (MRI, 1974)⁵

SIC code	SIC description	Factor (acres/\$10 ⁶)
1521	General Contractors-Single-Family Houses	5
1522	General Contractors-Residential Buildings, Other Than Single-Family	5
1531	Commercial, Institutional, Manufacturing, and Industrial Buildings	5
1541	General Contractors- Industrial Buildings and Warehouses	5
1542	General Contractors- Nonresidential Buildings, Other than Industrial Buildings	5
1611	Highway and Street Construction, Except Elevated Highways	25
1622	Bridge, Tunnel, and Elevated Highway Construction	25
1623	Water, Sewer, Pipeline, and Communications and Power Line Construction	5
1629	Heavy Construction; Non-building Structures Construction	150

Reference: Cowherd, Chatten, Christine Guenther, and Dennis Wallace. *Emissions Inventory of Agricultural Tilling, Unpaved Roads and Airstrips, and Construction Sites*. EPA-450/3-74-085, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1974.

Acres under construction, if obtained from construction cost data, are usually temporally resolvable only to a monthly level. It is possible to extrapolate to a daily emission estimate by dividing either annual or monthly emission estimates by the appropriate number of workdays in a month.

Table 4-2 identifies the original data resources used by MRI for the estimation of construction activity variables to support the methodology developed in 1974 for estimating county-by-county construction activity levels and emissions. Annual TSP emissions were estimated by MRI by determining the average construction duration (in months) for each type of construction and multiplying by the monthly emission estimate.

Table 4-2. Estimation of Construction Emissions—National Inventory by MRI

Variable	Data resource
Statewide dollars spent on construction	U.S. Bureau of Census, <i>Census of Construction 1972</i> .
Dollars-to-acres conversion factors	Developed by MRI using <i>Census of Construction 1972</i> .
County acres under construction	U.S. Bureau of Census, <i>Census of Construction 1972</i> , construction employment data.
Average duration of construction	Developed by MRI economists; 6 months for residential, 11 months for nonresidential, and 18 months for nonbuilding construction.

Reference: Cowherd, Chatten, Christine Guenther, and Dennis Wallace. *Emissions Inventory of Agricultural Tilling, Unpaved Roads and Airstrips, and Construction Sites*. EPA-450/3-74-085, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1974.

Summary. Using a composite emission factor of 1.2 tons TSP/acre/month is believed to overestimate PM₁₀ emissions from construction activities. The emission factor assumes all construction produces emissions at the same level on a per acre basis. The indicator for the level of activity that occurs at construction sites, dollar value of construction, is a good indicator of activity but conversion factors may not be accurate for converting dollar value to acres for all types of construction. The emission factor and the conversion factors were developed in 1974 and require changes to reflect current construction activity and economic factors.

ภาคผนวก ก

พารามิเตอร์ที่ใช้ในการประเมินผลกระทบด้านเสียง

โดยใช้โปรแกรมคอมพิวเตอร์

พารามิเตอร์ที่ใช้ในการประเมินผลกระทบด้านเสียงโดยใช้โปรแกรมคอมพิวเตอร์

กรณีเมื่อมีการทำเหมืองเข้าใกล้บริเวณหมู่ที่ 4 บ้านวังตะเคียน ต.ท่าสายลวด (หลังที่ใกล้ที่สุด)

Project Setting

dB Foresight: C:\Users\Ae\Documents\TOP-CLASS\TCC Job\NOISE MAP\YVK\dB Foresight\YVK-Left-2\YVK-Left-2.xdb

File | Edit | Settings | Run | Help

Project Settings		Computation Settings	
Project Name	YVK-Left-2	Site SPL Data (Current or Previous Project)	Current Project
North Latitude	16.781139	Run Simulations For Full Project Site	Yes
South Latitude	16.718211	Run Simulations For POR Points	Yes
East Longitude	98.527519	Create Contour Lines Plots	Yes
West Longitude	98.462311	Create Filled Contours Plots	Yes
Resolution (divisions/axis)	100		
Ground Type	Mixed		
Include Cmet Effect	No		
Co Factor Value (dB)	1		
Receiver (Map) Height (m)	1.5		
Include Elevation Effects	Yes		
Number of Elevation Levels	20		

Output Data Folder Location


C:\Users\Ae\Documents\TOP-CLASS\TCC Job\NOISE MAP\YVK\dB Foresight\YVK-Left-2\ Browse

Elevations File Path

C:\Users\Ae\Documents\TOP-CLASS\TCC Job\NOISE MAP\YVK\global mapper\YVK for dB.csv Browse

Site SPL Data Input, File Path (Previous Project)

Browse

 **dB Foresight™** Noise Level Prediction And Mapping

Source Setting

dB Foresight: C:\Users\Ae\Documents\TOP-CLASS\TCC Job\NOISE MAP\YVK\dB Foresight\YVK-Left-2\YVK-Left-2.xdb

File | Edit | Settings | Run | Help

Source Settings										
	Source Name	Include	Number	Latitude	Longitude	SWL	Atmo	Snd Ht	Dir	Mid Band
1	Hydraulic Crawler Drill	Yes	1	16.750214	98.492061	121	23.1	1.5	H	4000
2	Dump Truck	Yes	2	16.750081	98.492095	115	3.1	1.5	H	500
3	Water Truck	Yes	3	16.749250	98.492238	112	7.4	1.5	H	1000
4	Back hoe	Yes	4	16.750217	98.492236	112	1.0	1.5	H	250
5		No	1	0	0	0	0	1.5	E	1000
6		No	1	0	0	0	0	1.5	E	1000
7		No	1	0	0	0	0	1.5	E	1000
8		No	1	0	0	0	0	1.5	E	1000
9		No	1	0	0	0	0	1.5	E	1000
10		No	1	0	0	0	0	1.5	E	1000
11		No	1	0	0	0	0	1.5	E	1000
12		No	1	0	0	0	0	1.5	E	1000
13		No	1	0	0	0	0	1.5	E	1000
14		No	1	0	0	0	0	1.5	E	1000
15		No	1	0	0	0	0	1.5	E	1000
16		No	1	0	0	0	0	1.5	E	1000
17		No	1	0	0	0	0	1.5	E	1000
18		No	1	0	0	0	0	1.5	E	1000
19		No	1	0	0	0	0	1.5	E	1000
20		No	1	0	0	0	0	1.5	E	1000
21		No	1	0	0	0	0	1.5	E	1000
22		No	1	0	0	0	0	1.5	E	1000
23		No	1	0	0	0	0	1.5	E	1000
24		No	1	0	0	0	0	1.5	E	1000
25		No	1	0	0	0	0	1.5	E	1000
26		No	1	0	0	0	0	1.5	E	1000
27		No	1	0	0	0	0	1.5	E	1000
28		No	1	0	0	0	0	1.5	E	1000
29		No	1	0	0	0	0	1.5	E	1000
30		No	1	0	0	0	0	1.5	E	1000
31		No	1	0	0	0	0	1.5	E	1000
32		No	1	0	0	0	0	1.5	E	1000
33		No	1	0	0	0	0	1.5	E	1000

Solid Barrier Settings

dB Foresight, C:\Users\Ae\Documents\TOP-CLASS\TCC Job\NOISE MAP\VKY\dB Foresight\VKY-Left-2\VKY-Left-2.xdb

File | Edit | Settings | Run | Help |

Solid Barrier Settings									
	Barrier Name	Include	Start Lat	Start Lon	End Lat	End Lon	Height	Thickness	Exclude Src
1	Berm 1	Yes	16.750671	98.491478	16.750719	98.492242	1.5	2	0
2	Berm 2	Yes	16.750719	98.492242	16.751131	98.494113	1.5	2	0
3	Berm 3	Yes	16.751131	98.494113	16.750885	98.495347	1.5	2	0
4	Berm 4	Yes	16.750885	98.495347	16.751687	98.495172	1.5	2	0
5	Berm 5	Yes	16.751687	98.495172	16.750878	98.498500	1.5	2	0
6	Berm 6	Yes	16.750878	98.498500	16.748297	98.497678	1.5	2	0
7	Berm 7	Yes	16.748297	98.497678	16.747658	98.494898	1.5	2	0
8	Berm 8	Yes	16.747658	98.494898	16.748030	98.491922	1.5	2	0
9	Berm 9	Yes	16.748030	98.491922	16.748666	98.492597	1.5	2	0
10	Berm 10	Yes	16.748666	98.492597	16.749685	98.491538	1.5	2	0
11	Berm 11	Yes	16.749685	98.491538	16.750671	98.491478	1.5	2	0
12		No	0	0	0	0	0	0	0
13		No	0	0	0	0	0	0	0
14		No	0	0	0	0	0	0	0
15		No	0	0	0	0	0	0	0
16		No	0	0	0	0	0	0	0
17		No	0	0	0	0	0	0	0
18		No	0	0	0	0	0	0	0
19		No	0	0	0	0	0	0	0
20		No	0	0	0	0	0	0	0
21		No	0	0	0	0	0	0	0
22		No	0	0	0	0	0	0	0
23		No	0	0	0	0	0	0	0
24		No	0	0	0	0	0	0	0
25		No	0	0	0	0	0	0	0
26		No	0	0	0	0	0	0	0
27		No	0	0	0	0	0	0	0
28		No	0	0	0	0	0	0	0
29		No	0	0	0	0	0	0	0
30		No	0	0	0	0	0	0	0
31		No	0	0	0	0	0	0	0
32		No	0	0	0	0	0	0	0

Receptors

dB Foresight, C:\Users\Ae\Documents\TOP-CLASS\TCC Job\NOISE MAP\VKY\dB Foresight\VKY-Left-2\VKY-Left-2.xdb

File | Edit | Settings | Run | Help |

Points Of Reception Settings							
	POR Name	Include	POR Number	Latitude	Longitude	Day Ambient SPL	Night Ambient SPL
1	POR1	Yes	1	16.751799	98.489518	62.2	50.8
2	POR2	Yes	2	16.763298	98.520150	62.2	50.8
3	POR3	Yes	3	16.723667	98.500240	62.2	50.8
4	POR4	Yes	4	16.723348	98.506732	62.2	50.8
5	POR5	Yes	5	16.749993	98.505284	62.2	50.8
6	POR6	Yes	6	16.760465	98.491822	58.9	50.8
7	POR7	Yes	7	16.760855	98.492421	62.2	50.8
8	POR8	Yes	8	16.739334	98.486089	62.2	50.8
9	POR9	Yes	9	16.738046	98.487931	62.2	50.8
10	POR10	Yes	10	16.757836	98.511391	62.2	50.8
11	POR11	Yes	11	16.731264	98.497969	57.3	49.3
12	POR12	Yes	12	16.725040	98.495949	62.2	50.8
13		No	0	0	0	0	0
14		No	0	0	0	0	0
15		No	0	0	0	0	0
16		No	0	0	0	0	0
17		No	0	0	0	0	0
18		No	0	0	0	0	0
19		No	0	0	0	0	0
20		No	0	0	0	0	0
21		No	0	0	0	0	0
22		No	0	0	0	0	0
23		No	0	0	0	0	0
24		No	0	0	0	0	0
25		No	0	0	0	0	0
26		No	0	0	0	0	0
27		No	0	0	0	0	0
28		No	0	0	0	0	0
29		No	0	0	0	0	0
30		No	0	0	0	0	0
31		No	0	0	0	0	0
32		No	0	0	0	0	0

Contour Line Settings

dB Foresight, C:\Users\Ae\Documents\TOP-CLASS\TCC Job\NOISE MAP\VK\dB Foresight\VK-Left-2\VK-Left-2.xdb

File | Edit | Settings | Run | Help

Contour Lines, User Settings

	Noise Level	Include	Color Code	Color Name	Opacity	Line Width	Font Size	Line Type
9	100	Yes	#FF0000	Red	100	0.75	6	solid
10	97.5	Yes	#FF3434	Red	100	0.75	6	solid
11	95	Yes	#FF6868	Red	100	0.75	6	solid
12	92.5	Yes	#FF9999	Red	100	0.75	6	solid
13	90	Yes	#633900	Orange	100	0.75	6	solid
14	87.5	Yes	#975900	Orange	100	0.75	6	solid
15	85	Yes	#C28730	Orange	100	0.75	6	solid
16	82.5	Yes	#A40000	Orange	100	0.75	6	solid
17	80	Yes	#C80000	Orange	100	0.75	6	solid
18	77.5	Yes	#FF0000	Orange	100	0.75	6	solid
19	75	Yes	#FF3434	Yellow	100	0.75	6	solid
20	72.5	Yes	#FF6868	Yellow	100	0.75	6	solid
21	70	Yes	#E8E800	Yellow	100	0.75	6	solid
22	67.5	Yes	#FFFF00	Yellow	100	0.75	6	solid
23	65	Yes	#FFFF80	Yellow	100	0.75	6	solid
24	62.5	Yes	#00A251	SpringGreen	100	0.75	6	solid
25	60	Yes	#00D168	SpringGreen	100	0.75	6	solid
26	57.5	Yes	#00FF7F	SpringGreen	100	0.75	6	solid

Contour Lines Plot, User Settings

Setting	Setting
Plot Source Markers	No
Source Marker Style	Star
Source Marker Size	4
Source Marker Color	#FF0000
Plot POR Markers	No
POR Marker Style	Pentagon
POR Marker Size	3
POR Marker Color	#0099CC
Plot Barriers	Yes
Barrier Line Width	1
Barrier Color	#00FFFF
Border Line Width	1
Border Color	
Plot Height (Inches)	4
Plot Resolution (DPI)	600

กรณีเมื่อมีการทำเหมืองเข้าใกล้บริเวณวัดป่าภูผาธรรม

Project Setting

dB Foresight, C:\Users\Ae\Documents\TOP-CLASS\TCC Job\NOISE MAP\VK\dB Foresight\VK-Right-2\VK-Right-2.xdb

File | Edit | Settings | Run | Help

Project Settings		Computation Settings	
Project Name	VK-Right-2	Site SPL Data (Current or Previous Project)	Current Project
North Latitude	16.781139	Run Simulations For Full Project Site	Yes
South Latitude	16.718211	Run Simulations For POR Points	Yes
East Longitude	98.527519	Create Contour Lines Plots	Yes
West Longitude	98.462311	Create Filled Contours Plots	Yes
Resolution (divisions/axis)	100		
Ground Type	Mixed		
Include Cmet Effect	No		
Co Factor Value (dB)	1		
Receiver (Map) Height (m)	1.5		
Include Elevation Effects	Yes		
Number of Elevation Levels	20		

Output Data Folder Location


C:\Users\Ae\Documents\TOP-CLASS\TCC Job\NOISE MAP\VK\dB Foresight\VK-Right-2\ Browse

Elevations File Path

C:\Users\Ae\Documents\TOP-CLASS\TCC Job\NOISE MAP\VK\Global mapper\VK for dB.csv Browse

Site SPL Data Input, File Path (Previous Project)

Browse

 **dB Foresight™** Noise Level Prediction And Mapping

Source Setting

dB Foresight. C:\Users\Ae\Documents\TOP-CLASS\TCC Job\NOISE MAP\YVK\dB Foresight\YVK-Right-2\YVK-Right-2.xdb

File | Edit | Settings | Run | Help

Source Settings										
	Source Name	Include	Number	Latitude	Longitude	SWL	Atmo	Snd Ht	Dir	Mid Band
1	Hydraulic Crawler Drill	Yes	1	16.750617	98.498136	121	23.1	1.5	H	4000
2	Dump Truck	Yes	2	16.750477	98.498092	115	3.1	1.5	H	500
3	Water Truck	Yes	3	16.750757	98.497488	112	7.4	1.5	H	1000
4	Back hoe	Yes	4	16.750637	98.497785	112	1.0	1.5	H	250
5		No	1	0	0	0	0	1.5	E	1000
6		No	1	0	0	0	0	1.5	E	1000
7		No	1	0	0	0	0	1.5	E	1000
8		No	1	0	0	0	0	1.5	E	1000
9		No	1	0	0	0	0	1.5	E	1000
10		No	1	0	0	0	0	1.5	E	1000
11		No	1	0	0	0	0	1.5	E	1000
12		No	1	0	0	0	0	1.5	E	1000
13		No	1	0	0	0	0	1.5	E	1000
14		No	1	0	0	0	0	1.5	E	1000
15		No	1	0	0	0	0	1.5	E	1000
16		No	1	0	0	0	0	1.5	E	1000
17		No	1	0	0	0	0	1.5	E	1000
18		No	1	0	0	0	0	1.5	E	1000
19		No	1	0	0	0	0	1.5	E	1000
20		No	1	0	0	0	0	1.5	E	1000
21		No	1	0	0	0	0	1.5	E	1000
22		No	1	0	0	0	0	1.5	E	1000
23		No	1	0	0	0	0	1.5	E	1000
24		No	1	0	0	0	0	1.5	E	1000
25		No	1	0	0	0	0	1.5	E	1000
26		No	1	0	0	0	0	1.5	E	1000
27		No	1	0	0	0	0	1.5	E	1000
28		No	1	0	0	0	0	1.5	E	1000
29		No	1	0	0	0	0	1.5	E	1000
30		No	1	0	0	0	0	1.5	E	1000
31		No	1	0	0	0	0	1.5	E	1000
32		No	1	0	0	0	0	1.5	E	1000
33		No	1	0	0	0	0	1.5	E	1000

Solid Barrier Settings

dB Foresight. C:\Users\Ae\Documents\TOP-CLASS\TCC Job\NOISE MAP\YVK\dB Foresight\YVK-Right-2\YVK-Right-2.xdb

File | Edit | Settings | Run | Help

Solid Barrier Settings									
	Barrier Name	Include	Start Lat	Start Lon	End Lat	End Lon	Height	Thickness	Exclude Src
1	Berm 1	Yes	16.750671	98.491478	16.750719	98.492242	1.5	2	0
2	Berm 2	Yes	16.750719	98.492242	16.751131	98.494113	1.5	2	0
3	Berm 3	Yes	16.751131	98.494113	16.750885	98.495347	1.5	2	0
4	Berm 4	Yes	16.750885	98.495347	16.751687	98.495172	1.5	2	0
5	Berm 5	Yes	16.751687	98.495172	16.750878	98.498500	1.5	2	0
6	Berm 6	Yes	16.750878	98.498500	16.748297	98.497678	1.5	2	0
7	Berm 7	Yes	16.748297	98.497678	16.747658	98.494898	1.5	2	0
8	Berm 8	Yes	16.747658	98.494898	16.748030	98.491922	1.5	2	0
9	Berm 9	Yes	16.748030	98.491922	16.748666	98.492597	1.5	2	0
10	Berm 10	Yes	16.748666	98.492597	16.749685	98.491538	1.5	2	0
11	Berm 11	Yes	16.749685	98.491538	16.750671	98.491478	1.5	2	0
12		No	0	0	0	0	0	0	0
13		No	0	0	0	0	0	0	0
14		No	0	0	0	0	0	0	0
15		No	0	0	0	0	0	0	0
16		No	0	0	0	0	0	0	0
17		No	0	0	0	0	0	0	0
18		No	0	0	0	0	0	0	0
19		No	0	0	0	0	0	0	0
20		No	0	0	0	0	0	0	0
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22		No	0	0	0	0	0	0	0
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24		No	0	0	0	0	0	0	0
25		No	0	0	0	0	0	0	0
26		No	0	0	0	0	0	0	0
27		No	0	0	0	0	0	0	0
28		No	0	0	0	0	0	0	0
29		No	0	0	0	0	0	0	0
30		No	0	0	0	0	0	0	0
31		No	0	0	0	0	0	0	0
32		No	0	0	0	0	0	0	0

Receptors

dB Foresight, C:\Users\Ae\Documents\TOP-CLASS\TCC Job\NOISE MAP\VK\dB Foresight\VK-Right-2\VK-Right-2.xdb

File Edit Settings Run Help

Points Of Reception Settings

	POR Name	Include	POR Number	Latitude	Longitude	Day Ambient SPL	Night Ambient SPL
1	POR1	Yes	1	16.751799	98.489518	62.2	50.8
2	POR2	Yes	2	16.763298	98.520150	62.2	50.8
3	POR3	Yes	3	16.723667	98.500240	62.2	50.8
4	POR4	Yes	4	16.723348	98.506732	62.2	50.8
5	POR5	Yes	5	16.749993	98.505284	62.2	50.8
6	POR6	Yes	6	16.760465	98.491822	58.9	50.8
7	POR7	Yes	7	16.760855	98.492421	62.2	50.8
8	POR8	Yes	8	16.739334	98.486089	62.2	50.8
9	POR9	Yes	9	16.738046	98.487931	62.2	50.8
10	POR10	Yes	10	16.757836	98.511391	62.2	50.8
11	POR11	Yes	11	16.731264	98.497969	57.3	49.3
12	POR12	Yes	12	16.725040	98.495949	62.2	50.8
13		No	0	0	0	0	0
14		No	0	0	0	0	0
15		No	0	0	0	0	0
16		No	0	0	0	0	0
17		No	0	0	0	0	0
18		No	0	0	0	0	0
19		No	0	0	0	0	0
20		No	0	0	0	0	0
21		No	0	0	0	0	0
22		No	0	0	0	0	0
23		No	0	0	0	0	0
24		No	0	0	0	0	0
25		No	0	0	0	0	0
26		No	0	0	0	0	0
27		No	0	0	0	0	0
28		No	0	0	0	0	0
29		No	0	0	0	0	0
30		No	0	0	0	0	0
31		No	0	0	0	0	0
32		No	0	0	0	0	0

Contour Line Settings

dB Foresight, C:\Users\Ae\Documents\TOP-CLASS\TCC Job\NOISE MAP\VK\dB Foresight\VK-Right-2\VK-Right-2.xdb

File Edit Settings Run Help

Contour Lines, User Settings

	Noise Level	Include	Color Code	Color Name	Opacity	Line Width	Font Size	Line Type
9	100	Yes	#FF0000	Red	100	0.75	6	solid
10	97.5	Yes	#FF3434	Red	100	0.75	6	solid
11	95	Yes	#FF6868	Red	100	0.75	6	solid
12	92.5	Yes	#FFA9A9	Red	100	0.75	6	solid
13	90	Yes	#633900	Orange	100	0.75	6	solid
14	87.5	Yes	#975900	Orange	100	0.75	6	solid
15	85	Yes	#C28730	Orange	100	0.75	6	solid
16	82.5	Yes	#A40000	Orange	100	0.75	6	solid
17	80	Yes	#C80000	Orange	100	0.75	6	solid
18	77.5	Yes	#FF0000	Orange	100	0.75	6	solid
19	75	Yes	#FF3434	Yellow	100	0.75	6	solid
20	72.5	Yes	#FF6868	Yellow	100	0.75	6	solid
21	70	Yes	#E8E800	Yellow	100	0.75	6	solid
22	67.5	Yes	#FFFF00	Yellow	100	0.75	6	solid
23	65	Yes	#FFFF80	Yellow	100	0.75	6	solid
24	62.5	Yes	#00A251	SpringGreen	100	0.75	6	solid
25	60	Yes	#00D168	SpringGreen	100	0.75	6	solid
26	57.5	Yes	#00FF7F	SpringGreen	100	0.75	6	solid

Contour Lines Plot, User Settings

Setting	Setting
Plot Source Markers	No
Source Marker Style	Star
Source Marker Size	4
Source Marker Color	#FF0000
Plot POR Markers	No
POR Marker Style	Pentagon
POR Marker Size	3
POR Marker Color	#0066CC
Plot Barriers	Yes
Barrier Line Width	1
Barrier Color	#00FFFF
Border Line Width	1
Border Color	
Plot Height (Inches)	4
Plot Resolution (DPI)	600

ภาคผนวก ฐ

เอกสารประกอบการขายเพื่อแสดงระดับเสียงของเครื่องจักร

เอกสารประกอบการขายเพื่อแสดงระดับเสียงของเครื่องจักร

รถเจาะระเบิด ของ JUNJIN รุ่น JD-800

CODE	SN109-0005-00
DATE	2009.08.14

SPECIFICATION

MODEL : HYD. CRAWLER DRILL
(JD-800)

CUSTOMER :



JD-800

SN109-0005-00

1. Outline

JUNJINCSM hydraulic crawler drill is a drilling machine for blasting with dynamite in the quarries, and mining and construction site. It is mainly composed of Travelling device as a base machine, Drifter, Guide shell, loading device as drilling device, power unit and running device operated by diesel engine. Differently from pneumatic drill, Air compressor and dust collector installed on the power unit make a high efficient rock drilling with low noise as much as possible.



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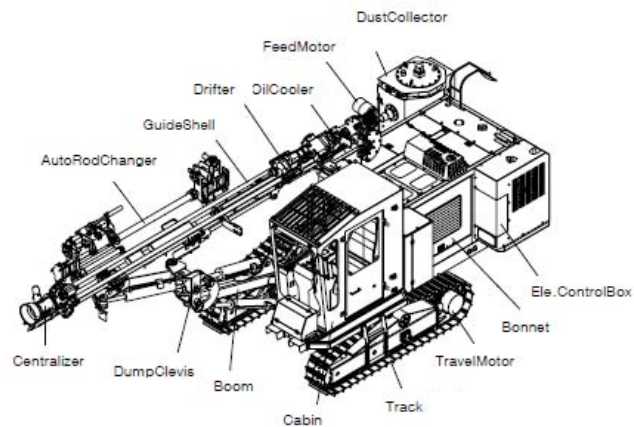


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JD-800

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2. Major Components

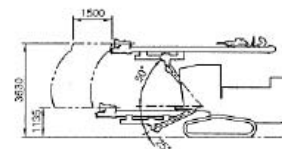


JD-800

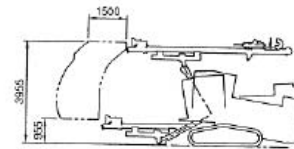
SN109-0005-00

3. Coverage Range

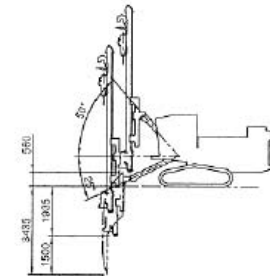
1) Boom Up & Down With Guide Slide
(Horizontal Drill)



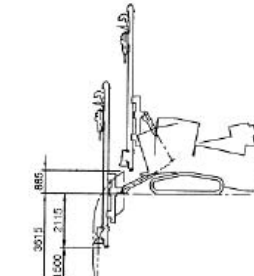
2) Boom Up & Down With Track Oscillation
(Horizontal Drill)



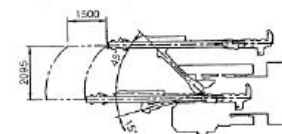
3) Boom Up & Down With Guide Slide
(Vertical Drill)



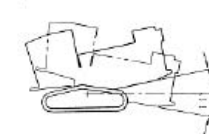
4) Boom Up & Down With Track Oscillation
(Vertical Drill)



5) Boom Swing



6) Track Oscillation



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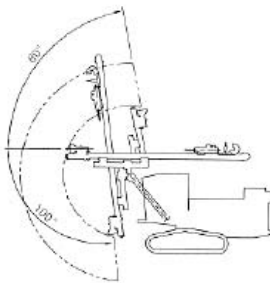
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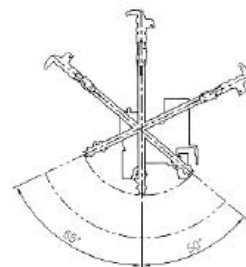
JD-800

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7) Guide Tilting



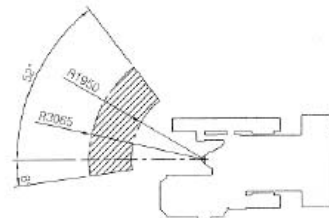
8) Guide Swing



9) Horizontal Drilling Area



10) Vertical Drill Area



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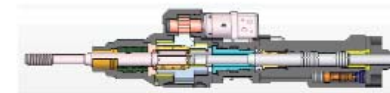
SN109-0005-00

4. Features

1) Powerful Drifter JET-8

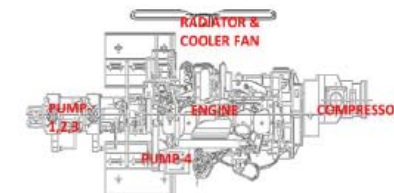
Drifter model JET-8 with hydraulic hammering system and hydraulic motor easily and speedily performs Drilling 64-102 by hammering, rotating and flushing the debris in the hole. Its simple and practical components are different from the others.

- ① Special seals adopted in the front and rear of the piston enhance its durability.
- ② Highly increased hammering energy increased drilling speed.
- ③ Chuck made of special alloy increases durability.



2) Innovative Power Unit

Alignment of power delivering structure decreases the engine load, which maximizes efficiency. High-performance compressor is installed to increase air outflow and radiator & cooler is installed in an independent structure to enhance stability.



3) Working safety

- ① Tumbler length 2205mm and shoe width 340mm maximizes safety.
- ② Ground clearance 540mm and track oscillation 11 on either side prevent the bottom from being damaged by projection on the rough zone.

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JD-800

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4) Anti-jamming system

Makes the stable operation possible on all kind of rock and makes an easy operations by an unskilled operator. This will be operated only in case the anti-jamming switch is on position.

5) Collaring

Collaring makes it easy to take a correct position for drilling and an unskilled operator performs drilling correctly.

6) Travelling speed and Gradeability

The piston pump and travelling motor with high efficiency maximize its travelling speed and gradeability—Travelling speed : 3.8km/h ; Max. gradeability : 30

7) Maintenance and inspection

Panel typed bonnet and vertical typed fuel tank make more room for checking and services.

The oil drain cocks installed on either side for engine oil, gear box oil, fuel, compressor oil make the oil exchange and cleaning easy.

8) Powerful Dust Collector

- ① Dust collector with 4 filters prevents dust from flying in drilling and its filters are protected by air flushing in each filter.
- ② To prevent the filter from being damaged by a water vein, shutter installed within stop collecting dust in case a water vein appears during drilling.

9) Comfortable and safe Cabin

Strong frame, safety glass on all directions, and safety net protect the operator and provide secure broad view in job site. Floating typed operators seat with air-bellows protects the operator from vibration and

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provides very comfortable working conditions. Air condition, radio, and the heater are provided as basic specifications.

10) Sliding Suction Hood

With suction hood cab slid up and down by the operator in the cabin , the operator can performs drilling without others assistance correctly. The hood stuck to the ground prevents the debris from flying in drilling.

11) Auto Lubrication for Drifter

Without additional device, lubricating oil can be supplied from hydraulic tank directly. The automatic lubrication system removes the inconvenience of feeding oil frequently and protects the drifter from being damaged by lubrication oil shortage.

12) Centralized Electric Control System

All the electric control devices are centralized in the control box for checking any trouble easily.

13) Pre-Cleaner(Cyclone)—Optional Parts

Pre-cleaner installed between hood and dust collector protects the filters in the dust collector and the hose from being damaged by the debris.

14) Auto Grease Gun

Before the rod and the sleeve connected, greases the external screw by only pushing the button, which helps the rod and the sleeve charged tightly to get easily loosed.

15) Automatic Rod Changer

The operator connects or disconnects the rods by controlling only a few levers in the cabin without an assistant. This automatic rod exchange can be performed by means of sequential hydraulic schematic.

5 Rods(including the first rod) can be equipped in the cartridge of ARC

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JD-800

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16) Cummins Engine with large output

Cummins engine with water cooling system supply sufficient power for travelling or operating at job site. Especially its world wide services network by Cummins will be a good point for the users.

17) Large Fuel Tank

Fuel tank can hold 250 liters and gives comparatively a long operating duration. The residual fuel can be observed in sight unless engine room opened.

18) Compressor On/Off Switch

Air compressor can be used only in case compressed air required by On/Off switch. The On/Off switch of compressor is effective to cut down the engine fuel consumption by unloading the compressor at the Off position.

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 **JUNJINCSM**

JD-800

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5. Specifications

NO	ITEM			MODEL
				JD-800
1	Overall Dimensions	Gross weight	kg	10,550
		Overall length	mm	8,300
		Overall width	mm	2,470
		Overall height	mm	2,860
2	Crawler	Ground clearance	mm	540
		Oscillating angle	°	11
		Gradeability	%	30
		Traveling speed	km/h	3.8
3	Engine	Model		B5.9-C (CUMMINS)
		Rated output	ps/rpm	156 / 2,200
		Oscillating Angle	°	±11
4	Drifter	Model		JET-8
		Total Length	Mm	1,132
		Total Width	Mm	379
		Total Height	Mm	297
		Weight	Kgf	270
		Impact Frequency	Hz	40~50
		Rotational Torque	Kgf-m	Max. 88
		Rotational Frequency	RPM	Max. 190
		Impact Frequency	Bar	130~170
		Rotation Pressure	Bar	130
5	Air compressor	Model		CF75G(GHH-RAND)
		Working pressure	kg/cm ²	10.5
		Free air delivery	m ³	5
		Tank capacity	m ³	0.051
6	Guide	Overall length	mm	6,800(7,040)
		Slide length	mm	1,500
		Feed length	mm	3,740(4,300)
		Swing angle	R/L	65 / 50
		Tilt angle	°	180

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เอกสารประกอบการขายเพื่อแสดงระดับเสียงของเครื่องจักร (ต่อ)

JD-800

SN109-0005-00

NO	ITEM			MODEL
				JD-800
7	Boom	Overall length	mm	2,100
		Lift angle	U/D _o	50/30
		Swing angle	R/L _o	45/15
8	Dust collector	Suction capacity	m ³ /min	24
		Number of filters	EA	4
		Blow pressure	mm/Aq	550
9	Rod changer	Weight	kg	300
		Number of rods		4+1
10	Bit & Rod	Bit dia		Φ 64~ Φ 102
		Bit design		CROSS,BUTTON
		Rod length	mm	3,060(3,660)
		Rod section		T38, T45
11	Hyd. sys.	Hyd. pump		Rexroth Variable Piston Pump
12	Auto rod changer	Type		○
		Number of Rod	EA	4 + 1

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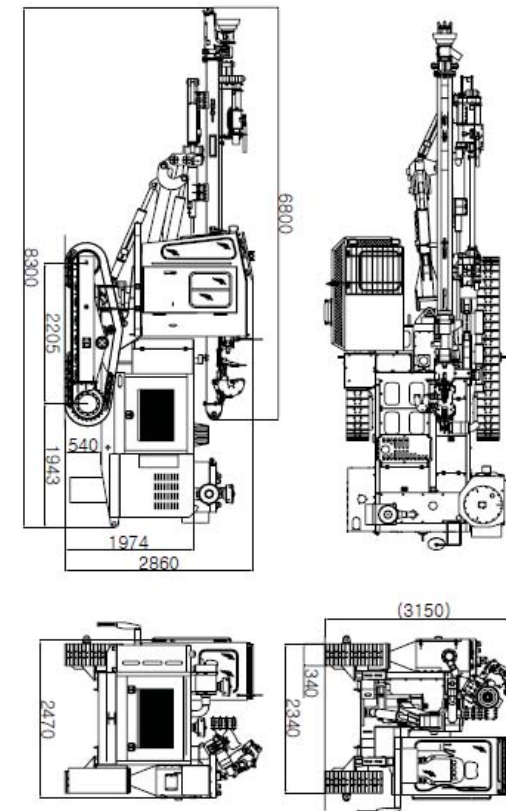
10

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6. Specification Diagram



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เอกสารประกอบการขายเพื่อแสดงระดับเสียงของเครื่องจักร (ต่อ)

รถเจาะกระแทก ของ VOLVO รุ่น EC210B LC

VOLVO EXCAVATOR EC210B LC EC210B NLC MONOBLOCK/2-PIECE BOOM



- Engine power, gross: 119 kW (159 hp)
- Operating weight: LC: 21,3 ~ 22,3 t NLC: 20,9 ~ 21,8 t
- Buckets (SAE) 750 ~ 1 550 l
- Turbocharged VOLVO diesel engine with direct injection and charged air cooler meets EU Step 2 and EPA Tier 2 emission standards

- Contronics, advanced mode selection system and electronically controlled system
- 2 variable displacement axial piston pumps. Independent and simultaneous movements of the digging equipment are controlled by "Automatic Sensing Work Mode".
- Cab
 - Ergonomic environment
 - Low sound level
 - Filtered air
 - Hydraulic dampening mounts

- Strong digging equipment, produced by robotic welding
- High lifting, breakout and tearout forces for tough digging conditions
- Undercarriage
 - LC: Long undercarriage for good stability
 - NLC: Narrow width for easy transportation
- Auxiliary hydraulic valve as standard
- Prepared for a number of optional items

VOLVO



ENGINE

The engine is a turbocharged, 4-stroke diesel engine with water cooling, direct injection and charged air cooler that meets EU Step 2 and EPA Tier 2 emission standards. The engine has been developed especially for excavator use, providing good fuel economy, low noise levels and a long service life.

Air Filter: 3-stage, includes pre-cleaner

Automatic Idling System: Reduces engine speed to idle when the levers and pedals are not activated resulting in less fuel consumption and low cab noise level.

Low-Emission Engine

Make VOLVO
Model D6D EAE2
Power output at 32 r/s (1 900 rpm)
Net (ISO 9249/
DIN 6271) 107 kW (145 ps / 143 hp)
Gross (SAE J1349) .. 119 kW (162 ps / 159 hp)
Max. torque 647 N·m (66 kg·m) at 1 425 rpm
No. of cylinders 6
Displacement 5,7 l
Bore 98 mm
Stroke 126 mm



ELECTRICAL SYSTEM

Well-protected electrical system with high capacity. Waterproof double-lock harness plugs are used to secure corrosion free connections. The main relays and solenoid valves are shielded to prevent damage. A master switch is standard.

Contronics, provides advanced monitoring of machine function and important diagnostic information.

Voltage 24 V
Batteries 2 x 12 V
Battery capacity 150 Ah
Alternator 28 V / 80 A



UNDERCARRIAGE

The undercarriage has a robust X-shaped frame, greased and sealed track chains are standard.

LC

No. of track shoes 2 x 49
Link pitch 190 mm
Shoe width, triple grouser 600 / 700 / 800 / 900 mm
No. of lower rollers 2 x 9
No. of top rollers 2 x 2

NLC

No. of track shoes 2 x 46
Link pitch 190 mm
Shoe width, triple grouser 600 / 700 / 800 / 900 mm
No. of lower rollers 2 x 7
No. of top rollers 2 x 2



DRIVE

Each track is powered by an automatic two-speed shift travel motor. The track brakes are multi-disc, spring-applied and hydraulic released. The travel motor, brake and planetary gears are well protected in the track frame.

Max. tractive effort 183 kN
Max. travel speed 3,2 / 5,5 km/h
Gradeability 35° (70%)



SLEW SYSTEM

The superstructure is slewed by the means of an axial piston motor and a planetary reduction gear. Automatic slew holding brake and anti-rebound valve are standard.

Max. slew speed 11,6 rpm



SERVICE REFILL CAPACITIES

Fuel tank 350 l
Hydraulic system, total 295 l
Hydraulic tank 160 l
Engine oil 25 l
Engine coolant 27,5 l
Slew reduction unit 6 l
Travel reduction unit 2 x 5,8 l

เอกสารประกอบการขายเพื่อแสดงระดับเสียงของเครื่องจักร (ต่อ)



HYDRAULIC SYSTEM

The hydraulic system, named "Automatic Sensing Work Mode", is designed for high-productivity, high-digging capacity, high-maneuvering precision and good fuel economy. The summation system, boom, arm and slew priority along with boom and arm regeneration are provides optimum performance.

The following important functions are included in the system:

Summation system: Combining the flow of both hydraulic pumps to ensure quick cycle times and high productivity.

Boom priority: Gives priority to the boom operation for faster raising when loading or deep excavation.

Arm priority: Gives priority to the arm operation for faster cycle times in leveling and for increased bucket filling when digging.

Slew priority: Supplies priority to the slew operation for faster slew simultaneous operations.

Regeneration system: Prevents cavitation and provides flow to other movements during simultaneous operations for maximum productivity.

Power boost: All digging and lifting forces are increased.

Holding valves: Boom and arm holding valves prevent the digging equipment from creeping.

Power Max: All function speeds are increased.

Main pump

Type 2 x variable displacement axial piston pumps
Maximum flow 2 x 200 l/min

Pilot pump

Type Gear pump
Maximum flow 1 x 19 l/min

Hydraulic motors

Travel Variable displacement axial piston motors
Slew Fixed displacement axial piston motor with mechanical brake

Relief valve setting

Implement 32,4 / 34,3 Mpa
Travel circuit 34,3 Mpa
Slew circuit 26,5 Mpa
Pilot circuit 3,9 Mpa

Hydraulic cylinders

Monoblock boom 2
bore x stroke #125 x 1 235 mm
1st boom of 2-piece boom 2
bore x stroke #125 x 1 235 mm
2nd boom of 2-piece boom 1
bore x stroke #160 x 1 070 mm
Arm 1
bore x stroke #135 x 1 540 mm
Bucket 1
bore x stroke #120 x 1 060 mm



CAB

The operator's cab has easy access via a wide door opening. The cab is supported on hydraulic dampening mounts to reduce shock and vibration levels. These along with a sound absorbing lining provide low noise levels. The cab has excellent all-round visibility. The front windshield can easily slide up into the ceiling, and the lower front glass can be removed and stored. The glass is stored in the door.

Integrated air conditioning and heating system:

The pressurized and filtered cab air is supplied by automatically controlled fan. The air is distributed via 13 vents.

Ergonomic operator's seat: The adjustable seat and joystick consoles move independently to accommodate the operator. The seat has nine different adjustments and a seat belt to meet any operator's comfort and safety.

Sound Level:

Sound level in cab
according to ISO 6396 LpA 72 dB(A)
External sound level
according to ISO 6395 LwA 102 dB(A)
(Directive 2000/14/EC)



GROUND PRESSURE

• Long crawler machine with 5,7 m monoblock boom, 2,9 m arm, 920 l (740 kg) bucket and 4 200 kg counterweight

Description	Shoe width	Operating weight	Ground pressure	Overall width
Triple grouser	600 mm	21 340 kg	44,3 kPa	2 990 mm
	700 mm	21 790 kg	38,7 kPa	3 090 mm
	800 mm	22 060 kg	34,3 kPa	3 190 mm
	900 mm	22 340 kg	30,9 kPa	3 290 mm

• Narrow long crawler machine with 5,7 m monoblock boom, 2,9 m arm, 920 l (740 kg) bucket and 4 200 kg counterweight

Description	Shoe width	Operating weight	Ground pressure	Overall width
Triple grouser	600 mm	20 870 kg	46,7 kPa	2 800 mm
	700 mm	21 290 kg	40,9 kPa	2 900 mm
	800 mm	21 550 kg	36,2 kPa	3 000 mm
	900 mm	21 820 kg	32,6 kPa	3 100 mm

Sound Level:

Sound level in cab
according to ISO 6396 LpA 72 dB(A)
External sound level
according to ISO 6395 LwA 102 dB(A)
(Directive 2000/14/EC)

เอกสารประกอบการขายเพื่อแสดงระดับเสียงของเครื่องจักร (ต่อ)

MAX. PERMITTED BUCKETS

Note: 1. Bucket size based on SAE-J296, heaped material with a 1:1 angle of repose.
2. "Max permitted sizes" are for reference only and are not necessarily available from the factory.

- Max. permitted sizes for direct fit buckets:
Long crawler machine with counterweight 4 200 kg *

Description	Unit	5,7 m Boom		
		2,5 m Arm	2,9 m Arm	3,9 m Arm
GP bucket 1,5 t/m³	I	1 550	1 450	1 250
GP bucket 1,8 t/m³	I	1 350	1 275	1 100
RB bucket 1,8 t/m³	I	1 200	1 125	950
RB bucket 2,0 t/m³	I	1 100	1 025	900

- Max. permitted sizes for quick fit buckets:
Long crawler machine with counterweight 4 200 kg *

Description	Unit	5,7 m Boom		
		2,5 m Arm	2,9 m Arm	3,9 m Arm
GP bucket 1,5 t/m³	I	1 475	1 375	1 175
GP bucket 1,8 t/m³	I	1 300	1 200	1 025
RB bucket 1,8 t/m³	I	1 300	1 200	1 025
RB bucket 2,0 t/m³	I	1 150	1 075	900

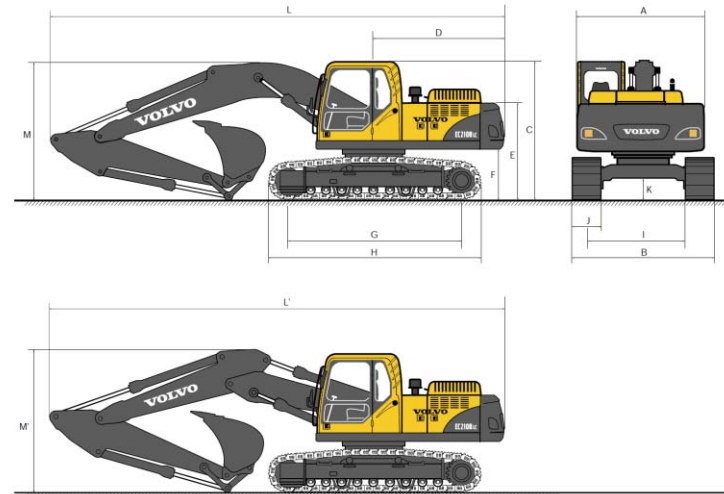
- Max. permitted sizes for direct fit buckets:
Narrow long crawler machine with counterweight 4 200 kg

Description	Unit	5,7 m Boom		
		2,5 m Arm	2,9 m Arm	3,9 m Arm
GP bucket 1,5 t/m³	I	1 375	1 300	1 125
GP bucket 1,8 t/m³	I	1 200	1 125	975
RB bucket 1,8 t/m³	I	1 075	1 000	850
RB bucket 2,0 t/m³	I	1 000	925	800

- Max. permitted sizes for quick fit buckets:
Narrow long crawler machine with counterweight 4 200 kg

Description	Unit	5,7 m Boom		
		2,5 m Arm	2,9 m Arm	3,9 m Arm
GP bucket 1,5 t/m³	I	1 325	1 225	1 050
GP bucket 1,8 t/m³	I	1 150	1 075	925
RB bucket 1,8 t/m³	I	1 025	950	800
RB bucket 2,0 t/m³	I	950	875	750

DIMENSIONS



- Long crawler machine

Description	Unit	5,7 m Boom		
		2,5 m Arm	2,9 m Arm	3,9 m Arm
A. Overall width of superstructure	mm	2 700	2 700	2 700
B. Overall width	mm	2 990	2 990	2 990
C. Overall height of cab	mm	2 930	2 930	2 930
D. Tail slew radius	mm	2 750	2 750	2 750
E. Overall height of engine hood	mm	2 330	2 330	2 330
F. Counterweight clearance *	mm	1 025	1 025	1 025
G. Tumbler length	mm	3 660	3 660	3 660
H. Track length	mm	4 460	4 460	4 460
I. Track gauge	mm	2 390	2 390	2 390
J. Shoe width	mm	600	600	600
K. Min. ground clearance *	mm	460	460	460
L. Overall length	mm	9 750	9 690	9 670
L': Overall length	mm	9 510	9 470	9 370
M. Overall height of boom	mm	3 120	3 000	3 550
M': Overall height of boom	mm	3 040	2 960	3 630

* Without shoe grouser

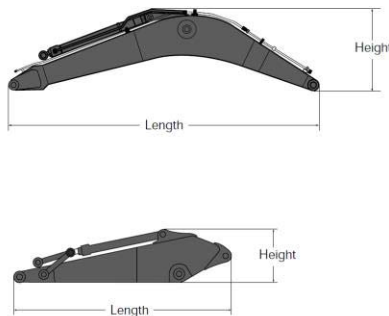
เอกสารประกอบการขายเพื่อแสดงระดับเสียงของเครื่องจักร (ต่อ)

DIMENSIONS

• Narrow long crawler machine

Description	Unit	5,7 m Boom		
		2,5 m Arm	2,9 m Arm	3,9 m Arm
A. Overall width of superstructure	mm	2 700	2 700	2 700
B. Overall width	mm	2 800	2 800	2 800
C. Overall height of cab	mm	2 930	2 930	2 930
D. Tail slew radius	mm	2 750	2 750	2 750
E. Overall height of engine hood	mm	2 330	2 330	2 330
F. Counterweight clearance *	mm	1 025	1 025	1 025
G. Tumbler length	mm	3 370	3 370	3 370
H. Track length	mm	4 170	4 170	4 170
I. Track gauge	mm	2 200	2 200	2 200
J. Shoe width	mm	600	600	600
K. Min. ground clearance *	mm	460	460	460
L. Overall length	mm	9 750	9 690	9 670
L'. Overall length	mm	9 610	9 570	9 470
M. Overall height of boom	mm	3 120	3 000	3 550
M'. Overall height of boom	mm	3 040	2 960	3 630

* Without shoe grouser



• Boom

Description	5,7 m	5,57 m 2-piece
Length	5 910 mm	5 780 mm
Height	1 585 mm	1 570 mm
Width	670 mm	670 mm
Weight	1 785 kg	2 090 kg

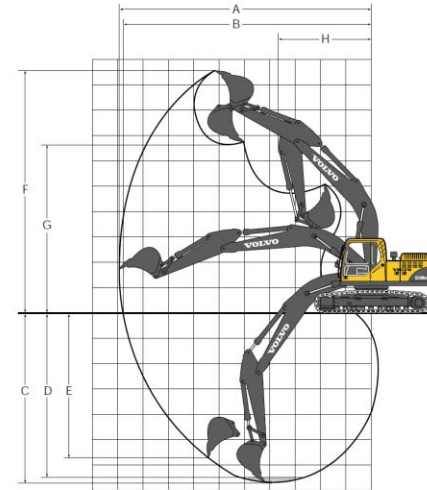
* Includes cylinder, pin and piping

• Arm

Description	2,5 m	2,9 m	3,9 m
Length	3 530 mm	3 900 mm	4 940 mm
Height	880 mm	880 mm	820 mm
Width	440 mm	440 mm	440 mm
Weight	975 kg	1 000 kg	1 135 kg

* Includes cylinder, piping and linkage

WORKING RANGES & DIGGING FORCES



• 5,7 m monoblock boom with direct fit bucket:

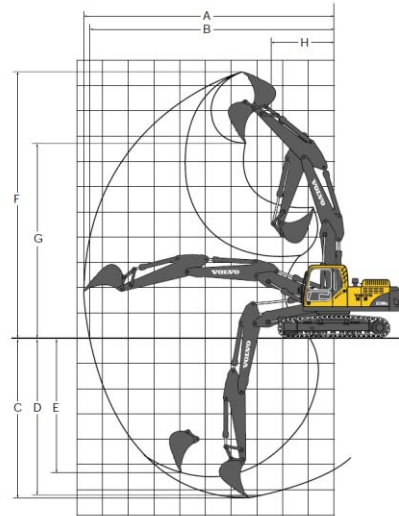
Description	Unit	5,7 m Boom		
		2,5 m Arm	2,9 m Arm	3,9 m Arm
A. Max. digging reach	mm	9 540	9 940	10 760
B. Max. digging reach on ground	mm	9 350	9 750	10 610
C. Max. digging depth	mm	6 330	6 730	7 730
D. Max. digging depth	mm	6 110	6 510	7 550
E. Max. vertical wall digging depth	mm	5 520	5 830	6 570
F. Max. cutting height	mm	9 220	9 450	9 620
G. Max. dumping height	mm	6 430	6 650	6 850
H. Min. front slew radius	mm	3 670	3 650	3 640

• Digging forces with direct fit bucket

Description	Unit	5,7 m Boom		
		2,5 m Arm	2,9 m Arm	3,9 m Arm
Bucket radius	mm	1 470	1 470	1 470
Breakout force – bucket (Normal / Power boost)	SAE kN	122,6 / 130,4	122,6 / 130,4	122,6 / 130,4
Breakout force – bucket (Normal / Power boost)	ISO kN	136,3 / 147,1	136,3 / 147,1	136,3 / 147,1
Tearout force – arm (Normal / Power boost)	SAE kN	110,4 / 117,2	95,6 / 103,0	80,2 / 86,3
Tearout force – arm (Normal / Power boost)	ISO kN	113,7 / 120,7	98,2 / 104,9	81,9 / 88,3
Rotation angle, bucket	deg	175	175	174

เอกสารประกอบการขายเพื่อแสดงระดับเสียงของเครื่องจักร (ต่อ)

WORKING RANGES & DIGGING FORCES



• 5,57 m 2-piece boom with direct fit bucket:

Description	Unit	5,57 m 2-piece boom		
		2,5 m Arm	2,9 m Arm	3,9 m Arm
A. Max. digging reach	mm	9 450	9 840	10 680
B. Max. digging reach on ground	mm	9 280	9 680	10 530
C. Max. digging depth	mm	5 930	6 300	7 240
D. Max. digging depth	mm	5 820	6 200	7 150
E. Max. vertical wall digging depth	mm	4 910	5 320	6 180
F. Max. cutting height	mm	10 390	10 710	11 180
G. Max. dumping height	mm	7 470	7 780	8 270
H. Min. front slew radius	mm	2 740	2 440	2 840

• Digging forces with direct fit bucket

Description	Unit	5,57 m 2-piece boom		
		2,5 m Arm	2,9 m Arm	3,9 m Arm
Bucket radius	mm	1 470	1 470	1 470
Breakout force – bucket (Normal / Power boost)	SAE kN	122,6 / 130,4	122,6 / 130,4	122,6 / 130,4
Breakout force – bucket (Normal / Power boost)	ISO kN	136,3 / 147,1	136,3 / 147,1	136,3 / 147,1
Tearout force – arm (Normal / Power boost)	SAE kN	110,4 / 117,2	95,6 / 103,0	80,2 / 86,3
Tearout force – arm (Normal / Power boost)	ISO kN	113,7 / 120,7	98,2 / 104,9	81,9 / 88,3
Rotation angle, bucket	deg	175	175	174

LIFTING CAPACITY (At the arm and without bucket)

Note: For lifting capacity including bucket, simply subtract actual weight of the direct fit bucket or the bucket with quick fit from the following values.

EC210B LC

	Lifting hook related to ground level	3,0 m		4,5 m		6,0 m		7,5 m		9,0 m		Max. reach	
		Along undercarriage	Across undercarriage	Along undercarriage	Across undercarriage	Along undercarriage	Across undercarriage	Along undercarriage	Across undercarriage	Along undercarriage	Across undercarriage	Along undercarriage	Across undercarriage
with 600 mm shoe 4 200 kg CWT monoblock boom 5,7 m + Arm 2,5 m	6,0 m kg					*5 190	*5 190					*5 280	4 220 6 850
	4,5 m kg			*6 610	*6 610	*5 680	5 130	*5 360	3 590			*5 360	3 520 7 590
	3,0 m kg			*8 500	7 420	*6 510	4 890	5 420	3 500			4 910	3 180 7 980
	1,5 m kg			*10 140	6 940	7 350	4 660	5 300	3 400			4 750	3 050 8 070
	0 m kg			*10 880	6 730	7 230	4 500	5 220	3 320			4 870	3 110 7 870
	-1,5 m kg	*9 840	*9 840	*10 800	6 690	7 180	4 460					5 350	3 400 7 360
with 600 mm shoe 4 200 kg CWT monoblock boom 5,7 m + Arm 2,9 m	-3,0 m kg	*13 870	13 270	*9 930	6 790	7 260	4 520					*6 520	4 110 6 460
	-4,5 m kg	*10 700	*10 700	*7 650	7 070							*6 720	6 150 4 960
	6,0 m kg					*4 800	*4 800					*4 160	3 850 7 300
	4,5 m kg					*5 340	5 200	*5 040	3 650			*4 110	3 270 8 000
	3,0 m kg			*7 950	7 570	*6 210	4 950	*5 420	3 540			*4 220	2 970 8 370
	1,5 m kg			*9 750	7 040	*7 120	4 700	5 320	3 420			4 440	2 860 8 460
with 600 mm shoe 4 200 kg CWT monoblock boom 5,7 m + Arm 3,9 m	0 m kg	*4 920	*4 920	*10 740	6 760	7 260	4 520	5 220	3 330			4 540	2 910 8 270
	-1,5 m kg	*9 380	*9 380	*10 890	6 680	7 170	4 450	5 190	3 300			4 930	3 140 7 780
	-3,0 m kg	*14 700	13 140	*10 260	6 740	7 210	4 480					5 850	3 710 6 940
	-4,5 m kg	*11 950	*11 950	*8 490	6 950							*6 490	5 150 5 570
	6,0 m kg							*4 010	3 820			*3 230	3 210 8 250
	4,5 m kg							*4 270	3 740			*3 220	2 790 8 870
with 600 mm shoe 4 200 kg CWT monoblock boom 5,7 m + Arm 3,9 m	3,0 m kg			*6 410	*6 410	*5 300	5 080	*4 750	3 600	*3 980	2 670	*3 320	2 560 9 210
	1,5 m kg			*8 150	*8 150	*8 470	7 250	*6 350	4 770	*5 320	3 440	*5 530	2 460 9 280
	0 m kg			*6 940	*6 940	*9 990	6 790	*7 240	4 520	5 200	3 300	3 900	2 480 9 110
	-1,5 m kg	*9 110	*9 110	*10 700	6 570	7 100	4 370	5 100	3 210			4 150	2 630 8 680
	-3,0 m kg	*12 770	12 700	*10 640	6 540	7 050	4 330	5 090	3 200			4 710	2 980 7 930
	-4,5 m kg	*14 180	12 980	*9 720	6 650	*7 120	4 410					5 990	3 760 6 770
with 600 mm shoe 4 200 kg CWT 2-piece boom 5,57 m + Arm 2,5 m	6,0 m kg					*7 590	*7 590	*6 670	5 260			*5 660	4 300 6 740
	4,5 m kg					*12 070	*12 070	*8 580	8 020	*6 990	5 100	5 500	3 550 7 490
	3,0 m kg					*9 950	7 410	*7 530	4 860	5 400	3 470	4 980	3 200 7 880
	1,5 m kg					*10 850	6 900	7 400	4 620	5 280	3 360	4 820	3 070 7 970
	0 m kg					*10 690	6 670	7 220	4 460	5 210	3 290	4 950	3 140 7 770
	-1,5 m kg	*10 430	*10 430	*9 580	6 630	7 170	4 420					*5 420	3 440 7 250
with 600 mm shoe 4 200 kg CWT 2-piece boom 5,57 m + Arm 2,9 m	-3,0 m kg			*7 450	6 750	*5 400	4 510					*4 770	4 210 6 340
	-4,5 m kg												
	6,0 m kg					*6 440	*6 440	*6 350	5 350			*4 140	3 910 7 200
	4,5 m kg			*8 270	*8 270	*8 130	*8 130	*6 730	5 190	5 560	3 610	*4 050	3 290 7 900
	3,0 m kg					*9 570	7 570	*7 330	4 930	5 450	3 510	*4 140	2 990 8 280
	1,5 m kg					*10 690	7 010	7 450	4 660	5 310	3 380	*4 400	2 870 8 360
with 600 mm shoe 4 200 kg CWT 2-piece boom 5,57 m + Arm 3,9 m	0 m kg			*5 400	*5 400	*10 830	6 700	7 240	4 480	5 210	3 290	4 610	2 920 8 170
	-1,5 m kg			*9 860	*9 860	*9 990	6 620	7 160	4 400	5 190	3 270	5 020	3 170 7 680
	-3,0 m kg			*10 440	*10 440	*8 170	6 690	*6 060	4 450			*4 740	3 770 6 820
	-4,5 m kg												
	6,0 m kg							*4 850	*4 850	*4 350	3 800	*3 210	*3 210 8 160
	4,5 m kg					*5 070	*5 070	*5 430	5 370	*5 090	3 720	*3 180	2 800 8 790
with 600 mm shoe 4 200 kg CWT 2-piece boom 5,57 m + Arm 3,9 m	3,0 m kg			*12 130	*12 130	*8 360	7 940	*6 650	5 070	5 530	3 570	*3 260	2 570 9 120
	1,5 m kg			*9 430	*9 430	*9 890	7 240	*7 370	4 750	5 350	3 410	4 030	2 560 9 200
	0 m kg			*7 400	*7 400	*10 700	6 750	7 270	4 480	5 190	3 260	3 960	2 480 9 030
	-1,5 m kg			*9 530	*9 530	*10 530	6 510	7 090	4 330	5 100	3 180	4 200	2 640 8 590
	-3,0 m kg			*13 220	12 600	*9 420	6 480	*7 000	4 290	5 100	3 180	*4 660	3 010 7 840
	-4,5 m kg					*7 170	6 620	*5 160	4 390			*4 170	3 830 6 660

Notes: 1. Machine in "Fine Mode-F" (Power Boost), for lifting capacities.
2. The above loads are in compliance with SAE and ISO Hydraulic Excavator Lifting Capacity Standards.
3. Rated loads do not exceed 87% of hydraulic lifting capacity or 75% of tipping load.
4. Rated loads marked with an asterisk (*) are limited by hydraulic capacity rather than tipping load.

เอกสารประกอบการขายเพื่อแสดงระดับเสียงของเครื่องจักร (ต่อ)

LIFTING CAPACITY (At the arm and without bucket)

Note: For lifting capacity including bucket, simply subtract actual weight of the direct fit bucket or the bucket with quick fit from the following values.

EC210B NLC

	Lifting hook related to ground level	3,0 m		4,5 m		6,0 m		7,5 m		9,0 m		Max. reach	
		Along undercarriage	Across undercarriage	Along undercarriage	Across undercarriage	Along undercarriage	Across undercarriage	Along undercarriage	Across undercarriage	Along undercarriage	Across undercarriage	Along undercarriage	Across undercarriage
with 600 mm shoe 4 200 kg CWT monoblock boom 5,7 m + Arm 2,5 m	6,0 m	kg				5 190	4 790					5 280	3 820
	4,5 m	kg		6 610	6 610	5 680	4 630	4 900	3 240			4 800	3 170
	3,0 m	kg		8 500	6 640	6 510	4 400	4 810	3 150			4 360	2 860
	1,5 m	kg			10 130	6 180	6 520	4 170	4 690	3 050		4 210	2 740
	0 m	kg			9 880	5 970	6 350	4 020	4 610	2 980		4 310	2 790
	-1,5 m	kg	9 840	9 840	9 840	5 930	6 300	3 980				4 730	3 050
with 600 mm shoe 4 200 kg CWT monoblock boom 5,7 m + Arm 2,9 m	6,0 m	kg											
	4,5 m	kg				7 950	6 780	6 210	4 460	4 850	3 190	4 070	2 670
	3,0 m	kg				9 750	6 270	6 570	4 220	4 720	3 070	3 940	2 570
	1,5 m	kg					4 920	4 920	9 910	6 000	6 370	4 020	2 600
	0 m	kg					9 380	9 380	9 820	5 920	6 290	4 360	2 810
	-1,5 m	kg					11 410	9 890	5 980	6 330	4 000	5 160	3 320
with 600 mm shoe 4 200 kg CWT monoblock boom 5,7 m + Arm 3,9 m	6,0 m	kg											
	4,5 m	kg											
	3,0 m	kg											
	1,5 m	kg											
	0 m	kg											
	-1,5 m	kg											
with 600 mm shoe 4 200 kg CWT monoblock boom 5,7 m + Arm 2,5 m	6,0 m	kg											
	4,5 m	kg											
	3,0 m	kg											
	1,5 m	kg											
	0 m	kg											
	-1,5 m	kg											
with 600 mm shoe 4 200 kg CWT monoblock boom 5,7 m + Arm 2,9 m	6,0 m	kg											
	4,5 m	kg											
	3,0 m	kg											
	1,5 m	kg											
	0 m	kg											
	-1,5 m	kg											
with 600 mm shoe 4 200 kg CWT monoblock boom 5,7 m + Arm 3,9 m	6,0 m	kg											
	4,5 m	kg											
	3,0 m	kg											
	1,5 m	kg											
	0 m	kg											
	-1,5 m	kg											
with 600 mm shoe 4 200 kg CWT monoblock boom 5,7 m + Arm 2,5 m	6,0 m	kg											
	4,5 m	kg											
	3,0 m	kg											
	1,5 m	kg											
	0 m	kg											
	-1,5 m	kg											
with 600 mm shoe 4 200 kg CWT monoblock boom 5,7 m + Arm 2,9 m	6,0 m	kg											
	4,5 m	kg											
	3,0 m	kg											
	1,5 m	kg											
	0 m	kg											
	-1,5 m	kg											
with 600 mm shoe 4 200 kg CWT monoblock boom 5,7 m + Arm 3,9 m	6,0 m	kg											
	4,5 m	kg											
	3,0 m	kg											
	1,5 m	kg											
	0 m	kg											
	-1,5 m	kg											

- Notes: 1. Machine in "Fine Mode-F" (Power Boost), for lifting capacities.
2. The above loads are in compliance with SAE and ISO Hydraulic Excavator Lifting Capacity Standards.
3. Rated loads do not exceed 87% of hydraulic lifting capacity or 75% of tipping load.
4. Rated loads marked with an asterisk (*) are limited by hydraulic capacity rather than tipping load.

STANDARD EQUIPMENT

Engine Turbocharged, 4 stroke diesel engine with water cooling, direct injection and charged air cooler that meets EU Step 2 requirements 3-stage air filter with indicator, including pre-cleaner Block heater, 240 V Air intake heater Electric engine shut-off Fuel filter and water separator Fuel filter pump: 50 l/min with automatic shut-off Coolant filter Alternator, 80 A	Automatic idling system One-touch power boost Safety stop/start function Adjustable monitor Master switch Engine restart prevention circuit High capacity halogen lights: <ul style="list-style-type: none">– Frame mounted 2– Boom mounted 2 Batteries, 2 x 12 V / 150 Ah Start motor, 24 V / 4,8 kW	Control joystick, with 5 switches each Auxiliary hydraulic valve Straight travel circuit Automatic two-speed travel motors Hydraulic oil, ISO VG 46	<ul style="list-style-type: none">– Door locks– Tinted glass– Floor mat– Horn– Large storage area– Pull-up type front window– Removable lower windshield– Seat belt– Safety glass– Windshield wiper with intermittent feature– Stereo cassette radio Anti-vandalism kit assembly preparation Sun shield, front, roof, rear Master ignition key
Electric / Electronic control system Contronics <ul style="list-style-type: none">– Advanced mode control system– Self-diagnostic system Machine status indication Engine speed sensing power control "Power Max" mode system	Hydraulic system Automatic hydraulic system <ul style="list-style-type: none">– Summation system– Boom priority– Arm priority– Slew priority Boom and arm regeneration valves Slew anti-rebound valves Boom and arm holding valves Multi-stage filtering system Cylinder cushioning Cylinder contamination seals	Superstructure Access way with handrail Tool storage area Punched metal anti-slip plates Counterweight, 4 200 kg Undercover (2,3 mm)	Cab and interior Heater & air-conditioner, automatic Hydraulic dampening cab mounts Adjustable operator seat and joystick control console Flexible antenna Hydraulic safety lock lever Cab, all-weather sound suppressed, includes: <ul style="list-style-type: none">– Ashtray– Cup holder– Lighter
			Undercarriage Hydraulic track adjusters Greased and sealed track chain Track guards Undercover (heavy duty 10 mm)
			Service Tool kit, daily maintenance

ALTERNATIVE EQUIPMENT

Cab and interior Seat: – Fabric seat – Fabric seat, with heater – Fabric seat, with heater and air suspension	Track shoes 600/700/800/900 mm track shoes with triple grousers	Digging equipment Boom: 5,7 m monoblock 5,57 m 2-piece Arm: 2,5 / 2,9 / 3,9 m	Undercarriage LC (Long crawler) NLC (Narrow long crawler)
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OPTIONAL EQUIPMENT (Standard in certain markets)

Engine Diesel coolant heater Tropical cooling kit	Hydraulic system Hose rupture valve: boom, arm Control joystick, with 3 switches each Pump flow control for hammer & shears Hydraulic piping – Hammer & shears: 1 pump flow 2 pump flow Additional return filter Extra piping for slope & rotator – Slope & rotator – Grapple – Oil leak (drain) line – Quick fit piping Volvo hydraulic quick-fit, S1 size Hydraulic oil, ISO VG 32 Hydraulic oil, ISO VG 68 Hydraulic oil, biodegradable 32 Hydraulic oil, biodegradable 46 Boom floating function	Superstructure Undercover (heavy duty 4,5 mm)	Digging equipment Long last bushing
Electric Extra lamps: – Cab-mounted 3, (front 2, rear 1) – Counterweight-mounted 1 Overload warning device Rotating warning beacon Travel alarm	Cab and interior Falling object guard (FOG) Cab mounted falling object protective structures (FOPS) Rain shield, front Sunlight protection, roof (steel) Safety net for front window Lower wiper Anti-vandalism kit Specific key	Undercarriage Full track guards	Service Tool kit, full scale

All products are not available in all markets. Under our policy of continuous improvement, we reserve the right to change specifications and designs without prior notice. The illustrations do not necessarily show the standard version of the machine.

VOLVO
Construction Equipment

Ref. 21 1 435 1641
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Volvo, Seoul

English, global
KOR



HYDRAULIC EXCAVATOR

- Model Code : ZX210-3 / ZX210LC-3 / ZX210LCN-3
- Engine Rated Power : 122 kW (164 HP)
- Operating Weight : ZX210-3 : 20 300 kg - 22 000 kg
ZX210LC-3 : 20 900 kg - 22 600 kg
ZX210LCN-3 : 21 000 kg - 22 100 kg
- Backhoe Bucket : SAE, PCSA Heaped : 0.51 - 1.20 m³
CECE Heaped : 0.45 - 1.00 m³

HITACHI

ZAXIS
210

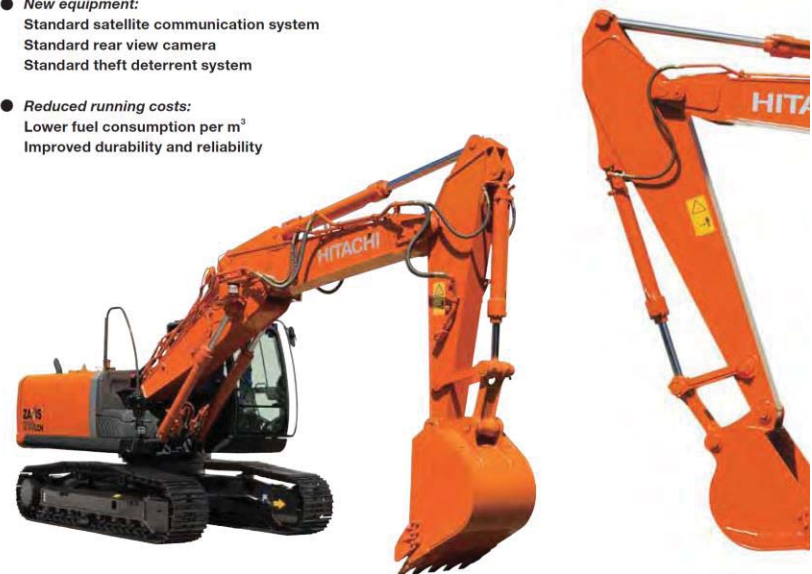
รถขุด (Back hoe) ของ HITACHI รุ่น ZAXIS 210

The Power to Perform

The ZAXIS-3 series is a new generation of excavators designed to provide more efficient power, productivity and improved operator comfort. By listening carefully to the wishes of the end-user, HITACHI not only understands your business, but also provides the reliable solutions you've been looking for.

NEW AND IMPROVED

- **Performance:**
12% higher production
- **Comfort:**
Excellent visibility
Enhanced controllability
Lower noise level
- **New equipment:**
Standard satellite communication system
Standard rear view camera
Standard theft deterrent system
- **Reduced running costs:**
Lower fuel consumption per m³
Improved durability and reliability



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Productivity

New E-mode
New hydraulic system HIOS III
Hydraulic boosting system
Enhanced boom recirculation system
New electronic controlled diesel engine
Page 4-5

Operator comfort

High visibility inside cab
Short stroke levers
Wide foot space
Comfort designed seat
Improved controllability and operator comfort
Page 6-7

Multi function monitor

Maintenance support
Attachment support system
Rear view camera
Theft deterrent system
Fuel consumption monitoring
Page 8-9

Durability and reliability

Strengthened undercarriage
Strengthened X beam
Improved idler brackets
Strengthened front attachment
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Maintenance

Conveniently located inspection points
Parallel arrangement of the cooling pack
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Safety measures

CRES II cab
Cab right protection bars
Pilot control shut-off lever
Engine shut-off switch
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Environment measures

Array of low noise mechanisms
Ecological design
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e-Service Owner's site

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Specifications

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- The new engine complies with the Emission Regulations EU Stage III A
- The advanced low noise design complies with the coming EU noise regulation 2000 / 14 / EC, STAGE II



Notes : Some of the pictures in this catalog show an unmanned machine with attachments in an operating position. These were taken for demonstration purposes only and the actions shown are not recommended under normal operating conditions.

3



Boosted Productivity

New hydraulic system HIOS III and new OHC 4-valve diesel engine were developed for ZAXIS-3. These advanced technologies are at work to yield bigger output with higher fuel efficiency.

4

More production, less fuel consumption

Increased Production

A combination of the hydraulic system (HIOS III) and new OHC** 4-valve engine allows the efficient use of hydraulic pressure to increase speeds of actuators and boost production with higher fuel efficiency. The productivity is increased 12% in comparison to previous model ZAXIS-1.

*Human & Intelligent Operation System
**OverHead Camshaft

New E-mode

The new E mode, H/P mode and P mode can be selected to suit job needs. The new E mode can save fuel consumption by up to 13% compared to the previous model's P mode, while yielding similar production.

Increase in Swing Torque and Traction Force

Swing torque and traction force are increased significantly.
-Swing torque 13% UP
-Traction force 11% UP
Sophisticated Travel Control; At climbing or steering, when the machine needs more traction force, the engine speed automatically increases which makes the machine faster.

Efficient hydraulic control - HIOS III

ZAXIS-1 adapted HIOS II hydraulic system that is suitable for fine controllability by the operators. Continuously HITACHI developed new advanced hydraulic technology HIOS III for ZAXIS-3. In addition to the fine controllability this new system increases the efficiency of hydraulic circuit and increases speed of actuators.

The Hydraulic Boosting System

In arm roll-in and boom raise operation, excess pressure oil is delivered from boom cylinder rod side to arm cylinder bottom side to increase flow rate for higher arm roll-in speed with 20%. Excess pressure oil from boom cylinder rod side is delivered to arm cylinder bottom side through a regenerative valve to increase flow rate for productive operation.

Enhanced Boom Recirculation System

In combined operation of boom lower and arm, pressure oil from boom cylinder bottom side is delivered to boom cylinder rod side, assisted by boom weight, for boom lowering. At the same time, pressure oil from the pump is delivered to the arm cylinder for arm movement. This mechanism allows an increase of speed in combined operation of 15%.

Development concept of new engine

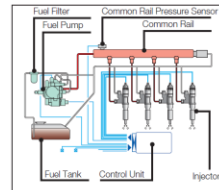
OHC 4-Valve Engine

The new OHC 4-valve diesel engine is developed and built to comply with the rigorous Emission Regulations enforced in 2006 in U.S and EU. This new engine contributes to environmental preservation. At the same time it realizes high durability and low fuel consumption by adapting the latest advanced engine technology.



Common Rail Type Fuel Injection System

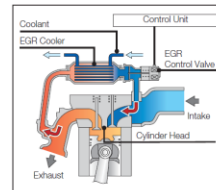
Electronic control common rail type fuel injection system drives an integrated fuel pump at an ultrahigh pressure to distribute fuel to each injector per cylinder through a common rail. This enables optimum combustion to generate big horsepower, and reduce PM* (diesel plume) and fuel consumption.



Cooled EGR** System

Exhaust gas is partially mixed with intake air to lower combustion temperature for reducing NOx and fuel consumption. What's more, the EGR cooler cools down exhaust gas to increase air concentration for complete combustion, reducing PM* (diesel plume).

*Particulate Matter
**Exhaust Gas Recirculation



5

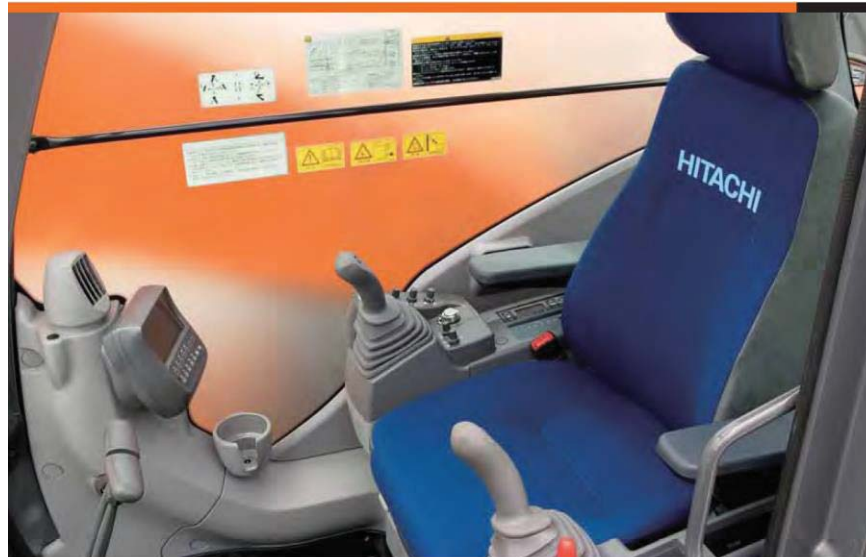
A New Standard in Operator Comfort

The operator's seat of the ZAXIS-3 series gives the operator an excellent view of the jobsite. On the widescreen colour LCD monitor the operator can see what is behind the machine. Ample legroom, short stroke levers and a large seat ensure optimum working conditions for the operator during long hours.



6

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The ZAXIS-3 series cab has been redesigned to meet demands of customers. From the operator's seat the operator has an excellent view of the jobsite. On the widescreen color LCD monitor the operator can see machine conditions and with the rear view camera, what is behind the machine. Ample legroom, short stroke levers and a suspension seat with heating ensure optimum working conditions. The seat features horizontal, vertical adjustments and has a backrest contoured for comfort, with a HITACHI logo.



Wide adjustable armrests and a retractable seat belt are included. Short stroke levers allow for continuous operation with less fatigue. Three switches on the lever (optional) can be set to operate attachments other than buckets. The cab is pressurized to keep out dust. Noise and vibrations are kept to a minimum due to the elastic mounts, filled with silicone oil, the cab rests on.

Visibility is improved especially for the right downward view. Sliding windows on the front and side enable direct communication between operator and other workers. Foot space has increased and travel pedals have been redesigned for easier operation. A flat floor allows for easy cleaning. Ergonomic controls and switches, fully automatic air conditioner and a radio complete the package.

Embedded Information Technology

The ZAXIS-3 series is equipped with a widescreen color LCD monitor with adjustable contrast for day and night shifts. With the monitor the operator can check maintenance intervals, select work modes, monitor fuel consumption, and connect to the rear view camera. A theft deterrent system and multi-language selection is also available.

Multi function monitor



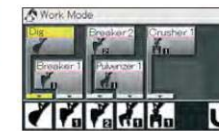
The color LCD monitor, located in the cab, indicates coolant temperature, fuel level, and maintenance data. It also allows one-touch adjustment of the attachment. The display can also be adjusted to day or night shift.

Maintenance support



Replacement timing of hydraulic oil and fuel filters is alerted to the operator through the LCD monitor according to the schedule preset by the user each time when turning the key switch. The scheduled maintenance can prevent the failure of the machine.

Attachment support system (work mode selector)



When replacing the attachment, oil flow adjustment can automatically be done by one touch on the work mode selection display on the LCD monitor. Minor adjustments of oil flow is possible if necessary.

Multi-language selection



The menu allows selection from 12 languages.



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Rear view camera



The widescreen color LCD, teamed up with the rear view camera on the counterweight provides rearward viewing. The rear view camera automatically works when traveling, and can also be manually turned on with a select switch on the monitor.

Theft deterrent system



The electronic immobiliser requires the entry of an encryption code to the multifunctional monitor each time when starting the engine to prevent theft and vandalism.

Fuel consumption monitoring

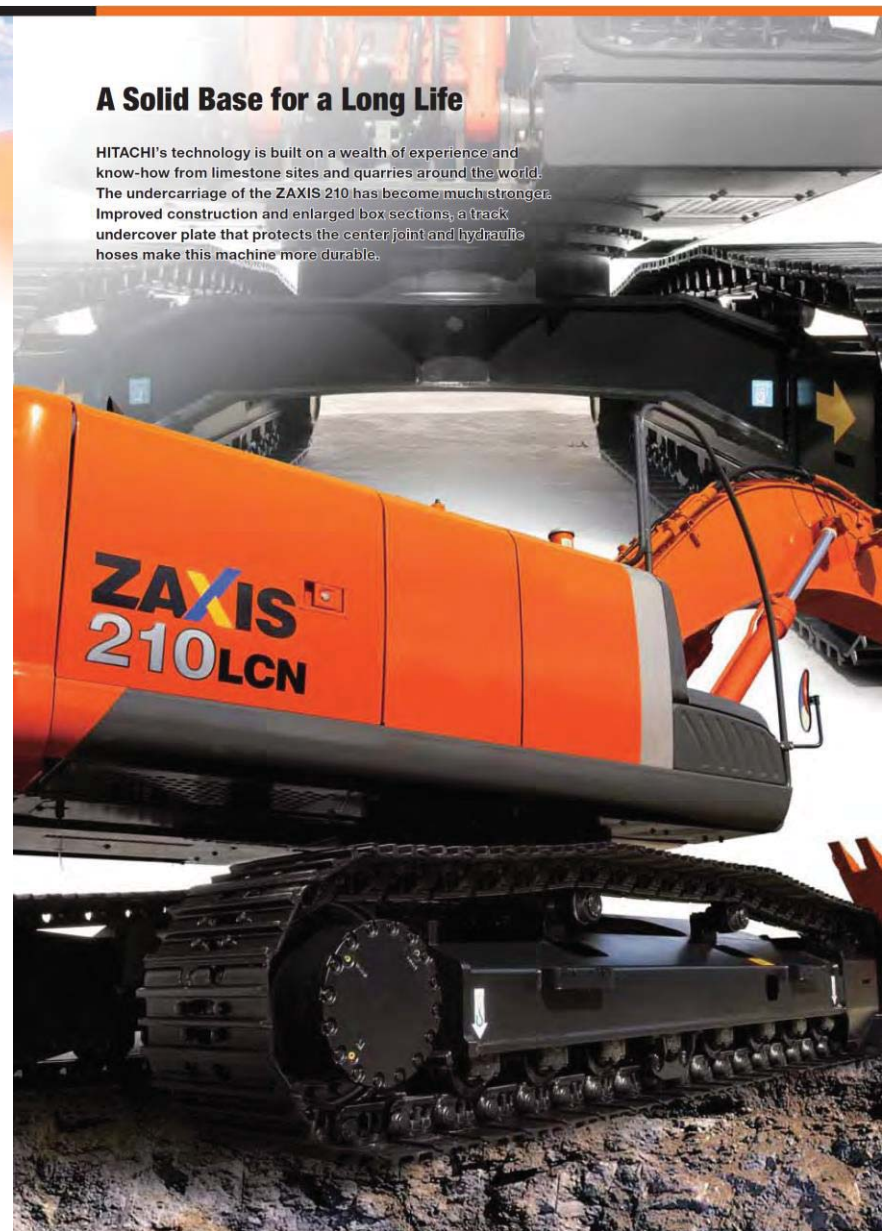


Fuel consumption per operating hour is computed, and the result is displayed on the LCD monitor. This information suggests refuelling timing, and guides energy-saving operation and efficient job management.

9

A Solid Base for a Long Life

HITACHI's technology is built on a wealth of experience and know-how from limestone sites and quarries around the world. The undercarriage of the ZAXIS 210 has become much stronger. Improved construction and enlarged box sections, a track undercover plate that protects the center joint and hydraulic hoses make this machine more durable.



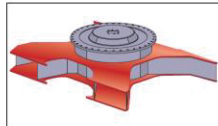
Strengthened undercarriage

Upper rollers and upper roller brackets are increased in size for higher durability. Track links are thickened and reshaped for higher durability and rigidity.



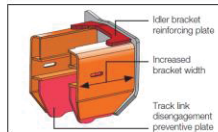
Strengthened X beam and side frames

The X-beam is strengthened by the improved construction and enlarged box sections. The section is increased in strength up to 35 % (maximum). Top and bottom plates of the X-beam use monolithic plates, instead of conventional welded four plates. This eliminates welding to strengthen the X-beam.



Improved idler brackets

The idler bracket reinforcing plate is thickened greatly for higher durability to prevent the opening of the idler bracket. The track link disengagement preventive plate, located immediately behind the idler bracket, extends its top to prevent track link disengagement and increase durability.



Strengthened front attachment

The boom top bracket is strengthened by using high-tensile steel.

At arm-bucket joint, the arm top is hardened with WC thermal spraying (Tungsten-Carbide) for greater wear resistance at its contact surface with bucket, reducing jerking. Reinforced resin thrust plates designed to reduce noise and resist wear.

The new HN bushings, containing "solid molybdenum-based lubricant", are utilized at the boom-arm joint and arm cylinder mounting area for better lubrication and higher durability. (At other joints, conventional HN bushings are also utilized.)

The boom foot is enlarged for higher strength. This improvement increases the durability and reliability under heavy-duty operation.



WC Thermal spraying



Reinforced resin thrust plates

Simplified Maintenance

The ZAXIS-3 series meet customer demands for simplified maintenance. Regular maintenance is the key for keeping equipment in top condition, which can help to prevent costly downtime. In addition, a regular serviced machine has higher residual value. There are many service features to be found on the ZAXIS-3 series.



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Conveniently located inspection points



Wide doors give access, from ground level, to the fuel filter, water separator and engine oil filter. A large handrail, steps and anti-skid plates lead to the engine cover. The engine oil pan is fitted with a drain coupler. When draining, an associated drain hose is connected to the drain coupler. The drain coupler is reliable, avoiding oil leakage and vandalism.

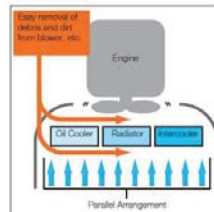


The fresh air filter for the air conditioner is relocated to cab door side from conventional location behind the operator seat. This allows easy cleaning and replacement of the fresh air filter, like the air circulation filter inside the cab.

Parallel arrangement of the cooling pack



The oil cooler, radiator and intercooler are laid out in a parallel arrangement, instead of the conventional in-line arrangement. This parallel arrangement is significantly easier to clean around the engine. The air conditioner condenser can be opened for easy cleaning of the condenser and the radiator located behind.



Extended oil and filter change intervals

Front Pin Lubricating Intervals and Consumables Replacement		
		New ZAXIS 210
Lubricant	Bucket	500 h
	Bloom Foot	500 h
	Front	500 h
Consumables	Engine Oil	500 h
	Engine Oil Filter	500 h
	Hydraulic Oil	5 000 h
	Hydraulic Oil Filter	1 000 h
	Fuel Filter	500 h

The oil and filter change intervals have been extended considerably, reducing maintenance time and expenses. Engine oil consumption is lower. Hydraulic oil can be used up to 5 000 hours.

Safety Features

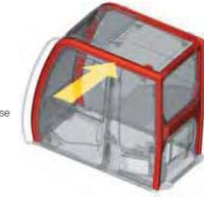
Ensuring the safety of the operator and other workers on the jobsite is an important concern for HITACHI. That is why the ZAXIS-3 series has a number of safety features including a new reinforced cab and shut-off mechanisms for engine and pilot controls.



CRES II cab

The CRES II cab is designed to help with "just in case" protection for the operator. Safety in case of tipping is improved. The cab top, for instance, can withstand about 2.5 times conventional load when side load is applied to the cab top until its deformation reaches 200 mm.

withstanding load : 2.5-fold increase



Additional features

Cab right protection bars



Evacuation hammer



Engine shut-off switch



Pilot control shut-off lever



FOPS guard



Retractable seat belt



Other features include a retractable seatbelt, evacuation hammer and emergency engine shut-off switch. A shut-off lever for pilot control helps to prevent unintentional movements. In addition a Falling Object Protective Structure (FOPS) guard is optionally available. For the cab windows there is a choice of laminated or tempered glass.

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Environmental Features

HITACHI takes its responsibility when it comes to the environment. Our production facilities have ISO 14001 certification. The HITACHI machine is lead free and has a low-noise design, therefore HITACHI customers get one of the most environmentally considerate hydraulic excavators available today.

A cleaner machine

The ZAXIS-3 series is equipped with a clean but powerful engine to comply with Tier 3, and Stage III A. An engine emission regulations effective in the U.S. EPA and European Union from 2006. Exhaust gas is partly re-combusted to reduce particulate matter (PM) output and lower nitrogen oxide (NOx) levels.



A quieter machine

A number of features make this machine quieter. First, isochronous control of the engine speed means a restriction of engine speed during no-load and light-duty operation to suppress sound. A fan with curved blades reduces air resistance and air flow noise. Third, a time-tested muffler suppresses engine noise significantly.



A recyclable machine

Over 97% of the ZAXIS-3 series can be recycled. All resin parts are marked to facilitate recycling. The machine is completely lead-free. The radiator and oil cooler are made from aluminium and all wires are lead-less. In addition, biodegradable hydraulic oil is available for jobsites where special environmental care is required.



Parts & Service

Over the years, we have gained experience in one of the most competitive service markets in the world - Japan. Using our know-how in dealing directly with customers, we have created a worldwide support system that is highly capable.

Parts

HITACHI only offers genuine high quality parts. We guarantee that these parts have high performance and long life. We manage around 1 000 000 types of parts all around the world. They are designed and built to be the best match for your HITACHI equipment. HITACHI has a global parts distribution network that makes sure you get what you need as quickly as possible. We have more than 150 dealers worldwide who provide the closest support for your needs.

In most cases, your dealer will have the replacement part that you require. If a dealer does not have a certain part, he can order it from four fully stocked parts depots located across the world. These distribution centres are all connected by an on-line system that gives them access to shared information on stocks, such as the number and type of available parts.

The depots, which in turn are stocked by a parts center in Japan, minimize delivery time and enable you to get your parts as efficiently and quickly as possible.

Service

Our goal is to "keep customer equipment at a maximum performance level". To fulfil this goal, we have set more than 150 dealers all over the world. They have highly trained technicians, and provide a number of support programs. HITACHI provides a unique extended warranty program called HITACHI Extended Life Program, or HELP.

To minimize downtime during troubleshooting, we developed a PDA based diagnostic system called "Dr.ZX". To keep our customers' equipment in top running shape, good service is indispensable. We believe personnel training is the key to providing the best service.

If you would like more information regarding parts and/or service, please ask your nearest HITACHI dealer. Not all programs and/or services are available in every market or region.

Remote fleet management with e-Service Owner's Site

Reduce maintenance effort and costs for your machine fleet with e-Service Owner's Site; latest machine information of each of your machines available on-line, in your office.

e-Service Owner's Site features

Operation

Remote access to all relevant machine operation information such as daily operating hours and machine fuel level as well as historically cumulated temperatures and pressures.



Maintenance

For each machine, maintenance history as well as recommended maintenance due is displayed in one view, allowing for accurate and efficient fleet maintenance management.



Location

In addition to any general GPS function, GIS (Geographical Information System) will not only show the geographical position of each machine with immediate serial number identification, it will also allow for dedicated multiple machine searches using specific operational information as search criteria.



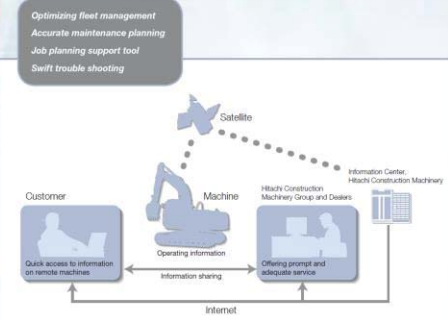
Check and monitor each of your machines from your office

Enhanced service support from your local dealer

Actual geographical location of each of your machines

e-Service Owner's Site is an on-line fleet management tool offered by HCME to each of its customers. It will present all operational information and location of your machines on a PC in your office, giving you an up to date overview of your machines, allowing for full fleet control. Each machine will regularly send its operational data to a satellite and from there, via a ground station to a Hitachi server. The data collected in the server will then be processed and directed to each customer around the world. Your machine information will be available through a secure internet connection for you and your dealer. This communication chain is operational 24h a day, each day of the year. It will support your job planning, help you maintain your machine and allow for enhanced service and trouble shooting support by your local dealer, all directly contributing to reduce downtime and increase the cost performance of your fleet.

All new ZAXIS-3 and ZW machines supplied by HCME will have a satellite communication unit installed as standard*, meaning each owner can directly enjoy the benefits of e-Service Owner's Site. Your local dealer will be able to give you access to e-Service Owner's Site.



* (1) Satellite communication may be forbidden by the local regulatory standards (including safety standards) and legal requirements of the particular country where you wish to use it. Please contact HITACHI dealer for details.
(2) Satellite communication basically allows for worldwide coverage. Contact your local dealer for the latest situation on actual satellite communication availability for your country or specific jobs.
(3) If transmission of the satellite signal is hindered in any way, satellite communication may not be possible.

EQUIPMENT

ENGINE

Model	Isuzu AI-4HK1X
Type	4-cycle water-cooled, direct injection
Aspiration	Turbocharged, intercooled
No. of cylinders	4
Rated power	
ISO 9249, net	122 kW (164 HP) at 2 000 min ⁻¹ (rpm)
EEC 80/1269, net ..	122 kW (164 HP) at 2 000 min ⁻¹ (rpm)
SAE J1349, net	122 kW (164 HP) at 2 000 min ⁻¹ (rpm)
Maximum torque	655 N·m (67 kgf·m) at 1 500 min ⁻¹ (rpm)
Piston displacement ..	5.193 L
Bore and stroke	115 mm x 125 mm
Batteries	2 x 12 V / 88 Ah

HYDRAULIC SYSTEM

- Work mode selector
 - Digging mode / Attachment mode
 - Engine speed sensing system
- | | |
|---------------------|--|
| Main pumps | 2 variable displacement axial piston pumps |
| Maximum oil flow .. | 2 x 212 L/min |
| Pilot pump | 1 gear pump |
| Maximum oil flow .. | 30 L/min |

Hydraulic Motors

Travel	2 variable displacement axial piston motors
Swing	1 axial piston motor

Relief Valve Settings

Implement circuit	34.3 MPa (350 kgf/cm ²)
Swing circuit	34.3 MPa (350 kgf/cm ²)
Travel circuit	34.3 MPa (350 kgf/cm ²)
Pilot circuit	3.9 MPa (40 kgf/cm ²)
Power boost	36.3 MPa (370 kgf/cm ²)

Hydraulic Cylinders

High-strength piston rods and tubes. Cylinder cushion mechanisms provided in boom and arm cylinders to absorb shock at stroke ends.

Dimensions

	Quantity	Bore	Rod diameter
Boom	2	120 mm	85 mm
Arm	1	135 mm	95 mm
Bucket	1	115 mm	80 mm
Positioning	1	150 mm	100 mm

Hydraulic Filters

Hydraulic circuits use high-quality hydraulic filters. A suction filter is incorporated in the suction line, and full-flow filters in the return line and swing/travel motor drain lines.

CONTROLS

Pilot controls. Hitachi's original shockless valve.

Implement levers	2
Travel levers with pedals	2

UPPERSTRUCTURE

Revolving Frame

Welded sturdy box construction, using heavy-gauge steel plates for ruggedness. D-section frame for resistance to deformation.

Swing Device

Axial piston motor with planetary reduction gear is bathed in oil. Swing circle is single-row, shear-type ball bearing with induction-hardened internal gear. Internal gear and pinion gear are immersed in lubricant. Swing parking brake is spring-set/hydraulic-released disc type.

Swing speed

Operator's Cab

Independent spacious cab, 1 005 mm wide by 1 675 mm high, conforming to ISO* Standards. Reinforced glass windows on 4 sides for visibility. Front windows (upper and lower) can be opened. Reclining seat with armrests; adjustable with or without control levers.

* International Standardisation Organisation

UNDERCARRIAGE

Tracks

Tractor-type undercarriage. Welded track frame using selected materials. Side frame welded to track frame. Lubricated track rollers, idlers, and sprockets with floating seals. Track shoes with triple grousers made of induction-hardened rolled alloy. Heat-treated connecting pins with dirt seals. Hydraulic (grease) track adjusters with shock-absorbing recoil springs.

Numbers of Rollers and Shoes on Each Side

Upper rollers	2
Lower rollers	7 : ZX210-3 8 : ZX210LC-3 / ZX210LCN-3
Track shoes	46 : ZX210-3 49 : ZX210LC-3 / ZX210LCN-3
Track guard	1

Travel Device

Each track driven by 2-speed axial piston motor through planetary reduction gear for counterrotation of the tracks. Sprockets are replaceable.

Parking brake is spring-set/hydraulic-released disc type. Travel shockless relief valve built in travel motor absorbs shocks when stopping travel. Automatic transmission system: High-Low.

Travel speeds

Maximum traction force ..

Gradeability

เอกสารประกอบการขายเพื่อแสดงระดับเสียงของเครื่องจักร (ต่อ)

ZAXIS 210

SPECIFICATIONS

WEIGHTS AND GROUND PRESSURE

ZX210-3 WITH MONOBLOCK BOOM:

Equipped with 5.68 m monoblock boom, 2.91 m arm and 0.80 m³ bucket (SAE, PCSA heaped).

Shoe type	Shoe width	Operating weight	Ground pressure
Triple grouser	600 mm	20 300 kg	45 kPa (0.46 kgf/cm ²)
	700 mm	20 700 kg	40 kPa (0.41 kgf/cm ²)
	800 mm	21 000 kg	35 kPa (0.36 kgf/cm ²)
	900 mm	21 500 kg	32 kPa (0.33 kgf/cm ²)

ZX210LC-3 WITH MONOBLOCK BOOM:

Equipped with 5.68 m monoblock boom, 2.91 m arm and 0.80 m³ bucket (SAE, PCSA heaped).

Shoe type	Shoe width	Operating weight	Ground pressure
Triple grouser	600 mm	20 900 kg	43 kPa (0.44 kgf/cm ²)
	700 mm	21 300 kg	38 kPa (0.39 kgf/cm ²)
	800 mm	21 600 kg	33 kPa (0.34 kgf/cm ²)
	900 mm	22 100 kg	30 kPa (0.31 kgf/cm ²)

ZX210LCN-3 WITH MONOBLOCK BOOM:

Equipped with 5.68 m monoblock boom, 2.91 m arm and 0.80 m³ bucket (SAE, PCSA heaped).

Shoe type	Shoe width	Operating weight	Ground pressure
Triple grouser	500 mm	21 000 kg	52 kPa (0.53 kgf/cm ²)

ZX210-3 WITH 2-PIECE BOOM:

Equipped with 2-piece boom, 2.03 m arm and 0.80 m³ bucket (SAE, PCSA heaped).

Shoe type	Shoe width	Operating weight	Ground pressure
Triple grouser	600 mm	20 900 kg	47 kPa (0.48 kgf/cm ²)
	700 mm	21 300 kg	41 kPa (0.42 kgf/cm ²)
	800 mm	21 600 kg	36 kPa (0.37 kgf/cm ²)
	900 mm	22 000 kg	32 kPa (0.33 kgf/cm ²)

ZX210LC-3 WITH 2-PIECE BOOM:

Equipped with 2-piece boom, 2.03 m arm and 0.80 m³ bucket (SAE, PCSA heaped).

Shoe type	Shoe width	Operating weight	Ground pressure
Triple grouser	600 mm	21 500 kg	44 kPa (0.45 kgf/cm ²)
	700 mm	21 900 kg	39 kPa (0.40 kgf/cm ²)
	800 mm	22 100 kg	34 kPa (0.35 kgf/cm ²)
	900 mm	22 600 kg	31 kPa (0.32 kgf/cm ²)

ZX210LCN-3 WITH 2-PIECE BOOM:

Equipped with 2-piece boom, 2.03 m arm and 0.80 m³ bucket (SAE, PCSA heaped).

Shoe type	Shoe width	Operating weight	Ground pressure
Triple grouser	500 mm	21 600 kg	54 kPa (0.55 kgf/cm ²)

Weight of the basic machines [including 4 750 kg or 5 500 kg counterweight and triple grouser shoes, excluding front-end attachment, fuel, hydraulic oil, engine oil and coolant etc.] are:

ZX210-3	15 900 kg with 600 mm shoes
ZX210LC-3	16 500 kg with 600 mm shoes
ZX210LCN-3	16 700 kg with 500 mm shoes

SERVICE REFILL CAPACITIES

Fuel tank	400.0 L
Engine coolant	26.0 L
Engine oil	23.0 L
Swing device	6.2 L
Travel device	6.8 L
(each side)	
Hydraulic system	240.0 L
Hydraulic oil tank	135.0 L

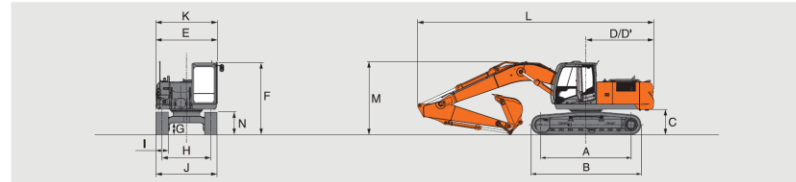
BACKHOE ATTACHMENTS

Boom and arms are of welded, box-section design. 5.68 m monoblock boom, 2-piece boom and 2.03 m, 2.42 m and 2.91 m arms are available.

BUCKETS

Capacity SAE, PCSA heaped	Width without side cutters	Weight
0.56 m ³	700 mm	498 kg
0.68 m ³	800 mm	548 kg
0.80 m ³	1 030 mm	660 kg
0.90 m ³	1 000 mm	608 kg
1.02 m ³	1 100 mm	658 kg
1.13 m ³	1 200 mm	688 kg
1.25 m ³	1 300 mm	718 kg

DIMENSIONS : MONOBLOCK BOOM

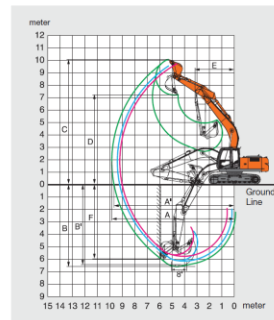


Unit: mm

	ZX210-3	ZX210LC-3	ZX210LCN-3
A Distance between tumbler	3 370	3 660	3 660
B Undercarriage length	4 170	4 460	4 460
* C Counterweight clearance	1 030	1 030	1 020
D Rear-end swing radius	2 750	2 750	2 750
D' Rear-end length	2 750	2 750	2 740
E Overall width of upperstructure	2 710	2 710	2 480
F Overall height of cab	2 950	2 950	2 950
* G Min. ground clearance	450	450	450
H Track gauge	2 200	2 390	1 980
I Track shoe width	G 600	G 600	G 500
J Undercarriage width	2 800	2 960	2 480
K Overall width	2 860	2 990	2 500
L Overall length			
With 2.03 m arm	9 610	9 610	9 680
With 2.42 m arm	9 610	9 610	9 680
With 2.91 m arm	9 520	9 520	9 580
M Overall height of boom			
With 2.03 m arm	3 150	3 150	3 150
With 2.42 m arm	3 180	3 180	3 180
With 2.91 m arm	2 940	2 940	2 940
N Track height with triple grouser shoes	920	920	920

* Excluding track shoe lug G: Triple grouser shoe

WORKING RANGES



Unit: mm

	ZX210-3 / ZX210LC-3 / ZX210LCN-3		
	5.68 m Monoblock boom		
Arm length	2.03 m	2.42 m	2.91 m
A Max. digging reach	9 300	9 500	9 990
A' Max. digging reach (on ground)	9 110	9 320	9 820
B Max. digging depth	5 800	6 180	6 670
B' Max. digging depth (B' level)	5 580	5 950	6 480
C Max. cutting height	9 850	9 670	10 040
D Max. dumping height	6 940	6 830	7 180
E Min. swing radius	3 480	3 350	3 250
F Max. vertical wall	5 210	5 300	5 990
Bucket digging force** ISO	151 kN (15 400 kgf)		
Bucket digging force** SAE : PCSA	129 kN (13 200 kgf)		
Arm crowd force** ISO	145 kN (14 800 kgf)	133 kN (13 600 kgf)	109 kN (11 100 kgf)
Arm crowd force** SAE : PCSA	134 kN (13 700 kgf)	124 kN (12 700 kgf)	102 kN (10 400 kgf)

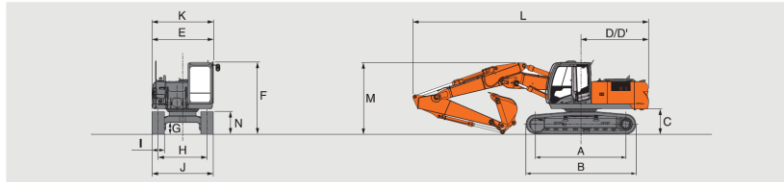
Excluding track shoe lug ** At power boost

เอกสารประกอบการขายเพื่อแสดงระดับเสียงของเครื่องจักร (ต่อ)

ZAXIS 210

LIFTING CAPACITIES

DIMENSIONS : 2-PIECE BOOM

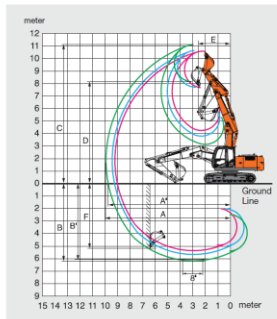


Unit: mm

	ZX210-3	ZX210LC-3	ZX210LCN-3
A Distance between tumbler	3 370	3 660	3 660
B Undercarriage length	4 170	4 460	4 460
C Counterweight clearance	1 030	1 030	1 020
D Rear-end swing radius	2 750	2 750	2 750
E Overall width of upperstructure	2 710	2 710	2 480
F Overall height of cab	2 950	2 950	2 950
G Min. ground clearance	450	450	450
H Track gauge	2 200	2 390	1 980
I Track shoe width	G 600	G 600	G 500
J Undercarriage width	2 800	2 990	2 480
K Overall width	2 860	2 990	2 500
L Overall length			
With 2.03 m arm	9 570	9 570	9 640
With 2.42 m arm	9 550	9 550	9 620
With 2.91 m arm	9 490	9 490	9 560
M Overall height of boom			
With 2.03 m arm	3 010	3 010	3 010
With 2.42 m arm	3 060	3 060	3 060
With 2.91 m arm	2 910	2 910	2 910
N Track height with triple grouser shoes	920	920	920

* Excluding track shoe lug G: Triple grouser shoe

WORKING RANGES

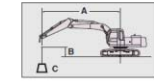


	ZX210-3 / ZX210LC-3 / ZX210LCN-3		
	2-piece boom		
Arm length	2.03 m	2.42 m	2.91 m
A Max. digging reach	9 280	9 500	10 000
A' Max. digging reach (on ground)	9 090	9 320	9 820
B Max. digging depth	5 420	5 720	6 230
B' Max. digging depth (B' level)	5 300	5 610	6 120
C Max. cutting height	10 590	10 640	11 080
D Max. dumping height	7 670	7 700	8 150
E Min. swing radius	2 700	2 700	2 390
F Max. vertical wall	4 560	4 720	5 280
Bucket digging force** ISO	151 kN (15 400 kgf)		
Bucket digging force** PCSA	129 kN (13 200 kgf)		
Arm crowd force** ISO	145 kN (14 800 kgf)	133 kN (13 600 kgf)	109 kN (11 100 kgf)
Arm crowd force** SAE : PCSA	134 kN (13 700 kgf)	124 kN (12 700 kgf)	102 kN (10 400 kgf)

Excluding track shoe lug ** At power boost

Metric measure

- Notes: 1. Ratings are based on ISO 10567.
2. Lifting capacity of the ZAXIS Series does not exceed 75% of tipping load with the machine on firm, level ground or 87% full hydraulic capacity.
3. The load point is the center-line of the bucket pivot mounting pin on the arm.
4. *Indicates load limited by hydraulic capacity.
5. 0 m = Ground.



A: Load radius
B: Load point height
C: Lifting capacity

ZX210-3 MONOBLOCK BOOM

Conditions	Load point height	Load radius						At max. reach		
		1.5	3.0	4.5	6.0	7.5		meter		
Boom 5.68 m	6.0 m			*6 251	*6 251	*5 880	4 701	*5 955	4 102	6.50
Arm 2.03 m	4.5 m			*7 491	7 005	*6 246	4 575	5 559	3 392	7.27
Counterweight 4 750 kg	3.0 m			*9 244	8 491	*6 640	4 370	4 752	3 170	7.67
Shoe 600 m	1.5 m					6 431	4 183	4 670	3 095	7.75
	0 (Ground)			9 770	6 001	6 311	4 075	4 628	3 066	7.54
	-1.5 m			9 788	6 016	6 298	4 063		5 116	6.99
	-3.0 m		*11 571	*11 571	*9 787	6 144	*6 205	4 187	*6 138	6.03
	-4.5 m									

Conditions	Load point height	Load radius						At max. reach		
		1.5	3.0	4.5	6.0	7.5		meter		
Boom 5.68 m	6.0 m							*5 478	3 910	6.74
Arm 2.42 m	4.5 m			*6 955	*6 955	*5 901	4 597	4 850	3 252	7.48
Counterweight 4 750 kg	3.0 m			*8 722	8 555	6 654	4 375	4 747	3 161	7.87
Shoe 600 m	1.5 m			9 603	6 106	6 418	4 154	4 644	3 066	7.95
	0 (Ground)			9 710	5 940	6 288	4 030	4 576	3 003	7.74
	-1.5 m			9 687	5 921	6 227	3 993		4 828	7.21
	-3.0 m	*9 909	*9 909	9 687	5 921	6 227	3 993		5 930	6.28
	-4.5 m	*12 496	11 444	*9 195	6 023	6 316	4 073		5 930	6.28
				*6 488	6 110				*6 077	4.71

Conditions	Load point height	Load radius						At max. reach		
		1.5	3.0	4.5	6.0	7.5		meter		
Boom 5.68 m	6.0 m							*4 954	4 817	7.32
Arm 2.91 m	4.5 m			*6 274	*6 274	*5 437	4 658	4 881	3 281	8.01
Counterweight 4 750 kg	3.0 m			*8 079	6 700	*6 284	4 426	4 771	3 180	8.37
Shoe 600 m	1.5 m			*9 717	6 218	6 455	4 153	4 648	3 067	8.45
	0 (Ground)			9 788	5 967	6 272	4 030	4 566	2 982	8.25
	-1.5 m	*5 484	*5 484	*4 848	*4 848	9 651	5 855	6 194	3 960	8.25
	-3.0 m	*9 973	*9 973	*13 611	11 285	*9 670	5 944	6 231	3 993	6.90
	-4.5 m			*10 626	*10 626	*7 669	6 148		*5 890	5.52

ZX210LC-3 MONOBLOCK BOOM

Conditions	Load point height	Load radius						At max. reach		
		1.5	3.0	4.5	6.0	7.5		meter		
Boom 5.68 m	6.0 m			*6 251	*6 251	*5 880	5 276	*5 955	4 590	6.50
Arm 2.03 m	4.5 m			*7 491	*7 491	*6 246	5 098	5 756	3 786	7.27
Counterweight 4 750 kg	3.0 m			*9 244	7 313	*6 955	4 889	5 413	3 546	7.67
Shoe 600 m	1.5 m					7 389	4 698	5 329	3 469	7.75
	0 (Ground)			*10 705	6 810	7 264	4 588	5 286	3 430	7.54
	-1.5 m			*10 168	6 825	7 251	4 576		5 853	6.99
	-3.0 m			*12 496	*12 496	*9 195	6 834	7 180	4 506	
	-4.5 m			*6 488	6 488					

Conditions	Load point height	Load radius						At max. reach		
		1.5	3.0	4.5	6.0	7.5		meter		
Boom 5.68 m	6.0 m							*5 478	4 351	6.74
Arm 2.42 m	4.5 m			*6 955	*6 955	*5 901	5 122	5 500	3 620	7.48
Counterweight 4 750 kg	3.0 m			*8 722	7 361	*6 660	4 895	5 410	3 537	7.87
Shoe 600 m	1.5 m			*10 148	6 940	7 378	4 680	5 304	3 441	7.95
	0 (Ground)			*10 637	6 748	7 223	4 543	5 234	3 377	7.74
	-1.5 m			*9 909	*9 909	*10 318	6 729	7 180	4 506	
	-3.0 m			*12 496	*12 496	*9 195	6 834	7 180	4 506	
	-4.5 m			*6 488	6 488					

Conditions	Load point height	Load radius						At max. reach		
		1.5	3.0	4.5	6.0	7.5		meter		
Boom 5.68 m	6.0 m							*4 954	4 817	7.32
Arm 2.91 m	4.5 m			*6 274	*6 274	*5 437	5 185	*5 107	3 660	8.01
Counterweight 4 750 kg	3.0 m			*8 079	7 532	*6 284	4 948	5 435	3 567	8.37
Shoe 600 m	1.5 m			*9 717	7 036	*7 119	4 711	5 310	3 443	8.45
	0 (Ground)			*10 525	6 767	7 228	4 544	5 215	3 356	8.25
	-1.5 m	*5 484	*5 484	*9 103	*9 103	*10 490	6 693	7 147	4 473	8.25
	-3.0 m	*9 973	*9 973	*13 611	13 094	*9 670	6 753	*7 176	4 506	
	-4.5 m			*10 626	*10 626	*7 669	6 964		5 896	5.52

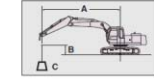
เอกสารประกอบการขายเพื่อแสดงระดับเสียงของเครื่องจักร (ต่อ)

ZAXIS 210

LIFTING CAPACITIES

Metric measure

- Notes: 1. Ratings are based on ISO 10567.
2. Lifting capacity of the ZAXIS Series does not exceed 75% of tipping load with the machine on firm, level ground or 87% full hydraulic capacity.
3. The load point is the center-line of the bucket pivot mounting pin on the arm.
4. *Indicates load limited by hydraulic capacity.
5. 0 m = Ground.



A: Load radius
B: Load point height
C: Lifting capacity

ZX210LCN-3 MONOBLOCK BOOM

Conditions	Load point height	Load radius										At max. reach	
		1.5		3.0		4.5		6.0		7.5		meter	meter
		0°	45°	0°	45°	0°	45°	0°	45°	0°	45°		
Boom 5.68 m	6.0 m					*6 281	*6 281	*5 883	4 698			*5 955	4 041 6.57
Arm 2.03 m	4.5 m					*7 581	6 917	*6 283	4 568			*5 892	3 358 7.34
Counterweight 5 500 kg	3.0 m					*9 418	6 405	*7 023	4 352	5 674	3 187	5 410	3 041 7.74
Shoe 500 m	1.5 m							*7 695	4 175	5 585	3 109	5 259	2 937 7.82
	0 (ground)					*10 877	5 934	7 608	4 068	5 537	3 066	5 435	3 016 7.61
	-1.5 m					*10 311	5 952	7 594	4 056			6 046	3 330 7.06
	-3.0 m					*8 907	6 076	*6 363	4 179			*6 138	4 107 6.01
	-4.5 m												

Conditions	Load point height	Load radius										At max. reach	
		1.5		3.0		4.5		6.0		7.5		meter	meter
		0°	45°	0°	45°	0°	45°	0°	45°	0°	45°		
Boom 5.68 m	6.0 m							*5 456	4 738			*5 478	3 855 6.81
Arm 2.42 m	4.5 m					*7 028	7 001	*5 933	4 589	*5 501	3 258	*5 500	3 221 7.55
Counterweight 5 500 kg	3.0 m					*8 874	6 468	*5 722	4 366	5 670	3 176	5 197	2 914 7.94
Shoe 500 m	1.5 m					*10 343	6 047	*7 473	4 155	5 560	3 079	5 043	2 804 8.02
	0 (ground)					*10 819	5 870	7 566	4 023	5 487	3 014	5 186	2 861 7.81
	-1.5 m			*9 559	*9 559	*10 473	5 856	7 523	3 986			5 716	3 129 7.28
	-3.0 m			*12 683	11 049	*9 325	5 956	*6 874	4 062			*6 302	3 791 6.35
	-4.5 m							*6 814	4 230			*6 077	5 746 4.78

Conditions	Load point height	Load radius										At max. reach	
		1.5		3.0		4.5		6.0		7.5		meter	meter
		0°	45°	0°	45°	0°	45°	0°	45°	0°	45°		
Boom 5.68 m	6.0 m							*4 956	4 808			*4 047	3 417 7.39
Arm 2.91 m	4.5 m					*6 328	*6 328	*5 499	4 649	*5 115	3 297	*3 993	2 915 8.08
Counterweight 5 500 kg	3.0 m					*8 207	6 612	*5 349	4 416	*5 476	3 194	*4 103	2 662 8.44
Shoe 500 m	1.5 m					*9 900	6 136	*7 201	4 184	5 566	3 080	*4 381	2 566 8.52
	0 (ground)			*4 514	*4 514	*10 713	5 885	7 571	4 022	5 469	2 984	4 726	2 908 8.32
	-1.5 m	*5 426	*5 426	*8 804	*8 804	*10 659	5 819	7 490	3 954	5 437	2 966	5 134	2 815 7.83
	-3.0 m	*9 865	*9 865	*13 855	10 893	*9 813	5 878	*7 275	3 985			*5 903	3 309 6.97
	-4.5 m			*10 797	*7 788	6 075						*5 889	4 566 5.59

ZX210-3 2-PIECE BOOM











Conditions	Load point height	Load radius										At max. reach	
		1.5		3.0		4.5		6.0		7.5		meter	meter
		0°	45°	0°	45°	0°	45°	0°	45°	0°	45°		
2-Piece Boom	9.0 m											*11 812	*11 812 2.56
Arm 2.03 m	7.5 m											*6 657	5 698 5.17
Counterweight 4 750 kg	6.0 m					*7 947	7 947	*7 395	7 395	*6 206	4 744	*5 472	4 075 6.48
Shoe 600 m	4.5 m					*10 924	10 924	*8 461	7 331	*6 389	4 789	*4 994	3 347 7.25
	3.0 m					*12 514	12 514	*10 091	7 167	6 627	4 678	4 748	3 124 7.65
	1.5 m					*14 734	12 818	10 176	6 967	6 729	4 474	4 673	3 055 7.73
	0 (ground)	*11 097	*11 097	*18 471	11 978	*10 258	6 534	6 569	4 242	*4 607	2 994	4 595	2 867 7.52
	-1.5 m	*19 564	19 564	*16 723	11 691	10 215	6 298	6 386	4 087			*5 018	3 322 6.97
	-3.0 m	*29 453	29 453	*15 218	11 751	*9 217	6 167					*6 136	4 303 5.77

Conditions	Load point height	Load radius										At max. reach	
		1.5		3.0		4.5		6.0		7.5		meter	meter
		0°	45°	0°	45°	0°	45°	0°	45°	0°	45°		
2-Piece Boom	9.0 m											*6 694	*6 694 3.19
Arm 2.42 m	7.5 m					*9 084	*9 084					*5 893	5 436 5.50
Counterweight 4 750 kg	6.0 m							*6 982	*6 982	*5 803	4 850	*4 970	3 866 6.74
Shoe 600 m	4.5 m					*11 542	*11 542	*7 922	7 333	*6 059	4 865	*4 590	3 197 7.49
	3.0 m					*12 969	*12 762	*9 737	7 173	*6 716	4 738	4 785	3 153 7.87
	1.5 m					*14 641	*12 681	10 113	7 054	6 700	4 504	4 681	3 057 7.95
	0 (ground)	*12 345	*12 345	*18 257	12 065	*10 149	6 567	6 562	4 238	*4 572	2 957	4 357	2 819 7.74
	-1.5 m	*18 413	*18 413	*16 548	11 648	10 191	6 268	6 342	4 040			4 810	3 090 7.21
	-3.0 m	*24 611	*24 611	*15 841	11 586	*9 788	6 063	*5 589	4 021			*4 640	3 821 6.25
	-4.5 m												

Conditions	Load point height	Load radius										At max. reach	
		1.5		3.0		4.5		6.0		7.5		meter	meter
		0°	45°	0°	45°	0°	45°	0°	45°	0°	45°		
2-Piece Boom	9.0 m											*5 426	*5 426 4.30
Arm 2.91 m	7.5 m							*6 088	*6 088	*5 066	4 822	*4 432	*4 432 6.20
Counterweight 4 750 kg	6.0 m							*6 219	*6 219	*5 431	4 990	*4 096	3 410 7.32
Shoe 600 m	4.5 m					*8 240	8 240	*7 319	7 319	*5 714	4 935	*4 789	3 303 8.01
	3.0 m	*10 980	10 980	*13 613	12 843	*9 102	7 176	*6 341	4 793	4 876	3 248	4 000	2 618 8.37
	1.5 m	*8 834	8 834	*14 176	12 864	*10 113	6 963	*6 698	4 622	4 759	3 127	3 876	2 518 8.45
	0 (ground)	*11 176	*11 176	*15 782	12 339	10 083	6 674	6 563	4 347	4 614	2 993	3 963	2 560 8.25
	-1.5 m	*15 159	15 159	*16 399	11 724	10 257	6 319	6 397	4 086	4 523	2 909	4 311	2 777 7.76
	-3.0 m	*19 211	19 211	*16 471	11 581	9 965	6 071	6 273	3 975			*4 411	3 295 6.91
	-4.5 m	*20 879	20 879	*12 128	11 611	*6 770	6 107					*6 594	5 976 4.57

ZX210LC-3 2-PIECE BOOM

Conditions	Load point height	Load radius										At max. reach	
		1.5		3.0		4.5		6.0		7.5		meter	meter
		0°	45°	0°	45°	0°	45°	0°	45°	0°	45°		
2-Piece Boom	9.0 m											*11 814	*11 814 2.56
Arm 2.03 m	7.5 m											*6 660	6 581 5.17
Counterweight 4 750 kg	6.0 m					*7 949	*7 949	*7 399	7 399	*6 210	5 284	*5 476	4 554 6.48
Shoe 600 m	4.5 m					*10 932	*10 932	*8 467	7 331	*6 374	5 330	*4 999	3 754 7.25
	3.0 m					*12 526	*12 526	*10 101	7 165	*7 061	5 218	*5 414	3 369 7.65
	1.5 m					*14 747	14 223	*10 581	7 825	*7 541	5 010	*4 925	3 274 7.73
	0 (ground)	*11 098	*11 098	*18 485	13 863	*10 599	7 381	7 546	4 775	*5 283	3 381	*5 255	3 372 7.52
	-1.5 m	*19 565	*19 565	*16 737	13 560	*10 823	7 138	7 367	4 617			*5 025	3 750 6.97
	-3.0 m	*29 452	*29 452	*15 230	13 621	*9 227	7 004					*5 144	4 916 5.77

Conditions	Load point height	Load radius										At max. reach		
		1.5		3.0		4.5		6.0		7.5		meter	meter	
														
2-Piece Boom	9.0 m											*8 696	*8 696	3.19
Arm 2.42 m	7.5 m											*5 895	*5 895	5.50
Counterweight 4 750 kg	6.0 m											*4 974	*4 974	6.20
Shoe 600 m	4.5 m											*5 984	*5 984	7.49
	3.0 m											*5 222	*5 222	7.87
	1.5 m											*4 581	*4 581	7.84
Ø wheels	12 347	12 347	16 271	13 957	*10 497	8 416	7 500	4 752	5 249	3 344	4 044	1 989	7.74	
	1.5 m											*4 581	*4 581	7.84
	3.0 m											*4 947	*4 947	7.21
	4.5 m											*4 947	*4 947	7.21
	6.0 m											*4 947	*4 947	7.21
	7.5 m											*4 947	*4 947	7.21

เอกสารประกอบการขายเพื่อแสดงระดับเสียงของเครื่องจักร (ต่อ)

ZAXIS 210

EQUIPMENT

STANDARD EQUIPMENT

Standard equipment may vary by country, so please consult your Hitachi dealer for details.

ENGINE

- H/P mode control
- E mode control
- 50 A alternator
- Dry-type air filter with evacuator valve (with air filter restriction indicator)
- Cartridge-type engine oil filter
- Cartridge-type fuel double filters
- Air cleaner double filters
- Radiator, oil cooler and intercooler with dust protective net
- Radiator reserve tank
- Fan guard
- Isolation-mounted engine
- Auto idle system
- Fuel cooler
- Electrical fuel feed pump
- Engine oil drain coupler

HYDRAULIC SYSTEM

- Work mode selector
- Power boost
- Auto power lift
- Control valve with main relief valve
- Extra port for control valve
- Suction filter
- Full-flow filter
- Pilot filter
- Swing dampener valve

CAB

- CRES II (Center pillar reinforced structure) cab
- OPG top guard fitted Level I (ISO10262) compliant cab
- All-weather sound suppressed steel cab
- Equipped with reinforced, tinted (green color) glass windows
- 4 fluid-filled elastic mounts
- Front windows on upper, lower and left side can be opened
- Intermittent windshield wipers
- Front window washer
- Adjustable reclining seat with adjustable armrests
- Footrest
- Electric double horn
- AM-FM radio with digital clock
- Seat belt
- Drink holder
- Cigarette lighter
- Ashtray
- Storage box
- Glove compartment
- Fire extinguisher bracket
- Floor mat
- Short wrist control levers
- Pilot control shut-off lever
- Engine shut-off switch
- Auto control air conditioner
- Transparent roof with slide curtain
- Mechanical suspension seat with heater

MONITOR SYSTEM

- Display of meters: water temperature, hour, fuel rate, clock
- Other displays: work mode, auto-idle, glow, rearview monitor, operating conditions, etc.
- Alarms: overheat, engine warning, engine oil pressure, alternator, minimum fuel level, hydraulic filter restriction, air filter restriction, work mode, overload, etc.
- Alarm buzzers: overheat, engine oil pressure, overload

LIGHTS

- 2 working lights

UPPER STRUCTURE

- Undercover
- 4 750 kg counterweight (ZX210-3, ZX210LC-3)
- 5 500 kg counterweight (ZX210LCN-3)
- Fuel level float
- Electric fuel refilling pump with auto stop
- Rear view camera
- 150 Ah batteries
- Hydraulic oil level gauge
- Tool box
- Utility space
- Rear view mirror (right & left side)
- Swing parking brake

UNDERCARRIAGE

- Travel parking brake
- Travel motor covers
- 1 track guard (each side) and hydraulic track adjuster
- Bolt-on sprocket
- Upper and lower rollers
- Reinforced track links with pin seals
- 4 tie down hooks

FRONT ATTACHMENTS

- HN bushing
- WC (tungsten-carbide) thermal spraying
- Reinforced resin thrust plate
- Flanged pin
- Casted bucket link A
- Centralized lubrication system
- Dirt seal on all bucket pins

MISCELLANEOUS

- Standard tool kit
- Lockable machine covers
- Lockable fuel refilling cap
- Skid-resistant tapes, plates and handrails
- Travel direction mark on track frame
- Onboard information controller

ZX210LC-3 2-PIECE BOOM

Conditions	Load point height	Load radius										At max. reach		
		1.5		3.0		4.5		6.0		7.5		meter	meter	meter
		0°	45°	0°	45°	0°	45°	0°	45°	0°	45°			
2-Piece Boom Arm 2.91 m Counterweight 4 750 kg Shoe 600 m	9.0 m					'6 091	'6 091	'5 068	'5 068			'5 428	'5 428	4.30
	7.5 m					'6 222	'6 222	'5 435	'5 435			'4 435	'4 435	6.20
	6.0 m											'4 098	'3 814	7.32
	4.5 m			'8 244	'8 244	'7 323	'7 323	'5 719	'5 396	'4 794	'3 694	'4 012	'3 239	8.01
	3.0 m	'10 081	'10 081	'13 624	'13 624	'9 110	'7 874	'6 347	'5 267	'5 045	'3 639	'4 009	'2 953	8.37
	1.5 m	'8 835	'8 835	'14 189	'14 189	'10 304	'7 725	'7 265	'5 106	'5 401	'3 516	'4 085	'2 848	8.45
	0 (Ground)	'11 177	'11 177	'15 794	'14 165	'10 454	'7 527	'7 448	'4 983	'5 283	'3 381	'4 340	'2 901	8.25
	-1.5 m	'15 160	'15 160	'16 413	'13 600	'10 506	'7 162	'7 382	'4 618	'5 200	'3 296	'4 856	'3 146	7.76
	-3.0 m	'19 212	'19 212	'16 483	'13 448	'10 428	'6 908	'6 910	'4 505			'4 418	'3 728	6.91
	-4.5 m	'20 080	'20 080	'12 140	'12 140	'6 779	'6 779					'6 603	'6 603	4.57

ZX210LCN-3 2-PIECE BOOM

Conditions	Load point height	Load radius										At max. reach		
		1.5		3.0		4.5		6.0		7.5		meter	meter	meter
		0°	45°	0°	45°	0°	45°	0°	45°	0°	45°			
2-Piece Boom Arm 2.03 m Counterweight 5 500 kg Shoe 500 m	9.0 m					'7 451	'7 451					'11 814	'11 814	2.63
	7.5 m											'6 660	'5 725	5.24
	6.0 m			'7 766	'7 766	'7 482	'7 408	'6 232	'4 741			'5 476	'4 002	6.55
	4.5 m			'11 008	'11 008	'8 612	'7 255	'6 439	'4 779			'4 998	'3 304	7.32
	3.0 m			'12 750	'12 457	'10 253	'7 078	'7 155	'4 669	'5 571	'3 143	'4 844	'2 981	7.72
	1.5 m			'14 966	'12 273	'10 753	'6 858	'7 797	'4 465	'5 610	'3 069	'4 825	'2 875	7.80
	0 (Ground)	'10 934	'10 934	'16 900	'11 494	'10 780	'6 434	'7 854	'4 232	'5 534	'3 002	'5 255	'2 957	7.59
	-1.5 m	'19 212	'19 212	'17 170	'11 235	'11 008	'6 212	'7 712	'4 077			'5 025	'3 379	7.04
	-3.0 m	'28 531	'28 531	'15 632	'11 306	'9 445	'6 085					'5 144	'4 261	5.84

Conditions	Load point height	Load radius										At max. reach		
		1.5		3.0		4.5		6.0		7.5		meter	meter	meter
		0°	45°	0°	45°	0°	45°	0°	45°	0°	45°			
2-Piece Boom Arm 2.42 m Counterweight 5 500 kg Shoe 500 m	9.0 m			'9 200	'9 200							'9 696	'9 696	3.26
	7.5 m					'6 927	'6 927					'5 896	'5 290	5.57
	6.0 m					'7 056	'7 056	'5 845	'4 841			'4 974	'3 801	6.81
	4.5 m			'11 644	'11 644	'8 052	'7 254	'6 126	'4 853	'4 751	'3 203	'4 594	'3 158	7.56
	3.0 m			'13 131	'12 439	'9 911	'7 094	'6 818	'4 727	'5 389	'3 170	'4 484	'2 847	7.94
	1.5 m			'14 901	'12 352	'10 661	'6 941	'7 693	'4 495	'5 620	'3 010	'4 681	'2 735	8.02
	0 (Ground)	'12 100	'12 100	'16 653	'11 569	'10 676	'6 463	'7 745	'4 228	'5 504	'2 968	'4 904	'2 792	7.81
	-1.5 m	'18 078	'18 078	'17 000	'11 187	'10 823	'6 182	'7 667	'4 028			'5 194	'3 062	7.28
	-3.0 m	'24 096	'24 096	'16 274	'11 146	'9 990	'5 978	'5 816	'4 002			'4 647	'3 753	6.32

Conditions	Load point height	Load radius										At max. reach		
		1.5		3.0		4.5		6.0		7.5		meter	meter	meter
		0°	45°	0°	45°	0°	45°	0°	45°	0°	45°			
2-Piece Boom Arm 2.91 m Counterweight 5 500 kg Shoe 500 m	9.0 m					'6 090	'6 090	'5 176	'4 817			'5 428	'5 428	4.37
	7.5 m							'6 214	'5 475	'4 911		'4 435	'4 431	6.27
	6.0 m											'4 098	'3 363	7.30
	4.5 m			'8 245	'8 245	'7 424	'7 292	'5 775	'4 916	'4 844	'3 321	'4 012	'2 854	8.08
	3.0 m	'9 230	'9 230	'13 741	'12 500	'9 311	'7 092	'6 432	'4 775	'5 087	'3 361	'4 009	'2 997	8.44
	1.5 m	'8 030	'8 030	'14 414	'12 338	'10 486	'6 877	'7 395	'4 636	'5 475	'3 141	'4 085	'2 900	8.52
	0 (Ground)	'10 863	'10 863	'16 122	'11 816	'10 632	'6 567	'7 690	'4 337	'5 551	'3 005	'4 340	'2 541	8.32
	-1.5 m	'14 854	'14 854	'16 848	'11 255	'10 707	'6 221	'7 729	'4 076	'5 449	'2 915	'4 856	'2 750	7.83
	-3.0 m	'18 816	'18 816	'16 901	'11 126	'10 636	'5 992	'7 072	'3 962			'4 418	'3 249	6.98
	-4.5 m	'20 439	'20 439	'12 466	'11 166	'7 003	'6 018					'6 603	'5 768	4.64

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ZAXIS 210

ZAXIS 210

OPTIONAL EQUIPMENT

Optional equipment may vary by country, so please consult your Hitachi dealer for details.

CAB

- Laminated round glass window
- FOPS guard
- Air suspension seat with heater
- Rain guard
- Sun visor
- 12 V power source

LIGHTS

- Additional cab roof front lights
- Additional cab roof rear lights
- Rotating lamp
- Additional boom light with cover

UNDERCARRIAGE

- 2 track guards
- Track undercover

ATTACHMENTS

- Hammer and crusher piping
- Parts for hammer and crusher
- 2 pump combined flow assist piping
- Additional pump (30 L/min)
- Pilot accumulator
- High mesh full flow filter with restriction indicator
- Welded bucket link A with welded hook

OTHERS

- Hose rupture valve
- Overload warning device
- Pre-cleaner
- 5 350 kg heavy counterweight (ZX210-3, ZX210LC-3)
- Biodegradable oil
- Lower cover

Designed to increase ventilation



- Tropical cover

Designed for use in the Tropics (severely hot climate), with extra wide opening for more heat dissipation, thus reducing sound suppression. The machine fitted with this cover cannot pass EU Noise Regulation 2000/14/EC, STAGE II, not permitting the use of the CE mark



Prior to operating this machine, including satellite communication system, in a country other than a country of its intended use, it may be necessary to make modifications to it so that it complies with the local regulatory standards (including safety standards) and legal requirements of that particular country. Please do not export or operate this machine outside the country of its intended use until such compliance has been confirmed. Please contact your Hitachi dealer in case of questions about compliance.

These specifications are subject to change without notice. Illustrations and photos show the standard models, and may or may not include optional equipment, accessories, and all standard equipment with some differences in colour and features. Before use, read and understand the Operator's Manual for proper operation.

KS-EN023EUQ

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Mining haul truck cab noise: an evaluation of three acoustical environments

Introduction

This study investigates haul truck cab noise in underground limestone mines that employ nearly 2,000 workers at 117 mines across the United States. In this industry, hazardous noise is present from drilling, blasting, rock crushing operations and the predominance of large and noisy equipment. Continued exposure of miners to high noise levels can cause damage to the inner ear. The result of this damage is a permanent shift in the hearing threshold, known as a noise-induced hearing loss (NIHL). A NIHL makes it difficult to hear and understand everyday speech and is irreversible.

Of special interest is the haul truck (Fig. 1) because it comprises of the largest class of equipment used in the underground limestone industry. With these trucks and most diesel-powered equipment, the engine is generally a major source of noise. Engine noise may emanate from the exhaust, the intake and the cooling fan. Other significant noise sources include the transmission, drive train and hydraulic system.

Abstract

Mining haul trucks comprise the majority of the equipment used in underground limestone mining operations and are known to emit high levels of noise. A previous study conducted by the National Institute for Occupational Safety and Health (NIOSH) indicates that 70-90 % of all miners have a noise-induced hearing loss (NIHL) great enough to be classified as a hearing disability by retirement age. These results demonstrate the public health need to protect the hearing of workers in the mining industry, including haul truck drivers.

Cab enclosures present an opportunity to isolate the haul truck operator from both truck and other noise in the mining environment. A total of 25 haul truck cabs were studied. They were divided into three style (treatment) categories determined by soundproofing features and technology for noise reduction: old-, new- and retrofitted-style. This study examines the contribution of cab acoustics, operator performance and maintenance to noise reduction for each cab style. Dosimeters were used to measure eight-hour time weighted average sound pressure levels (TWA_8 SPLs) inside and outside the cabs. The main objective was to determine the noise levels inside of the three types of cabs (with different acoustical treatments) and determine if the noise levels were significantly different. Adherence to the Mine Safety and Health Administration (MSHA) permis-

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Noise from these sources reaches the ear via several paths, both directly, by airborne paths and indirectly, by reflections from various surfaces. In addition, sound in the form of vibrations may travel along or through structures (Daniel et al., 1981). An approach to eliminate or control noise at its source, engineering controls, is through the use of mufflers, gaskets and control of reflected noise. Another way to lower noise levels is to identify, isolate and treat the many paths along which noise travels with barriers, absorbers and dampers.

Control of haul truck cab noise is important because haul truck operators spend a majority of their time inside the cab. Most mine policies require haul truck operators to remain inside their cab throughout the entire shift except for restroom use, attendance at safety meetings, during maintenance and sometimes during lunch breaks. Therefore, it is typical for operators to spend almost the entire shift (eight to 10 hours) inside the haul truck cab.

According to Daniel et al., "Cab enclosures generally

sible exposure limit (PEL) of 90 dB TWA_8 (with a 90 dB threshold) was used as the main indicator of overall noise reduction achieved. Dosimetry results indicated that all but two samples measured outside of the cab exceeded the MSHA PEL. However, only 2% of the samples measured inside of the cabs exceeded the PEL, but samples could still be reduced much further. Descriptive and comparative statistics indicate that noise levels inside the new-style cabs are significantly lower than the other two cab styles. Also, data suggest that there is no difference in noise exposures when comparing the old-style to retrofitted cab styles. Operator influence (opening doors and windows) was a significant factor for increasing noise exposure.

This paper demonstrates that properly designed cabs can achieve major noise reductions, but noise levels could still be reduced much further below the MSHA PEL. New-style cabs, equipped with modern noise-reduction treatments, exhibit much lower noise exposures than the other two cab styles, and the effectiveness of the current noise-reduction treatments for retrofitted cabs is questionable. Haul truck driver observations indicate that improved noise exposure reduction training is needed. Finally, specific targets for future noise reduction research are suggested that will further contribute to the prevention of hearing loss for haul truck operators.

are the most efficient way to prevent the radiation of sound through the cab walls." The effectiveness of noise reduction is greater if the cab is lined with an acoustically absorptive material. Most newer haul truck cabs are manufactured with features that are designed specifically for noise reduction (new-style cabs). These features are typically not found as original components in cabs of older trucks (old-style cabs). Sound-proofing materials may be added to the older cabs to upgrade their noise reduction potential (retrofitted cabs).

This study examines noise exposure inside haul truck cabs experienced during a typical workday with normal operator practices, the effect of noise-reduction features inside the cab, the consequence of disabling noise controls (unnecessary open doors/ windows) and the significance of haul truck and cab maintenance factors. The objectives of this study were to:

- Determine if current haul truck cabs provide enough protection to prevent a noise overexposure (as defined by the MSHA PEL) during normal operations.
- Determine if there is a significant difference in the noise exposure as measured inside the old-style, new-style and retrofitted cabs.
- Analyze critical factors that contribute to the cab noise protection potential.
- Observe and consider haul truck operator activities (opening of doors or windows) relative to established operating procedures and to determine this effect on the noise exposure inside the cab.
- Suggest specific research areas to further improve noise reduction in haul truck mining cabs.

Federal regulation of noise exposure in mining

Efforts to combat NIHL in miners began in 1969 with the enactment of the Federal Coal Mine Safety and Health Act (Public Law 91-173). This law set forth requirements for protecting coal miners from among other hazards, exposure to excessive noise. Later, the Federal Mine Safety and Health Act of 1977 (Public Law 95-144) broadened the scope of the law to include noise protection for all miners of all mineral types (the Acts are detailed in 30 CFR, Subchapter O, Part 70, Subpart F, 1997). MSHA enforced a PEL that was an eight-hour, time-weighted average (TWA_8) of 90 dBA (slow) (with a 90 dB threshold), but a hearing conservation program was not mandated unless a citation was issued for overexposure (Joy and Middendorf, 2007).

On Sept. 13, 2000, there was further progress in controlling mining-related noise when MSHA established the new Health Standards for Occupational Noise Exposure (Federal Register, 1999). This standard adopted a provision similar to Occupational Safety and Health Administration's (OSHA's) Hearing Conservation Amendment (29 CFR 1910.95), where a miner is required to be enrolled in a hearing conservation program (HCP) if the full-shift noise exposure is at or above the action level (AL) of TWA_8 85 dBA (slow) (80 dBA threshold).

With the PEL remaining the same, other requirements of the new regulations included the primacy of engineering and administrative controls for noise exposure reduction, the implementation of a noise exposure monitoring system and the relegation of the use of hearing protection to

FIGURE 1

Haul truck and cab.



the hearing conservation program. The implementation of these regulations has served to reinforce the importance of noise reduction throughout the mining industry.

Methodology

Categorization of haul truck cabs. Presently, haul truck cabs are manufactured with built-in design features for noise reduction (new-style cabs) whereas cabs on older vehicles lack many such features (old-style cabs). There are also cases where the cab components have worn out before the haul truck is taken out of service. Often, to extend the life of the truck, the original components of these cabs are upgraded with materials (e.g. foam-materials on cab walls or new gaskets around doors and windows) to reduce noise exposures (retrofitted cabs). In order to compare the noise reduction characteristics for each cab style, criteria were established to divide cabs into the three cab styles or treatment groups. A description of each cab style, along with illustrations, follows.

New-style cabs: Noise control features for new-style cabs include sound absorption, vibration damping and sound barriers. Sound absorption materials are soft and porous materials (e.g., flexible polyurethane foam) where the amount of sound absorption is directly related to the amount of treated surface area. Vibration damping materials reduce the amount of vibration energy transmitted between surfaces and are constructed of rigid materials. Sound barrier materials combine mass and flexibility to

FIGURE 2

Examples of new-style cab, a) full-upholstery and window seals b) newer gaskets, door handles and window cranks.



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FIGURE 3

Examples of old-style cab, a) and b) steel interior with older sealants and gaskets and c) older door handle.



reduce the sound energy passing between the noise source and the controlled area. Sound barriers, combined with sound absorption materials, can be very effective in controlling noise (Mohanty et al., 2000).

Besides new sound-proofing materials and technology, research has been conducted to reduce structure-borne noise by determining the best placement for sound-absorbing materials in cabs. Researchers created and tested cab designs using computer-aided-engineering methods. Some examples of the new-style cab characteristics are shown in Fig. 2. This figure demonstrates full-upholstery cabs that absorb noise and seals, gaskets and latches that minimize noise leakage and all-around cab vibration.

Old-style cabs: It is not uncommon to encounter haul trucks that are 20-years-old or older still in use at underground limestone mines. Needless to say, these cab enclosures lack some of the new technologies that reduce noise. A typical cab of this type has a hard steel interior that acts as a noise reflecting surface and there is little use of noise reducing materials. Because these cabs experience wear over time, the original components including cab sealants and gaskets may lose their effectiveness and allow noise leakage. In addition, cab integrity may deteriorate and increase cab noise due to the vibration of doors, windows or latches. Preserving the integrity of these components is

FIGURE 4

Examples of retrofitted cab with foam sound-absorbing material with sealants and gaskets around a) doors, b) windows and c) walls.



crucial for noise reduction and thus requires a proactive maintenance program. Some examples of old-style cab characteristics are shown in Fig. 3. This figure illustrates steel interior cabs with noise reflective surfaces, and older-style latches, gaskets and seals.

Retrofitted-style cabs: This style cab has been upgraded with new technology or materials such as floor mats, insulation, special glass and other methods to reduce noise. The upgrade may be due to original component deterioration or wear from extensive usage. Figure 4 demonstrates an old-style cab that was upgraded with a material approved by MSHA. This foam material shown was engineered for use in high noise environments and meets the MSHA flammability standards (adopted UL 94 HF-1). It is faced with an aluminized polyester material layer that reflects radiant heat. The facing and foam were fused during processing to create a bond that resists delamination. This material is ideal for sound absorption in enclosed equipment, such as compressors, motors, generators, and pumps (TUF-COTE, 2006). This material is just one example of the many commercially available soundproofing products. There are also products that reduce noise echo, stop vibrations and lower noise transmission through glass.

Associated co-variables

This study was designed to evaluate cab noise exposure levels given the current maintenance condition, in the typical environmental noise surroundings, and with the haul truck operators performing as usual during a typical workday. Therefore, besides noise-reduction features in cabs, there are other variables that effect sound levels inside the cab. As part of the methodology, two of these variables referred to as co-variables, were monitored closely throughout the survey. These two co-variables are maintenance and operator performance. Other potential co-variables were considered including maintenance down time, extreme weather and road conditions, and shortened work shifts.

Maintenance: Although the effect of noise reduction for specific cab components is difficult to identify and measure, it is evident that improper maintenance of haul trucks and cab enclosures can lessen (or degrade) cab attenuation. Also, deteriorated door and window seals should be replaced and holes in the cab frame should be patched because air gaps and holes can also allow noise leakage. Figure 5 shows examples of cab degradation including inadequate sealing around doors, holes in the cab frame and the deterioration of soundproofing materials on the roof.

Another essential maintenance issue is a functional air conditioning system to sustain a comfortable and healthy work environment. If the system is in disrepair, haul truck operators will, out of necessity, open doors and windows to seek relief from the heat. When this occurs, the haul truck operators circumvent some of the protective cab features and allow outside noise, dust or diesel exhaust to enter the cab.

Operator influence: Haul truck operators are encouraged to follow safe operating practices. Most procedures require equipment operators to keep their windows and doors closed as much as possible. However, observations of haul truck drivers during operations reveal that some operators do not always adhere to these practices. One

reason, which has already been mentioned, is to cope with malfunctioning air conditioning systems. Another reason is the preference for fresh wind and outside air, regardless of a guarantee for a noisier environment. Smoking and chewing tobacco use can also cause operators to frequently open their windows and doors.

Operators are also encouraged to stay inside the cab and away from noisy environments as much as possible and to report any maintenance needs. Adherence to good practices and procedures for equipment operation can help to reduce noise exposures.

Mine characteristics

Haul truck cab noise was studied at five underground limestone mines. The typical mining sequence for each mine included drilling the face, blasting the rock, and extraction using front-end loaders and haul trucks. The blasted material was transported to the crushing and screening facilities where it was processed into various sized aggregates. One mine had the crushing/screening plant located underground while the other mines had the facilities located outside the mine approximately 91 - 182 m (100 - 200 yards) from the mine portal.

Mine production ranged from 1.4 to 1.8 Mt/a (1.5 to 2 million stpy) of raw product and employment ranged from nine to 30 underground employees. Mining heights averaged 6.7 m (22 ft) and the mining widths were approximately 12 m (40 ft). Most of the underground equipment was diesel-powered with some smaller equipment powered by electricity.

Study procedure

Several tasks were completed prior to the start of the shift. Twenty-five haul trucks were examined and the cabs were categorized as follows: five old-style, 17 new-style and three retrofitted cabs. A pre-shift maintenance inspection of the cab was conducted, including noting the operational condition of the air conditioning unit and any obvious acoustic material maintenance needs.

Haul truck operators were then interviewed about their

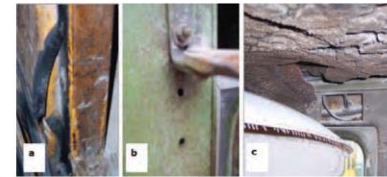
FIGURE 6

Dosimeter inside cab.



FIGURE 5

Examples of poor maintenance (a) inadequate sealing around roof, (b) hole in cab frame and (c) deteriorated roof materials.



habits, activities and common practices. The company's operating procedures for haul trucks were discussed including the requirement to keep the windows and doors closed, reporting of any maintenance problems and proper radio volume. Additional information was collected including truck engine data (e.g., horsepower, year, make/model), weather or road conditions and planned maintenance activities.

Upon completion of the pre-shift tasks, noise dosimeters were attached at two locations inside and outside of the cabs. In all, there were 44 samples collected over the 13-shift study period. For each sample, two noise dosimeters measured noise (dBA TWA₈) using the MSHA PEL exposure criteria during the full shift. The dosimeter placed outside the cab to get some idea of how loud noise levels could be without the protective aid of the haul truck cab. In addition, operator activities were monitored and noted throughout the shift as closely as possible. However, researchers could only observe the haul trucks when they were outside of the mine. At the end of the shift, the noise dosimeters were recovered and the data recorded. Finally, a second interview of the haul truck operator was conducted to determine driver activities and other potential co-variables, discuss maintenance issues and to receive feedback or concerns about the noise study.

FIGURE 7

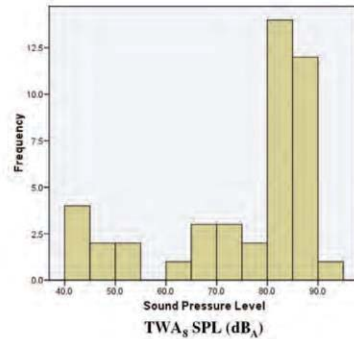
Dosimeter outside cab.



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FIGURE 8

Histogram of the TWA₈ SPL sample data.



Instrumentation and data collection

Worker noise exposures were monitored using Quest Q-400 noise dosimeters. This instrument is preferred over a sound level meter when the noise levels must be measured over a lengthy period and vary due to intermittent nature. Most dosimeters available today provide outputs in dose or TWA₈ using various exchange rates (e.g. 5 dB), response rates (fast or slow), eight hour criterion levels, and sound measurement ranges.

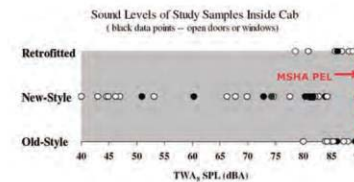
Noise dosimeters are typically used to measure personal noise exposures of employees, but can also be used to measure noise exposures as area samples where the dosimeter stays in a stationary location. The dosimeters used in this study measured and stored the sound levels during a time period and computed the readout as a percent dose. Equation 1 below was used to convert the MSHA PEL dose percent to TWA₈ SPL.

$$TWA_8 \text{ SPL (dBA)} = 16.6 \times \log_{10} (\text{Dose \%}/100) + 90 \quad (1)$$

Prior to the shift start, the noise dosimeters were calibrated and set to monitor an MSHA PEL of 100% or a TWA₈ of 90 dB Threshold, 5 dB Exchange Rate, a Slow Response, and a 140 dB Upper Limit. For uniformity, the dosimeter microphone inside the cab was placed as close to the operator's right ear as possible. As shown in Fig. 6, the

FIGURE 9

Sound level measurements for each type of cab.



microphone was placed 0.3 - 0.45 m (1 - 1.5 ft) to the right of the operator next to the engine-side window. Actions such as securing the microphone mount with tie wire/electrical tape, placing cloth or clothing around the dosimeter and utilizing microphone covers were taken to ensure the dosimeters or microphones did not vibrate or touch the window and produce structure-borne noise.

Measures were again also taken to protect the outside dosimeters and microphones from damage and vibration against the cab frame. Outside dosimeters were attached to the frame above the operator's door as shown in Fig. 7. This location was chosen to most closely represent the noise levels that the operator would experience if he/she did not have the protective measure of the cab and also out of convenience for fastening the dosimeters (handles and/or bars around or above the cab door in which to secure the dosimeter). There were a few occasions during the study where it was raining heavily. On these days, dosimeters were attached to the frame on the opposite side of the cab (engine-side) and were more directly exposed to engine noise than if they were located on the operator's side.

Results

A histogram of the TWA₈ SPLs for all of the measurements inside the cab is shown in Fig. 8. The shape of the histogram (skewed left) suggests that the data may not be normally distributed, but perhaps a larger sample size would lead to a more normal or log-normal sample distribution. It could also be a bi-modal distribution where the high number of quieter cabs (new-style) represents the first peak and the larger group of noisier cabs (older and retrofitted) represents the second peak. Again, the normality characteristics of the histogram could be clarified with a larger sample size.

The descriptive statistics for all of the sample measurements are as follows: sample mean, 75.1; median, 81.3; standard deviation, 15.4; and 95% confidence intervals of the mean, 70.5 (lower limit) and 79.8 (upper limit). There was one extreme outlier (97.7 dBA) in the sample measurements that was not used in the data analysis. When compared to the highest measurement from the study data (90.1 dBA), the sound energy from the outlier was as much as four times greater. This reading was so high that it was improbable that the haul truck driver could have operated for a full shift without reporting discomfort from excessive cab noise levels. Therefore, this sample measurement is extremely unlikely. Researchers found no plausible explanation for this reading except that the dosimeter may have malfunctioned or it was not properly secured to the cab frame causing excessive vibration noise.

Figure 9 graphically represents the data as the TWA₈ SPLs for each sample collected inside the cab for each cab type. The black data points represent samples where the haul truck drivers had unnecessary intervals of open doors and windows. Figure 9 also shows the limits for the PEL (TWA₈ 90 dBA) displayed in red. Only one out of the 44 sample measurements was above the MSHA PEL. However, 14 out of 44 (32%) did exceed levels of TWA₈ 85 dBA, which may be considered hazardous. Furthermore, Fig. 9 shows that the new-style cab samples were fairly spread out, but only one sample came near to exceeding the MSHA PEL. In contrast, the measurements for the old-style cabs and retrofitted cabs were spread out only over the upper range (right side) of the graph that contained the

higher noise level samples. Table 1 displays the descriptive statistics of the TWA₈ SPLs for each of the three cab styles including the mean, median, standard deviation, and 95% confidence interval of the mean.

Figure 10 depicts a box plot of the data showing the median, and upper and lower quartiles for each cab type. It appears that the median values of the MSHA PEL noise exposure for the old-style and retrofitted cabs are very similar, but both differ from the new-style cab median. The median value of the new cab style is much lower than the other two cab styles.

Because of questions regarding the underlying distribution of the sample data, the parametric ANOVA and non-parametric Kruskal-Wallis tests were performed to determine if there were significant differences in the TWA₈ SPLs inside the cab between the three cab styles. ANOVA tests were performed with Tukey post hoc comparisons. Although significance is usually set at alpha equal to 0.05, these tests were done to see if the p-values approached significance (p-value <0.05). Table 2 displays the results from all of these tests.

The null hypothesis for an ANOVA test is typically that there is no difference or effect among groups and a p-value close to zero signals that the null hypothesis is rejected. The ANOVA test of the sample data achieved a p-value of 0.0001, which achieves significance (p-value <0.05), suggesting that the null hypothesis should be rejected and that there is a difference in at least one of the three cab styles. As seen on Table 2, the Kruskal-Wallis test on the data achieved a p-value of 0.0001, which was the same as the ANOVA test. Results from the Tukey post hoc multiple comparison test on this data show that a p-value of 0.001 was achieved between the old-style and new-style cabs and a p-value of 0.007 was achieved between the retrofitted and new-style cabs. These two comparison tests indicate a significant difference between the groups for each test. The comparison for old-style and retrofitted cabs did not show significance (p-value = 0.987) that there was a difference between the groups.

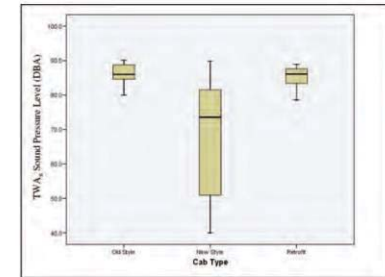
The outside dosimeter measurements (shown as a range of measurements in dB) are provided below. All but two of the data measurements were found to be above the MSHA PEL. Furthermore, the outside noise levels for the haul trucks with retrofitted cabs, overall, tended to be slightly lower than the trucks with new-style and old-style cabs. The measurements that were taken on the engine-side of the cabs were considerably higher than the ones taken on the operator's side of the cab.

- 89.3 – 93.8 dB for retrofitted cabs (driver-side measurements).
- 91.3 – 95.8 dB for old-style cabs (driver-side measurements).
- 91.3 – 95.1 dB for new-style cabs (driver-side measurements).
- 97.5 – 99.5 dB for old-style cabs (engine-side measurements).
- 98.8 – 99.8 dB for new-style cabs (engine-side measurements).

The category of “open doors and windows” was determined if the operator admitted that he/she had doors or windows open (an inch or more) for unnecessary reasons or that this practice was observed by the researcher

FIGURE 10

Box plot of TWA₈ SPL for the 3 cab styles.



more than three times throughout the shift. The occurrence of unnecessary open doors or windows was observed in 13 out of the 44 samples (30%). These observations were seen in three out of the four highest noise levels measured during the study, including the highest measurement of 90.1 dBA. Table 3 shows the mean noise exposure for samples with open doors or windows versus the mean for samples where open doors or windows were not observed for each cab style. The increase in noise was 8.5 dBA for the new-style cabs, 4.0 dBA for the old-style cabs, and 1.2 dBA for the retrofitted cabs. This data shows a significant increase in noise for the new-style and old-style cabs. A broken air conditioning unit was the reason for the higher noise measurement in only one of the samples. Operators provided the following additional reasons why they opened their doors or windows: fogged interior windows, tobacco use, the preference for outside air and the need to hear the horn/signal from the front-end loader.

Good road conditions were noted throughout the study and normal weather conditions were observed. Some cab deterioration was visible in the old-style and retrofitted cabs, but little in the new-style cabs. Aside from wear and tear due to normal use, the seals, gaskets and latches were in fair to good condition.

Discussion and conclusions

The noise levels measured outside of the cab clearly indicate that most noise levels that would be experienced by the operator would be above the MSHA PEL had they

Table 1

Descriptive statistics for three cab styles.

	Retrofitted n=7	New style n=26	Old style n=11
TWA ₈ SPL (dB)	75.1	81.3	86.3
Mean	85.1	67.7	86.3
Median	86.1	82.1	86.0
Standard deviation	3.86	16.2	3.0
95% CI on mean			
Lower	81.5	61.2	84.3
Upper	88.7	74.2	88.3

เอกสารประกอบการขายเพื่อแสดงระดับเสียงของเครื่องจักร (ต่อ)

Table 2

Comparison statistics for three cab styles.

Parametric test	F statistic	P-value
ANOVA	10.7	0.0001
Tukey post hoc test (multiple comparisons)		
New-style vs. retrofitted		0.007
Old-style vs. retrofitted		0.987
New-style vs. old-style		0.001
Non-Parametric Test	Chi-square statistic	P-value
Kruskal-Wallis	20.9	0.0001

not had the noise-reducing protection of a cab. The results from this study show that 43 out of 44 (98%) measurements inside cabs were below the MSHA PEL, regardless of open doors and windows, the cab maintenance condition or the cab style. However, noise reduction measures should be made to reduce noise even further to prevent NIHL.

Multiple comparison tests and descriptive data both show that there is a significant difference between the old-style and new-style cabs and the retrofitted and new-style cabs. Therefore, efforts to control noise inside the new-style cabs have been effective and mine management should continue their efforts to purchase haul trucks that have cabs equipped with these state-of-the-art noise-reduction features. Fortunately, as mines begin to replace old haul trucks with new haul trucks that have the new-style cabs, noise overexposures should become infrequent as long as operators keep the doors and windows closed.

Finally, multiple comparison tests and descriptive statistics suggest there is no difference between the old-style and retrofitted cab styles, highlighting the difficulty of designing and implementing retrofit noise controls. The multiple comparison tests show a lack of significant benefit from the retrofitted cabs, but with such a limited sample size, one cannot entirely rule out retrofits as a useful noise control strategy. The multiple comparison tests (Tukey post hoc tests) were sensitive to normality assumptions and without additional data measurements to test normality, making strong conclusions regarding the differences is somewhat questionable. Furthermore, some potential shortcomings were identified that, if corrected, could lead to more effective retrofits. Improved interventions to reduce door and window vibration could serve to further reduce these noise levels. Also, noise treatment of the cab floor could improve noise reduction significantly because of the relative proximity of the cab floor to the engine noise sources. Finally, treating the outside of the cab (engine side of the firewall and under the hood) with sound absorbing materials should also help to reduce the amount of noise inside

the cab.

Open doors and windows will increase the noise levels inside the cab and measures should be taken to encourage operators not to disable these protective cab features. Improved education and training of operators is needed regarding noise source awareness and noise overexposures. Furthermore, enforcement of noise policies should be strengthened. Technical interventions, such as alarms or lighted warnings that alert the operator when a window is open (similar to seat belt dash warnings), may heighten awareness that operators are at higher risk of a noise overexposure and encourage them to take appropriate action.

Three factors add a degree of uncertainty in this study. The first is the fairly small sample size for old-style and retrofitted cabs and the second is that the research was conducted at only five mine sites. Further studies of additional haul truck cabs (at a variety of mine sites) would enhance the certainty of the study results. In addition, the observations of operator activities could only be made while a haul truck was visible while on the surface and the activities that occurred underground could not be monitored. The collection of data on underground activities depended on the reliability of the information provided by the haul truck operator and could be affected by self-report bias and errors. More direct observation techniques, such as sensors around the windows or video cameras, could help alleviate this problem for future studies. Finally, no plausible explanation could be provided as to why the outside noise levels were lower for the trucks with retrofitted cabs except for that the majority of these vehicles had engines with lower horsepower than the other engines (old- and new-style), thus possibly producing less noise.

Disclaimer

The findings and conclusions in this report have not been formally disseminated by the National Institute for Occupational Safety and Health and should not be construed to represent any agency determination or policy.

References

- Bauer, Eric R. and Daniel R. Babich (2004), "Administrative Controls for Reducing Worker Noise Exposures," SME Annual Meeting, February 23-25, Denver, CO), preprint 04-09, 9 pages.
- Bauer, Eric R. and Daniel R. Babich (2006), "Limestone Mining – Is It Noisy or Not?" SME Annual Meeting, March 27-29, St. Louis, MO) preprint 06-017, 6 pages.
- Daniel, J. Harrison, J. Alton Burks, Roy C. Bartholomae, R. Madden and E. E. Ungar(1981), "The Noise Exposure of Operators of Mobile Machines in U.S. Coal Mines," Bureau of Mines, U.S. Department of the Interior, Pittsburgh, PA), IC 8841, 24 p.
- Federal Register (1999), "Health Standards for Occupational Noise Exposure: Final Rule," (Department of Labor, Mine Safety and Health Administration), 30 CFR Parts 56 and 57 et al., Vol. 64, No. 176, (September 13,) pp. 49548-49634.
- Joy, Gerlad J. and Paul J. Middendorf, (2007), "Noise Exposure and Hearing Conservation in U.S. Coal Mines—A Surveillance Report," *Journal of Occupational and Environmental Hygiene*, January, Vol. 4: 26-35.
- Mohanty, Amiya. R., Barry D. St. Pierre, and P. Suruli-Narayananasami (2000), "Structure-Borne Noise Reduction in a Truck Cab Interior Using Numerical Techniques," *Applied Acoustics*, January, Vol. 59, No. 1: 1-17.
- TUFCOTE (2006), "H-SM foams: E-A-R Acoustical Foams Meets UL Smoke and Flame Standard," <http://www.earse.com/HOME/products/BarriersandAbsorbers/AbsorbingFoams/index.asp?SID=314> (Dec).

Doors and windows

Open (dBA) Closed (dBA)

New-style cabs	73.6 (n=8)	65.1 (n=18)
Old-style cabs	88.8 (n=4)	84.8 (n=7)
Retrofitted cabs*	86.1 (n=1)	84.9 (n=6)

Table 3

Mean SPL for open vs. closed doors and windows for each cab style.

	Doors and windows	
	Open (dBA)	Closed (dBA)
New-style cabs	73.6 (n=8)	65.1 (n=18)
Old-style cabs	88.8 (n=4)	84.8 (n=7)
Retrofitted cabs*	86.1 (n=1)	84.9 (n=6)

ภาคผนวก ข

ผลการตรวจวัดระดับเสียงที่พนักงานขับรถเจาะกระแทก
จะได้รับขณะปฏิบัติงานจริง

รายงานสรุปผลการตรวจวัด
ระดับเสียงเฉลี่ยตลอดเวลาการทำงาน

บริษัท ทอพ - คลาส คอนซัลแทนท์ จำกัด
วันที่ 12 ตุลาคม พ.ศ. 2561



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รายงานสรุปผลการตรวจวัดระดับเสียงเฉลี่ยตลอดเวลาการทำงาน

บริษัท ทอพ - คลาส คอนซัลแทนท์ จำกัด ได้มอบหมายให้ บริษัท เอแอลเอส แลบบอราทอรี กรุ๊ป (ประเทศไทย) จำกัด ดำเนินการตรวจวัดระดับเสียงเฉลี่ยตลอดเวลาการทำงาน เมื่อวันที่ 12 ตุลาคม พ.ศ. 2561 โดยมีรายละเอียดดังต่อไปนี้

1. วัตถุประสงค์

- 1.1 เพื่อตรวจวัดระดับเสียงเฉลี่ยตลอดเวลาการทำงาน พร้อมนำผลที่ได้จากการวิเคราะห์จากห้องปฏิบัติการเปรียบเทียบกับค่ามาตรฐานที่ราชการกำหนดไว้
- 1.2 เพื่อเฝ้าระวังปัญหามลพิษหรือปัจจัยเสี่ยงที่อาจส่งผลกระทบต่อสุขภาพของพนักงาน รวมทั้งเพื่อนำมาปรับปรุงแก้ไขได้อย่างทันท่วงที

2. ขอบเขตการดำเนินงาน

สำหรับการดำเนินงานตรวจวัดระดับเสียงเฉลี่ยตลอดเวลาการทำงาน ของบริษัท ทอพ - คลาส คอนซัลแทนท์ จำกัด เมื่อวันที่ 12 ตุลาคม พ.ศ. 2561 สามารถสรุปรายละเอียดการตรวจวัดได้ ดังตารางที่ 1

ตารางที่ 1 รายละเอียดการตรวจวัด

สถานี	เลขที่ตัวอย่าง	พารามิเตอร์	วันที่ตรวจวัด
ระดับเสียงเฉลี่ยตลอดเวลาการทำงาน			
ภายในโรงจอดรถ	1892268-1	Noise Dose, TWA	12 ต.ค. 61

3. วิธีการเก็บและการตรวจวัด

ในการตรวจวัดระดับเสียงเฉลี่ยตลอดเวลาการทำงาน บริษัท เอแอลเอส แลบบอราทอรี กรุ๊ป (ประเทศไทย) จำกัด ได้ยึดถือปฏิบัติตามมาตรฐานที่หน่วยงานราชการกำหนดหรือวิธีที่ได้รับการยอมรับจากหน่วยงานราชการ โดยมีรายละเอียดดังตารางที่ 2

ตารางที่ 2 รายละเอียดวิธีการเก็บและการตรวจวัด

พารามิเตอร์	อุปกรณ์ / วิธีการตรวจวัด	วิธีการอ้างอิง
ระดับเสียงเฉลี่ยตลอดเวลาการทำงาน		
Noise Dose	Noise Dose Meter	Department of Labour Protection and Welfare (B.E. 2561)



4. บุคลากร

การดำเนินงานในครั้งนี้ บริษัท เอแอลเอส แลบบอราทอรี กรุ๊ป (ประเทศไทย) จำกัด ได้จัดสรรบุคลากรผู้มีประสบการณ์ในการตรวจวัดระดับเสียงเฉลี่ยตลอดเวลาการทำงาน ดังนี้

- 1) การเก็บตัวอย่าง
ตำแหน่ง เจ้าหน้าที่เก็บตัวอย่าง
- 2) การรายงานผลตรวจวัด/วิเคราะห์
ตำแหน่ง ผู้ควบคุมดูแลห้องปฏิบัติการวิเคราะห์
ตำแหน่ง ผู้ควบคุมดูแลห้องปฏิบัติการวิเคราะห์
ตำแหน่ง เจ้าหน้าที่ประจำห้องปฏิบัติการวิเคราะห์
- 3) การจัดทำรายงาน
ตำแหน่ง นักวิชาการสิ่งแวดล้อม

5. สรุปผลการตรวจวัดระดับเสียงเฉลี่ยตลอดเวลาการทำงาน

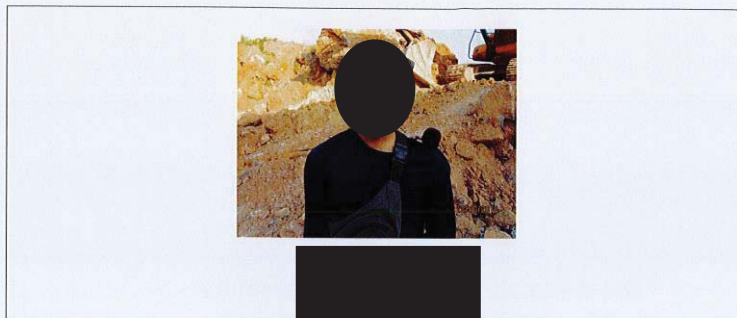
1) ผลการตรวจวัด

จากการตรวจวัดระดับเสียงเฉลี่ยตลอดเวลาการทำงาน เมื่อวันที่ 12 ตุลาคม พ.ศ. 2561 จำนวน 1 สถานี มีผลการตรวจวัดแสดงดังตารางที่ 3

2) สรุปผลการตรวจวัด

จากผลการตรวจวัดระดับเสียงเฉลี่ยตลอดเวลาการทำงาน เมื่อนำมาคำนวณหาปริมาณเสียงสะสม (Noise Dose) และระดับเสียงเฉลี่ยตลอดเวลาการทำงาน (TWA) ตามประกาศกรมสวัสดิการและคุ้มครองแรงงาน เรื่อง หลักเกณฑ์ วิธีการตรวจวัด และการวิเคราะห์สภาวะการทำงานเกี่ยวกับระดับความร้อน แสงสว่าง หรือเสียง รวมทั้งระยะเวลาและประเภทกิจการที่ต้องดำเนินการ (พ.ศ. 2561) และประกาศกรมสวัสดิการและคุ้มครองแรงงาน เรื่อง มาตรฐานระดับเสียงที่ยอมให้ลูกจ้างได้รับเสียงเฉลี่ยตลอดระยะเวลาในการทำงาน (พ.ศ. 2561) พบว่า มีค่าปริมาณเสียงสะสม (Noise Dose) 2.0 เปอร์เซ็นต์ และมีค่าระดับเสียงเฉลี่ยตลอดเวลาการทำงาน (TWA) 68.0 เดซิเบล (เอ) ซึ่งมีค่าอยู่ในเกณฑ์มาตรฐานฯ กำหนด

อย่างไรก็ตาม ทางโครงการควรทำการตรวจติดตามและเฝ้าระวังอย่างต่อเนื่อง นอกจากนี้ ทางโครงการควรวางแผนการในการป้องกันและควบคุม อาทิเช่น กำหนดให้พนักงานสวมใส่อุปกรณ์คุ้มครองความปลอดภัยส่วนบุคคล (PPE) สำหรับการลดเสียงให้กับพนักงานขณะปฏิบัติงาน เช่น ปลั๊กอุดเสียง (Ear Plugs) หรือครอบหูลดเสียง (Ear Muffs) สลับและหมุนเวียนพนักงานเข้าทำงานบริเวณที่อาจก่อให้เกิดเสียงดัง หากเกิดกรณีต้องมีการทำงานบริเวณที่อาจก่อให้เกิดเสียงดังเป็นเวลานานกว่าปกติ จัดสถานที่ติดตั้งอุปกรณ์ หรือเครื่องจักรให้อยู่ในห้วงที่มีประตูปิด ห่างไกลจากห้องทำงานของพนักงาน หรือติดเครื่องหมายเตือนให้ใช้อุปกรณ์คุ้มครองความปลอดภัยส่วนบุคคล เป็นต้น



ภาพแสดงการตรวจวัดระดับเสียงเฉลี่ยตลอดเวลาการทำงาน

ตารางที่ 3 สรุปผลการตรวจวัดระดับเสียงเฉลี่ยตลอดเวลาการทำงาน

สถานี	วันที่ตรวจวัด	ผลการตรวจวัด		มาตรฐาน (เดซิเบล (เอ))
		ระดับเสียงสะสม (%)	ระดับเสียงเฉลี่ย ตลอดเวลาการทำงาน 8 ชั่วโมง (TWA 8 hrs) (เดซิเบล (เอ))	
ภายในเขตเจาะกระแทก ()	12 ต.ค. 61	2.0	68.0	85

มาตรฐาน : ¹⁾ ประกาศกรมสวัสดิการและคุ้มครองแรงงาน เรื่อง หลักเกณฑ์ วิธีการตรวจวัด และการวิเคราะห์ผลการทำงานเกี่ยวกับระดับความรบกวน แสงสว่าง หรือเสียง รวมทั้งระยะเวลาและประเภทกิจการที่ต้องดำเนินการ (พ.ศ. 2561)
²⁾ ประกาศกรมสวัสดิการและคุ้มครองแรงงาน เรื่อง มาตรฐานระดับเสียงที่ยอมให้ลูกจ้างได้รับเสียงเฉลี่ยตลอดระยะเวลาในการทำงาน (พ.ศ. 2561)

ภาคผนวก

- ภาคผนวก ก ใบรับรองผลการวัด
- ภาคผนวก ข มาตรฐาน
- ภาคผนวก ค ใบรับรองการสอบเทียบเครื่องมือ
- ภาคผนวก ง สำเนาหนังสือใบอนุญาตขึ้นทะเบียนห้องปฏิบัติการวิเคราะห์เอกชน



Analysis / Test Report

Report to : Top-Class Consultant Co.,Ltd.
204 Muangthong 2/3, Soi Pattanakarn 53,
Pattanakarn Rd., Suanluang, Bangkok
Thailand 10250
Attn : Piyanut .
Phone : 0-2322-5758 Ext.
Fax : 0-2322-5759 Ext.
Email : top-class204@hotmail.com

Project Name :
Location :
P/O :
Receipt No :

Lot ID: 1882268
Date Received : Oct 12, 2018
Date Reported : Oct 23, 2018
Report Number : 1208600-1 Rev. No.1
Sampling by : Thananat Anake

Page 1 of 1

Reference Number 1882268-1
Sampling Date Oct 12, 2018
Sample Description Noise Dose
Location ภายในโรงงานเหล็ก
Personal Sampling [Redacted]

Sampling time	Noise Dose (%)	TWA (dB(A))	Standard TWA (dB(A))
08:00 AM - 04:00 PM	2.0	68.0	85

Reference Method : Department Labour Protection and Welfare (B.E.2561)

Standard :
1. Notification of Department Labour Protection and Welfare on the Criteria and Procedures for Measurement and Analysis of Working Conditions in relation to Heat, Light or Noise Levels, including Duration and Types of Business that must perform (B.E. 2561)
2. Notification of Department of Labour Protection and Welfare on the Standard of Time Weighted Average (TWA) Noise Level (B.E. 2561)

Note :

This Analysis test report is issued to supersede report No 1208600-1 Date: Oct 17, 2018

Technical Management

Scientist (4)

Approved by

Supervisor

The above results are valid only for the analyzed/tested sample(s) as indicated in this report. No part of this report or certificate may be reproduced in any form without written consent from the laboratory. ALS Laboratory Group (Thailand) strongly recommends that this report is not reproduced except in full.

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S:\Reports\Noisedose_S.rpt (04:17PM)

ภาคผนวก ก

ใบรับรองผลการวัด

ภาคผนวก ข

มาตรฐาน

หน้า ๑๑
เล่ม ๑๓๕ ตอนพิเศษ ๕๗ ง ราชกิจจานุเบกษา ๑๒ มีนาคม ๒๕๖๑

ประกาศกรมสวัสดิการและคุ้มครองแรงงาน เรื่อง หลักเกณฑ์ วิธีการตรวจวัด และการวิเคราะห์สภาวะการทำงานเกี่ยวกับระดับความร้อน แสงสว่าง หรือเสียง รวมทั้งระยะเวลาและประเภทกิจการที่ต้องดำเนินการ

โดยที่กฎกระทรวงกำหนดมาตรฐานในการบริหาร จัดการ และดำเนินการด้านความปลอดภัย อาชีวอนามัย และสภาพแวดล้อมในการทำงานเกี่ยวกับความร้อน แสงสว่าง และเสียง พ.ศ. ๒๕๕๔ ข้อ ๑๔ วรรคสอง กำหนดให้อธิบดีกรมสวัสดิการและคุ้มครองแรงงานกำหนดหลักเกณฑ์ วิธีการ ตรวจวัด และการวิเคราะห์สภาวะการทำงานเกี่ยวกับระดับความร้อน แสงสว่าง หรือเสียง รวมทั้ง ระยะเวลาและประเภทกิจการที่ต้องดำเนินการเพื่อให้การบริหารจัดการ และดำเนินการด้านความปลอดภัย อาชีวอนามัย และสภาพแวดล้อมในการทำงานได้อย่างปลอดภัย

อาศัยอำนาจตามความในข้อ ๑๔ วรรคสอง แห่งกฎกระทรวงกำหนดมาตรฐานในการบริหาร จัดการ และดำเนินการด้านความปลอดภัย อาชีวอนามัย และสภาพแวดล้อมในการทำงานเกี่ยวกับ ความร้อน แสงสว่าง และเสียง พ.ศ. ๒๕๕๔ อธิบดีกรมสวัสดิการและคุ้มครองแรงงานจึงออกประกาศไว้ ดังต่อไปนี้

ข้อ ๑ ประกาศนี้ให้ใช้บังคับตั้งแต่วันถัดจากวันประกาศในราชกิจจานุเบกษาเป็นต้นไป

หมวด ๑
บททั่วไป

ข้อ ๒ ให้นายจ้างจัดให้มีการตรวจวัดและวิเคราะห์สภาวะการทำงานเกี่ยวกับระดับความร้อน แสงสว่าง หรือเสียง ภายในสถานประกอบกิจการในสภาวะที่เป็นจริงของสภาพการทำงานอย่างน้อย ปีละหนึ่งครั้ง

กรณีที่มีการปรับปรุงหรือเปลี่ยนแปลงเครื่องจักรอุปกรณ์ กระบวนการผลิต วิธีการทำงาน หรือการดำเนินการใด ๆ ที่อาจมีผลต่อการเปลี่ยนแปลงระดับความร้อน แสงสว่าง หรือเสียง ให้นายจ้างดำเนินการตามวรรคหนึ่งเพิ่มเติมโดยตรวจวัดและวิเคราะห์สภาวะการทำงานบริเวณพื้นที่ หรือบุคคลที่อาจได้รับผลกระทบภายในเก้าสิบวันนับจากวันที่มีการปรับปรุงหรือเปลี่ยนแปลง

หมวด ๒
การตรวจวัดระดับความร้อนและประเภทกิจการที่ต้องดำเนินการ

ข้อ ๓ ให้นายจ้างจัดให้มีการตรวจวัดระดับความร้อนบริเวณที่มีลูกจ้างปฏิบัติงานอยู่ใน สภาพการทำงานปกติและต้องตรวจวัดในช่วงระยะเวลาที่ลูกจ้างอาจได้รับอันตรายจากความร้อนสูงสุด

ข้อ ๔ ประเภทกิจการที่ต้องดำเนินการตรวจวัด ได้แก่ การผลิตน้ำตาลและทำโบริสุทธี การปั่นทอที่มีการพอกหรือย้อมสี การผลิตเยื่อกระดาษหรือกระดาษ การผลิตยางรถยนต์หรือล้อดอกยาง การผลิตกระจก เครื่องแก้วหรือหลอดไฟ การผลิตซิเมนต์หรือปูนขาว การถลุง หล่อหลอมหรือรีดโลหะ หรือกิจการที่มีแหล่งกำเนิดความร้อนหรือมีการทำงานที่อาจทำให้ลูกจ้างได้รับอันตรายเนื่องจากความร้อน

ข้อ ๕ อุปกรณ์การตรวจวัดระดับความร้อน ประกอบด้วย

(๑) เทอร์โมมิเตอร์กระเปาะแห้ง เป็นชนิดปรอทหรือแอลกอฮอล์ที่มีความละเอียดของสเกล ๐.๕ องศาเซลเซียส และมีความแม่นยำบวกหรือลบ ๐.๕ องศาเซลเซียส มีการกำบังป้องกันเทอร์โมมิเตอร์จากแสงอาทิตย์ หรือแหล่งที่แผ่รังสีความร้อน โดยไม่รบกวนการไหลเวียนอากาศ

(๒) เทอร์โมมิเตอร์กระเปาะเปียกตามธรรมชาติ มีความละเอียดของสเกล ๐.๕ องศาเซลเซียส ที่มีความแม่นยำบวกหรือลบ ๐.๕ องศาเซลเซียส มีผ้าฝ้ายชื้นเดียวที่สะอาดห่อหุ้มกระเปาะ หยดน้ำกลั่น ลงบนผ้าฝ้ายที่หุ้มกระเปาะให้เปียกชุ่มและให้ปลายอีกด้านหนึ่งของผ้าจุ่มอยู่ในน้ำกลั่นเพื่อให้ผ้าส่วนที่หุ้มกระเปาะเทอร์โมมิเตอร์เปียกอยู่ตลอดเวลา

(๓) โกลบเทอร์โมมิเตอร์ มีช่วงการวัดตั้งแต่ลบ ๕ องศาเซลเซียส ถึง ๑๐๐ องศาเซลเซียส ที่ปลายกระเปาะเทอร์โมมิเตอร์เสียบอยู่ที่กลางทรงกลมกลวงที่ทำด้วยทองแดงขนาดเส้นผ่านศูนย์กลางสิบห้าเซนติเมตร ภายนอกหุ้มด้วยสีดำด้านที่สามารถดูดกลืนรังสีความร้อนได้ดี

อุปกรณ์ที่ใช้ในการตรวจวัดระดับความร้อนตามวรรคหนึ่งต้องทำการปรับเทียบความถูกต้อง (Calibration) อย่างน้อยปีละครั้ง

ในกรณีที่มิใช่ใช้อุปกรณ์ตามวรรคหนึ่ง ให้ใช้เครื่องวัดระดับความร้อนชนิดอิเล็กทรอนิกส์ที่สามารถอ่านและคำนวณค่าอุณหภูมิเวตบัลบ์โลก (WBGT) ได้ตามมาตรฐาน ISO 7243 ขององค์การมาตรฐานระหว่างประเทศ (International Organization for Standardization) หรือเทียบเท่า และให้ทำการปรับเทียบความถูกต้อง (Calibration) ก่อนใช้งานทุกครั้ง

ข้อ ๖ วิธีการตรวจวัดระดับความร้อนให้ติดตั้งอุปกรณ์หรือเครื่องวัดตามข้อ ๕ ในตำแหน่งสูงจากพื้นระดับหน้าอกของลูกจ้าง

อุปกรณ์ตามข้อ ๕ วรรคหนึ่ง ก่อนเริ่มอ่านค่าต้องตั้งอุปกรณ์ให้ทำงานไว้อย่างน้อยสามสิบนาที และให้บันทึกค่าตรวจวัดในช่วงระยะเวลาที่เหมาะสม ทั้งนี้ อุณหภูมิที่อ่านค่าเป็นองศาเซลเซียส ให้คำนวณหาค่าอุณหภูมิเวตบัลบ์โลก (WBGT) ตามวิธีการที่กำหนดไว้ในกฎกระทรวง

ให้หาค่าระดับความร้อนจากค่าเฉลี่ยของอุณหภูมิเวตบัลบ์โลก (WBGT) ที่คำนวณได้ในช่วงเวลาทำงานสองชั่วโมงที่ร้อนที่สุดได้จากสูตร ดังต่อไปนี้

$$WBGT_{(เฉลี่ย)} = \frac{WBGT_1 \times t_1 + WBGT_2 \times t_2 + + WBGT_n \times t_n}{t_1 + t_2 + + t_n}$$

WBGT₁ หมายถึง WBGT(°C) ในเวลา t₁ (นาที)

WBGT₂ หมายถึง WBGT(°C) ในเวลา t₂ (นาที)

WBGT_n หมายถึง WBGT(°C) ในเวลา t_n (นาที)

t₁+ t₂ ++ t_n = ๑๒๐ นาที ที่มีอุณหภูมิเวตบัลบ์โลก (WBGT) สูงสุด

ในกรณีที่ไม่สามารถระบุได้ว่าลักษณะงานที่ลูกจ้างทำในช่วงเวลาทำงานสองชั่วโมงที่ร้อนที่สุดตามวรรคสาม เป็นงานเบา งานปานกลาง หรืองานหนักตามที่กำหนดไว้ในกฎกระทรวง ให้คำนวณภาระงาน (Work-Load Assessment) เพื่อกำหนดลักษณะงานตามแนวทางของ OSHA Technical Manual (U.S. Department of Labor, Occupational Safety and Health Administration) หรือเทียบเท่า เช่น ISO 8996

ให้นำค่าระดับความร้อนที่คำนวณได้ตามวรรคสาม และลักษณะงานที่คำนวณได้ตามวรรคสี่ ไปเปรียบเทียบกับมาตรฐานระดับความร้อนตามที่กำหนดไว้ในกฎกระทรวง

หมวด ๓

การตรวจวัดความเข้มของแสงสว่างและประเภทกิจการที่ต้องดำเนินการ

ข้อ ๗ ให้นายจ้างจัดให้มีการตรวจวัดความเข้มของแสงสว่างในสถานประกอบกิจการทุกประเภทกิจการโดยให้ตรวจวัดบริเวณพื้นที่ทั่วไปและบริเวณการผลิตภายในสถานประกอบกิจการ และบริเวณที่ลูกจ้างต้องทำงานโดยใช้สายตามองเฉพาะจุดหรือต้องใช้สายตาคู่กับที่ในการทำงานในสภาพการทำงานปกติและในช่วงเวลาที่มีแสงสว่างตามธรรมชาติน้อยที่สุด

ข้อ ๘ การตรวจวัดความเข้มของแสงสว่าง ต้องใช้เครื่องวัดแสงที่ได้มาตรฐาน CIE 1931 ของคณะกรรมการระหว่างประเทศว่าด้วยความส่องสว่าง (International Commission on Illumination) หรือ ISO/CIE 10527 หรือเทียบเท่า เช่น JIS และก่อนเริ่มการตรวจวัดต้องปรับให้เครื่องวัดแสงอ่านค่าที่ศูนย์ (Photometer Zeroing)

ข้อ ๙ การตรวจวัดความเข้มของแสงสว่างบริเวณพื้นที่ทั่วไปและบริเวณการผลิตภายในสถานประกอบกิจการให้ตรวจวัดในแนวระนาบสูงจากพื้นเจดสิบห้าเซนติเมตร

ให้หาค่าเฉลี่ยความเข้มของแสงสว่าง โดยวัดค่าความเข้มของแสงสว่างทุก ๆ ๒ x ๒ ตารางเมตร แต่หากมีการติดหลอดไฟที่มีลักษณะที่แน่นอนซ้ำ ๆ กันสามารถวัดแสงในจุดที่เป็นตัวแทนของพื้นที่ที่มีแสงตกกระทบในลักษณะเดียวกันได้ ตามวิธีการวัดแสงและการคำนวณค่าเฉลี่ยตาม IES Lighting Handbook (1981 Reference Volume หรือเทียบเท่า) ของสมาคมวิศวกรรมด้านความส่องสว่างแห่งอเมริกาเหนือ (Illuminating Engineering Society of North America) หรือเทียบเท่า

สำหรับการตรวจวัดความเข้มของแสงสว่างบริเวณพื้นที่ทั่วไปที่มีการสัญจรในภาวะฉุกเฉินให้ตรวจวัดตามเส้นทางสัญจรในภาวะฉุกเฉินในแนวระนาบที่พื้นผิวทางเดิน แล้วนำมาคำนวณค่าเฉลี่ยตามวิธีการวัดแสงและการคำนวณค่าเฉลี่ยตามมาตรฐานระบบไฟฟ้าแสงสว่างฉุกเฉินและโคมไฟฟ้ายางออกฉุกเฉิน ภาคผนวก ก การวัดความส่องสว่างในระบบแสงสว่างฉุกเฉินของวิศวกรรมสถานแห่งประเทศไทย ในพระบรมราชูปถัมภ์ หรือ Compliance Document for New Zealand Building Code Clause F6 Visibility in Escape Routes Third Edition

นำค่าเฉลี่ยที่คำนวณได้ตามวรรคสองและวรรคสามเปรียบเทียบกับความเข้มของแสงสว่างตามที่กำหนดไว้ในประกาศกรมสวัสดิการและคุ้มครองแรงงาน เรื่อง มาตรฐานความเข้มของแสงสว่าง ลงวันที่ ๒๗ พฤศจิกายน พ.ศ. ๒๕๖๐

ข้อ ๑๐ การตรวจวัดความเข้มของแสงสว่างบริเวณที่ลูกจ้างต้องทำงานโดยใช้สายตามองเฉพาะจุด หรือต้องใช้สายตาอยู่กับที่ในการทำงาน ให้ตรวจวัดในจุดที่สายตาตกกระทบบนชิ้นงานหรือจุดที่ทำงานของลูกจ้าง (Workstation)

นำค่าความเข้มของแสงสว่างที่ตรวจวัดได้ตามวรรคหนึ่ง เปรียบเทียบกับความเข้มของแสงสว่างตามที่กำหนดไว้ในตามตารางในประกาศกรมสวัสดิการและคุ้มครองแรงงาน เรื่อง มาตรฐานความเข้มของแสงสว่าง ลงวันที่ ๒๗ พฤศจิกายน พ.ศ. ๒๕๖๐

หมวด ๔

การตรวจวัดระดับเสียงและประเภทกิจการที่ต้องดำเนินการ

ข้อ ๑๑ ประเภทกิจการที่ต้องดำเนินการตรวจวัดระดับเสียง ได้แก่ การระเบิด ย่อย ไม่หรือบดหิน การผลิตน้ำตาลหรือทำให้บริสุทธิ์ การผลิตน้ำแข็ง การป่น ทอโดยใช้เครื่องจักร การผลิตเครื่องเรือน เครื่องใช้จากไม้ การผลิตเยื่อกระดาษหรือกระดาษ กิจการที่มีการป่นหรือเจียรโลหะ กิจการที่มีแหล่งกำเนิดเสียง หรือสภาพการทำงานที่อาจทำให้ลูกจ้างได้รับอันตรายเนื่องจากเสียง

ข้อ ๑๒ การตรวจวัดระดับเสียง ต้องใช้อุปกรณ์ที่ได้มาตรฐานของคณะกรรมการระหว่างประเทศ ว่าด้วยเทคนิคไฟฟ้า (International Electrotechnical Commission) หรือเทียบเท่า ดังนี้

- (๑) เครื่องวัดเสียง ต้องได้มาตรฐาน IEC 61672 หรือ IEC 651 Type 2
- (๒) เครื่องวัดปริมาณเสียงสะสม (Noise Dosimeter) ต้องได้มาตรฐาน IEC 61252
- (๓) เครื่องวัดเสียงกระทบหรือเสียงกระแทก ต้องได้มาตรฐาน IEC 61672 หรือ IEC 60804

อุปกรณ์ที่ใช้ตรวจวัดระดับเสียงตามวรรคหนึ่ง ต้องทำการปรับเทียบความถูกต้อง (Calibration) ด้วยอุปกรณ์ตรวจสอบความถูกต้อง (Noise Calibrator) ที่ได้มาตรฐาน IEC 60942 หรือเทียบเท่า ตามวิธีการที่ระบุในคู่มือการใช้งานของผู้ผลิตก่อนการใช้งานทุกครั้งและให้จัดให้มีการปรับเทียบความถูกต้องของเครื่องมือกับหน่วยปรับเทียบมาตรฐานปีละหนึ่งครั้ง เว้นแต่สถานประกอบการมีเครื่องตรวจวัดเสียงที่ใช้สำหรับการตรวจวัดและวิเคราะห์ภายในสถานประกอบการ ให้ปรับเทียบความถูกต้องของเครื่องมือกับหน่วยปรับเทียบมาตรฐานทุก ๆ สองปี

ข้อ ๑๓ วิธีการตรวจวัดระดับเสียง ให้ตรวจวัดบริเวณที่มีลูกจ้างปฏิบัติงานอยู่ในสภาพการทำงานปกติ โดยตั้งค่าเครื่องวัดเสียงที่สเกล (Scale A) การตอบสนองแบบช้า (Slow) และตรวจวัดที่ระดับหูของลูกจ้างที่กำลังปฏิบัติงาน ณ จุดนั้นรัศมีไม่เกินสามสิบเซนติเมตร

กรณีใช้เครื่องวัดปริมาณเสียงสะสม (Noise Dosimeter) ต้องตั้งค่าให้เครื่องคำนวณปริมาณเสียงสะสม Threshold Level ที่ระดับเดซิเบลเฉลี่ย Criteria Level ที่ระดับเดซิเบลหาค่าเฉลี่ย Energy Exchange rate ที่สาม ส่วนการใช้เครื่องวัดเสียงกระทบหรือเสียงกระแทกให้ตั้งค่าตามที่ระบุในคู่มือการใช้งานของผู้ผลิต

ข้อ ๑๔ กรณีบริเวณที่ลูกจ้างปฏิบัติงานมีระดับเสียงดังไม่สม่ำเสมอ หรือลูกจ้างต้องย้ายการทำงานไปยังจุดต่าง ๆ ที่มีระดับเสียงดังแตกต่างกัน ให้ใช้สูตรในการคำนวณหาระดับเสียงเฉลี่ยตลอดเวลาการทำงานในแต่ละวัน ดังนี้

$$D = \{ (C_1/T_1) + (C_2/T_2) + \dots + (C_n/T_n) \} \times 100 \quad \text{๑}$$

และ $TWA_{(d)} = 10 \times \log (D/100) + ๘๕ \quad \text{๒}$

เมื่อ D = ปริมาณเสียงสะสมที่ลูกจ้างปฏิบัติงานได้รับหน่วยเป็นร้อยละ

C = ระยะเวลาที่สัมผัสเสียง

T = ระยะเวลาที่อนุญาตให้สัมผัสระดับเสียงนั้น ๆ (ตามตารางในประกาศกรม)

$TWA_{(d)}$ = ระดับเสียงเฉลี่ยตลอดเวลาการทำงาน ๘ ชั่วโมง/วัน

ค่า $TWA_{(d)}$ ที่คำนวณได้ต้องไม่เกินเดซิเบลหาค่าเฉลี่ย

หมวด ๕

คุณสมบัติผู้ตรวจวัดและวิเคราะห์สภาวะการทำงาน

ข้อ ๑๕ ผู้ที่ดำเนินการตรวจวัดและวิเคราะห์สภาวะการทำงานในสถานประกอบกิจการ ต้องมีคุณสมบัติอย่างหนึ่งอย่างใด ดังต่อไปนี้

- (๑) เป็นบุคคลที่ขึ้นทะเบียนเป็นเจ้าหน้าที่ความปลอดภัยในการทำงานระดับวิชาชีพของสถานประกอบกิจการกับกรมสวัสดิการและคุ้มครองแรงงาน สามารถดำเนินการตรวจวัดและวิเคราะห์สภาวะการทำงานเกี่ยวกับความร้อน แสงสว่าง หรือเสียง ภายในสถานประกอบกิจการของตนเอง
 - (๒) เป็นบุคคลที่ผู้สำเร็จการศึกษาไม่ต่ำกว่าปริญญาตรีสาขาอาชีวอนามัยหรือเทียบเท่าที่ขึ้นทะเบียนเป็นเจ้าหน้าที่ความปลอดภัยในการทำงานของสถานประกอบกิจการกับกรมสวัสดิการและคุ้มครองแรงงาน สามารถดำเนินการตรวจวัดและวิเคราะห์สภาวะการทำงานเกี่ยวกับความร้อน แสงสว่าง หรือเสียง ภายในสถานประกอบกิจการของตนเอง
 - (๓) เป็นบุคคลหรือนิติบุคคลที่ขึ้นทะเบียนตามมาตรา ๙ หรือมาตรา ๑๑ แห่งพระราชบัญญัติความปลอดภัย อาชีวอนามัย และสภาพแวดล้อมในการทำงาน พ.ศ. ๒๕๕๔ แล้วแต่กรณี
- ข้อ ๑๖ ผู้ตรวจวัดและวิเคราะห์สภาวะการทำงานต้องลงลายมือชื่อรับรองในแบบรายงานผลการตรวจวัดและวิเคราะห์สภาวะการทำงานเกี่ยวกับความร้อน แสงสว่าง หรือเสียงภายในสถานประกอบกิจการตามข้อ ๑๕ ที่กำหนดในกฎกระทรวง

หมวด ๖
การวิเคราะห์สภาวะการทำงานเกี่ยวกับระดับความร้อน แสงสว่าง และเสียง

ข้อ ๑๗ ให้นายจ้างทำการวิเคราะห์สภาวะการทำงานเกี่ยวกับระดับความร้อน แสงสว่าง หรือเสียงที่ลูกจ้างได้รับ

กรณีผลการตรวจวัดมีค่าเกินหรือต่ำกว่ามาตรฐานที่กำหนดไว้ในกฎกระทรวงหรือประกาศกรม แล้วแต่กรณี ต้องระบุสาเหตุและปัจจัยต่าง ๆ ที่เกี่ยวข้อง รวมทั้งอาคารสถานที่ การระบายอากาศ เครื่องจักร การบำรุงรักษา จำนวนลูกจ้างที่สัมผัสหรือเกี่ยวข้องกับอันตราย สภาพและลักษณะ การทำงานของลูกจ้าง รวมถึงวิธีการหรือมาตรการในการปรับปรุงแก้ไขและระยะเวลาที่คาดว่าจะแล้วเสร็จ

ประกาศ ณ วันที่ ๘ กุมภาพันธ์ พ.ศ. ๒๕๖๑
อนันต์ชัย อุทัยพัฒนาชีพ
อธิบดีกรมสวัสดิการและคุ้มครองแรงงาน

ประกาศกรมสวัสดิการและคุ้มครองแรงงาน
เรื่อง มาตรฐานระดับเสียงที่ยอมให้ลูกจ้างได้รับเฉลี่ยตลอดระยะเวลาการทำงานในแต่ละวัน

โดยที่กฎกระทรวงกำหนดมาตรฐานในการบริหาร จัดการ และดำเนินการด้านความปลอดภัย อาชีวอนามัย และสภาพแวดล้อมในการทำงานเกี่ยวกับความร้อน แสงสว่าง และเสียง พ.ศ. ๒๕๕๙ กำหนดให้นายจ้างต้องควบคุมระดับเสียงที่ลูกจ้างได้รับเฉลี่ยตลอดระยะเวลาการทำงานในแต่ละวัน มิให้เกินมาตรฐานตามที่อธิบดีประกาศกำหนด

อาศัยอำนาจตามความในข้อ ๘ แห่งกฎกระทรวงกำหนดมาตรฐานในการบริหาร จัดการ และดำเนินการด้านความปลอดภัย อาชีวอนามัย และสภาพแวดล้อมในการทำงานเกี่ยวกับความร้อน แสงสว่าง และเสียง พ.ศ. ๒๕๕๙ อธิบดีกรมสวัสดิการและคุ้มครองแรงงานจึงออกประกาศไว้ ดังต่อไปนี้

ข้อ ๑ ประกาศนี้เรียกว่า “ประกาศกรมสวัสดิการและคุ้มครองแรงงาน เรื่อง มาตรฐาน ระดับเสียงที่ยอมให้ลูกจ้างได้รับเฉลี่ยตลอดระยะเวลาการทำงานในแต่ละวัน”

ข้อ ๒ ประกาศนี้ให้ใช้บังคับเมื่อพ้นกำหนดเก้าสิบวันนับแต่วันประกาศในราชกิจจานุเบกษา

ข้อ ๓ นายจ้างต้องควบคุมระดับเสียงที่ลูกจ้างได้รับเฉลี่ยตลอดระยะเวลาการทำงาน ในแต่ละวัน (Time Weighted Average-TWA) มิให้เกินมาตรฐานตามตารางแนบท้ายประกาศ โดยหน่วยวัดระดับเสียงดังที่ใช้ในประกาศนี้ใช้หน่วยเป็น เดซิเบลเอ

ประกาศ ณ วันที่ ๑๓ ธันวาคม พ.ศ. ๒๕๖๐
อนันต์ชัย อุทัยพัฒนาชีพ
ผู้ตรวจราชการกระทรวง รักษาการแทน
อธิบดีกรมสวัสดิการและคุ้มครองแรงงาน

(ตารางแนบท้ายประกาศ)
 ตารางมาตรฐานระดับเสียงที่ยอมให้ลูกจ้างได้รับเฉลี่ยตลอดระยะเวลาการทำงานในแต่ละวัน

ระดับเสียงเฉลี่ยตลอดเวลาการทำงาน (TWA) ไม่เกิน (เดซิเบลเอ)	ระยะเวลาการทำงานที่ได้รับเสียงต่อวัน*	
	ชั่วโมง	นาที
๘๒	๑๖	-
๘๓	๑๒	๔๖
๘๔	๑๐	๕
๘๕	๘	-
๘๖	๖	๒๑
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๘๘	๔	-
๘๙	๓	๑๑
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๙๑	๒	-
๙๒	๑	๓๕
๙๓	๑	๑๖
๙๔	๑	-
๙๕	-	๔๘
๙๖	-	๓๘
๙๗	-	๓๐
๙๘	-	๒๔
๙๙	-	๑๙
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หมายเหตุ * ระยะเวลาการทำงานที่ได้รับเสียงและระดับเสียงเฉลี่ยตลอดเวลาการทำงาน (TWA) ให้ใช้ค่ามาตรฐานที่กำหนดในตารางข้างต้นเป็นลำดับแรก หากไม่มีค่ามาตรฐานที่กำหนดตรงตามตารางให้คำนวณจากสูตรดังนี้

$$T = \frac{L}{1.5 \times 10^4}$$

เมื่อ T หมายถึง เวลาการทำงานที่ยอมให้ได้รับเสียง (ชั่วโมง)

L หมายถึง ระดับเสียง (เดซิเบลเอ)

ในการนี้ค่าระดับเสียงเฉลี่ยตลอดเวลาการทำงาน (TWA) ที่ได้จากการคำนวณมีเลขทศนิยมให้ตัดเศษทศนิยมออก

ภาคผนวก ค

ใบรับรองการสอบเทียบเครื่องมือ



ALS Laboratory Group (Thailand) Co., Ltd.
104 Phatthanakan 40, Phatthanakan Rd.,
Khwaeng Suan Luang, Khet Suan Luang,
Bangkok 10250 Thailand
T +66 2 715 8700 F +66 2 715 8797

รายการเครื่องมือที่ใช้ในการวิเคราะห์ / ทดสอบ

Sample Name	Parameter	Equipment Name	ID No.	Calibrated Date	Next Cal	Freq. Calibrate (Months)
Noise Noise	Noise Dose, TWA Noise Dose, TWA	Noise Dose Calibrator Dose Meter	BKK_FS0931 188-2-312-01	10-Aug-18	10-Aug-19	12 On site Calibration

Certificate of Calibration



Equipment Details

Instrument Manufacturer Cirrus Research plc
Instrument Type RC:110A
Description DoseBadge Reader
Serial Number 83554

Calibration Procedure

The instrument detailed above has been calibrated to the publish test and calibration data as detailed in the instrument hand book, using the techniques recommended in the latest revisions of the International Standards IEC 61672-1:2013, IEC 61672-1:2002, IEC 60651:1979, IEC 60804:2001, IEC 61260:1995, IEC 60942:2003, IEC 60942:1997, IEC 61252:1993, ANSI S1.4-1983, ANSI S1.11-1986 and ANSI S1.43-1997 where applicable. Sound Level Meters: All Calibration procedures were carried out by substituting the microphone capsule with a suitable electrical signal, apart from the final acoustic calibration.

Calibration Traceability

The equipment detailed above was calibrated against the calibration laboratory standards held by Cirrus Research plc. These are traceable to International Standards (A.0.6). The standards are:

Microphone Type	B&K 4192	Serial Number	1920791	Calibration Ref.	S6450
Pistonphone Type	B&K 4220	Serial Number	613843	Calibration Ref.	S6388

Calibrated by

Calibration Date

Calibration Certificate Number

10 August 2018

262748

This Calibration Certificate is valid for 12 months from the date above.

Cirrus Research plc, Acoustic House, Bridlington Road, Hunmanby, North Yorkshire, YO14 0PH
Telephone: +44 (0) 1723 891655 Fax: +44 (0) 1723 891742
Email: sales@cirrusresearch.co.uk

REVIEW BY	
APPROVED BY	
NEXT CAL. DATE	10/9/19



188-2-312-01

NOISE DOSIMETER CALIBRATION DATA SHEET

Date : 12-Oct-18 Calibration Sheet No. : C-121018-188-2-312-01
Ambient Temperature (°C) : 33.0 Atmospheric Pressure (mmHg) : 756

INSTRUMENT CALIBRATED

Instrument ID. : 188-2-312-01 Serial No. : YG563
Brand : CIRRUS Model : RC:110AIS

CALIBRATOR

Calibrator ID. : 258-1-51-01 Serial No. : 83554
Brand : CIRRUS Model : RC:110A
Sound Pressure Level [db(A)] : 114 Date of Calibration : 10-Aug-18
Calibrate By : CIRRUS Calibration Certification No. : 262748

Standard Expected Reading [db(A)]	Noise Dosimeter Reading [db(A)]	Adjustment [db(A)]
114.0	114.0	0

Calibrated by



Field Environmental Scientist (1)

Approved by



Acting General Manager

FORM NO.: F 06-030 REVISION NO.: 2 ISSUE DATE: 13/02/13
ALS Laboratory Group

ภาคผนวก ง

สำเนาหนังสือใบอนุญาตขึ้นทะเบียน
ห้องปฏิบัติการวิเคราะห์เอกชน

ที่ อก ๐๓๑๐/(๑) ๕๙๖๒



กรมโรงงานอุตสาหกรรม
ถนนพระรามที่ ๖ เขตราชเทวี
กรุงเทพมหานคร ๑๐๕๐๐

๓๐ มีนาคม ๒๕๖๑

เรื่อง ต่ออายุหนังสือรับขึ้นทะเบียนห้องปฏิบัติการวิเคราะห์เอกชน

เรียน กรรมการผู้จัดการ บริษัท เอแอลเอส แลบอราทอรี กรุ๊ป (ประเทศไทย) จำกัด

อ้างถึง ๑. คำขอขึ้นทะเบียน/ต่ออายุหนังสืออนุญาตขึ้นทะเบียนห้องปฏิบัติการวิเคราะห์เอกชน

ลงวันที่ ๘ สิงหาคม ๒๕๖๐

๒. หนังสือบริษัท เอแอลเอส แลบอราทอรี กรุ๊ป (ประเทศไทย) จำกัด ลงวันที่ ๘ สิงหาคม ๒๕๖๐

๓. หนังสือบริษัท เอแอลเอส แลบอราทอรี กรุ๊ป (ประเทศไทย) จำกัด ลงวันที่ ๘ สิงหาคม ๒๕๖๐

สิ่งที่ส่งมาด้วย เอกสารแนบท้ายหนังสือรับต่ออายุขึ้นทะเบียนห้องปฏิบัติการวิเคราะห์เอกชน
บริษัท เอแอลเอส แลบอราทอรี กรุ๊ป (ประเทศไทย) จำกัด จำนวน ๒๘ แผ่น

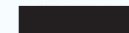
ตามหนังสือที่อ้างถึง ๑, ๒ และ ๓ บริษัท เอแอลเอส แลบอราทอรี กรุ๊ป (ประเทศไทย) จำกัด
ขอต่ออายุหนังสือรับขึ้นทะเบียนห้องปฏิบัติการวิเคราะห์เอกชน เลขทะเบียน ว-๒๐๔ สถานที่ตั้งเลขที่ ๑๐๔
ซอยพัฒนาการ ๔๐ ถนนพัฒนาการ แขวงสวนหลวง เขตสวนหลวง กรุงเทพมหานคร ต่อกรมโรงงาน
อุตสาหกรรม นั้น

กรมโรงงานอุตสาหกรรมพิจารณาแล้ว ให้บริษัท เอแอลเอส แลบอราทอรี กรุ๊ป (ประเทศไทย) จำกัด
ต่ออายุหนังสือรับขึ้นทะเบียนห้องปฏิบัติการวิเคราะห์เอกชน โดยมีองค์ประกอบดังนี้

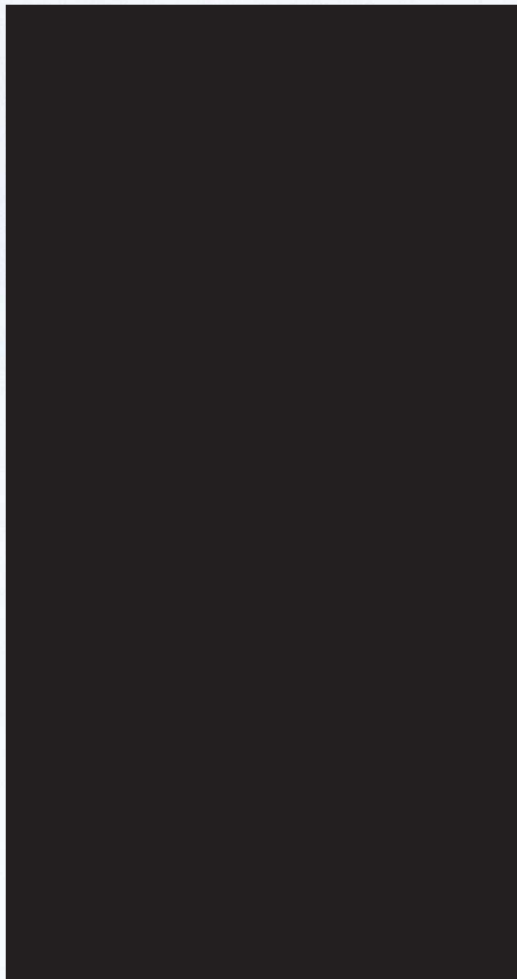
ก. ผู้ควบคุมดูแลห้องปฏิบัติการวิเคราะห์



ข. เจ้าหน้าที่ประจำห้องปฏิบัติการวิเคราะห์



-๓-



-๔-



ค. สารมลพิษที่เห็นชอบให้วิเคราะห์ในน้ำเสีย จำนวน ๔๗ รายการ น้ำใต้ดิน
จำนวน ๑๒๓ รายการ อากาศเสีย จำนวน ๑๖ รายการ กากอุตสาหกรรม จำนวน ๓๖ รายการ และดิน
จำนวน ๑๒๕ รายการ รวมทั้งสิ้นจำนวน ๓๔๗ รายการ ตามสิ่งที่ส่งมาด้วย

หนังสือฉบับนี้จะหมดอายุในวันที่ ๒ กันยายน ๒๕๖๓ หากประสงค์จะต่ออายุหนังสือ
รับขึ้นทะเบียนห้องปฏิบัติการวิเคราะห์เอกชน ให้ยื่นคำขอต่ออายุพร้อมเอกสารประกอบคำขอต่อ
กรมโรงงานอุตสาหกรรมภายใน ๓๐ วัน ก่อนสิ้นอายุของหนังสือรับขึ้นทะเบียนห้องปฏิบัติการวิเคราะห์เอกชน
ซึ่งคำขอต่ออายุดังกล่าวขอรับได้ที่กรมโรงงานอุตสาหกรรม

จึงเรียนมาเพื่อทราบ

ขอแสดงความนับถือ



รองอธิบดี ปฏิบัติราชการแทน
อธิบดีกรมโรงงานอุตสาหกรรม

กองวิจัยและเฝ้าระวังมลพิษโรงงาน

กลุ่มมาตรฐานวิธีการวิเคราะห์ทดสอบมลพิษและทะเบียนห้องปฏิบัติการ

โทร. ๐ ๒๒๐๒ ๔๑๕๖-๗ ๐ ๒๒๐๒ ๔๐๐๒

โทรสาร ๐ ๒๓๕๔ ๓๒๐๘ ๐ ๒๓๕๔ ๓๔๑๕

เอกสารแนบท้ายหนังสือรับต่ออายุขึ้นทะเบียนห้องปฏิบัติการวิเคราะห์เอกชน
บริษัท เอแอลเอส แลบบอราทอรี กรุป (ประเทศไทย) จำกัด เลขทะเบียน 7-204
ที่ ออก ๐๓๑๐/(๑) ๕ ๕๖๒ ลงวันที่ ๓๐ มีนาคม ๒๕๖๑
สารมลพิษที่เห็นชอบให้วิเคราะห์ จำนวน 347 รายการ

บัญชี จำนวน 47 รายการ

ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
1	Aldrin	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
2	Arsenic	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾
3	Barium	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾
4	α-BHC	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
5	β-BHC	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
6	γ-BHC	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
7	Biochemical Oxygen Demand	1) 5-Day BOD Test, Azide Modification Method ⁽⁴⁾ 2) 5-Day BOD Test, Membrane Electrode Method ⁽⁴⁾
8	Cadmium	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾
9	Chemical Oxygen Demand	1) Closed Reflux, Colorimetric Method ⁽⁴⁾ 2) Open Reflux, Titrimetric Method ⁽⁴⁾
10	Chlordane	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
11	Chromium	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾
12	Color	ADMI Weighted-Ordinate Spectrophotometric Method ⁽⁴⁾
13	Copper	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾
14	Cyanide	Distillation, Colorimetric Method ⁽⁴⁾
15	o,p'-DDD	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
16	p,p'-DDD	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
17	o,p'-DDE	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
18	p,p'-DDE	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾

/19 o,p'-DDT...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
19	o,p'-DDT	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
20	p,p'-DDT	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
21	Dieldrin	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
22	Endosulfan Sulfate	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
23	Endosulfan I	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
24	Endosulfan II	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
25	Endrin	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
26	Endrin Aldehyde	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
27	Formaldehyde	Distillation, Colorimetric Method ⁽³⁾
28	Free Chlorine	1) DPD Ferrous Titrimetric Method ⁽⁴⁾ 2) Iodometric Method ⁽⁴⁾
29	Heptachlor	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
30	Heptachlor Epoxide	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
31	Hexavalent Chromium	Filtration, Colorimetric Method ⁽⁴⁾
32	Lead	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾
33	Manganese	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾
34	Mercury	1) Cold-Vapor Atomic Absorption Spectrometric Method ⁽⁴⁾ 2) Cold-Vapor Atomic Fluorescence Spectrometric Method ⁽¹²⁾ 3) Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾
35	Methoxychlor	Liquid-Liquid Extraction, Gas Chromatographic Method ⁽⁴⁾
36	Nickel	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾
37	Oil & Grease	1) Liquid-Liquid, Partition-Gravimetric Method ⁽⁴⁾ 2) Soxhlet Extraction Method ⁽⁴⁾
38	pH	Electrometric Method ⁽⁴⁾
39	Phenols	Distillation, Chloroform Extraction Method ⁽⁴⁾

/40 Selenium...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
40	Selenium	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾
41	Sulfide	ZnS Precipitation, Iodometric Method ⁽⁴⁾
42	Temperature	Laboratory and Field Methods ⁽⁴⁾
43	Total Dissolved Solids	Dried at 180°C ⁽⁴⁾
44	Total Kjeldahl Nitrogen	Digestion, Semi-Micro Kjeldahl Method ⁽⁴⁾
45	Total Suspended Solids	Dried at 103-105°C ⁽⁴⁾
46	Trivalent Chromium	1) Digestion, Inductively Coupled Plasma Method; Filtration, Colorimetric Method; Calculation ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method; Filtration, Colorimetric Method; Calculation ⁽⁴⁾
47	Zinc	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾

น้ำใต้ดิน จำนวน 123 รายการ

ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
1	Acenaphthene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
2	Acetone	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
3	Aldrin	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
4	Anthracene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
5	Antimony	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾
6	Arsenic	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾
7	Atrazine	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾

/8 Barium...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
8	Barium	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾
9	Benz(a)anthracene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
10	Benzene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
11	Benzo(b)fluoranthene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
12	Benzo(k)fluoranthene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
13	Benzoic Acid	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
14	Benzo(a)pyrene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
15	Benzo(g,h,i)perylene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
16	Beryllium	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾
17	Bis(2-chloroethyl)ether	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
18	Bis(2-ethylhexyl)phthalate	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
19	Bromodichloromethane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
20	Bromoform	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
21	Butanol	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
22	Butyl Benzyl Phthalate	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
23	Cadmium	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾

/24 Carbazole...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
24	Carbazole	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
25	Carbon Disulfide	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
26	Carbontetrachloride	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
27	Chlordane	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
28	p-Chloroaniline	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
29	Chlorobenzene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
30	Chlorodibromomethane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
31	Chloroform	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
32	2-Chlorophenol	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
33	Chromium	1) Digestion, Inductively Coupled Plasma Method ^[4] 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ^[4]
34	Chromium (III)	1) Digestion, Inductively Coupled Plasma Method; Filtration, Colorimetric Method; Calculation ^[4] 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method; Filtration, Colorimetric Method; Calculation ^[4]
35	Chromium (VI)	Filtration, Colorimetric Method ^[4]
36	Chrysene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
37	Cyanide	Distillation, Colorimetric Method ^[4]
38	2,4-D	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
39	DDD	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
40	DDE	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]

1 DDT...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
41	DDT	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
42	Dibenz(a,h)anthracene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
43	Di-n-Butyl Phthalate	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
44	1,2-Dichlorobenzene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
45	1,3-Dichlorobenzene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
46	1,4-Dichlorobenzene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
47	3,3-Dichlorobenzidine	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
48	1,1-Dichloroethane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
49	1,2-Dichloroethane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
50	1,1-Dichloroethylene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
51	cis-1,2-Dichloroethylene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
52	trans-1,2-Dichloroethylene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
53	2,4-Dichlorophenol	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
54	1,2-Dichloropropane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
55	1,3-Dichloropropane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
56	1,3-Dichloropropene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
57	Dieldrin	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
58	Diethyl Phthalate	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]

/59 2,4-Dimethylphenol...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
59	2,4-Dimethylphenol	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
60	2,4-Dinitrophenol	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
61	2,4-Dinitrotoluene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
62	2,6-Dinitrotoluene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
63	Di-n-Octyl Phthalate	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
64	Endosulfan	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
65	Endrin	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
66	Ethylbenzene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
67	Fluoranthene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
68	Fluorene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
69	Heptachlor	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
70	Heptachlor Epoxide	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
71	Hexachlorobenzene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
72	Hexachloro-1,3-butadiene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
73	n-Hexane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
74	α-HCH	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
75	β-HCH	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
76	γ-HCH	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾

/77 Hexachlorocyclopentadiene...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
77	Hexachlorocyclopentadiene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
78	Hexachloroethane	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
79	Indeno(1,2,3-cd) Pyrene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
80	Isophorone	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
81	Lead	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾
82	Manganese	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾
83	Mercury	1) Cold Vapor Atomic Absorption Spectrometric Method ⁽⁴⁾ 2) Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾
84	Methanol	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
85	Methoxychlor	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
86	Methyl Bromide	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
87	Methylene Chloride	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
88	2-Methylphenol	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
89	2-Methylnaphthalene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^(25,26,4)
90	Methyl Tert-Butyl Ether	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
91	Naphthalene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ⁽⁴⁾
92	Nickel	1) Digestion, Inductively Coupled Plasma Method ⁽⁴⁾ 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ⁽⁴⁾

/93 Nitrobenzene...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
93	Nitrobenzene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
94	N-Nitrosodiphenylamine	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
95	N-Nitrosodi-n-Propylamine	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
96	Polychlorinated Biphenyls - PCB 1016 - PCB 1221 - PCB 1232 - PCB 1242 - PCB 1248 - PCB 1254 - PCB 1260	Liquid-Liquid Extraction, Gas Chromatographic/ Method ^[4]
97	Pentachlorophenol	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
98	pH	Electrometric Method ^[4]
99	Phenanthrene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
100	Phenol	1) Distillation, Direct Photometric Method ^[4] 2) Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
101	Pyrene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
102	Selenium	1) Digestion, Inductively Coupled Plasma Method ^[4] 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ^[4]
103	Silver	1) Digestion, Inductively Coupled Plasma Method ^[4] 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ^[4]
104	Styrene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
105	1,1,2,2-Tetrachloroethane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
106	Tetrachloroethylene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]

/107 Toluene...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
107	Toluene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
108	Toxaphene	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
109	1,2,4-Trichlorobenzene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
110	1,1,1-Trichloroethane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
111	1,1,2-Trichloroethane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
112	Trichloroethylene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
113	2,4,5-Trichlorophenol	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[25,26]
114	2,4,6-Trichlorophenol	Liquid-Liquid Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[4]
115	1,3,5-Trimethylbenzene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
116	Vanadium	1) Digestion, Inductively Coupled Plasma Method ^[4] 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ^[4]
117	Vinyl Acetate	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
118	Vinyl Chloride	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
119	m-Xylene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
120	o-Xylene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
121	p-Xylene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
122	Xylene (Total)	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[4]
123	Zinc	1) Digestion, Inductively Coupled Plasma Method ^[4] 2) Digestion, Inductively Coupled Plasma-Mass Spectrometric Method ^[4]

/อากาศเสีย...

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อากาศเสีย (ปล่อยระบาย) จำนวน 16 รายการ

ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
1	Antimony	Isokinetic, Digestion, Inductively Coupled Plasma Method ^[5]
2	Arsenic	Isokinetic, Digestion, Inductively Coupled Plasma Method ^[5]
3	Carbon Monoxide	1) Sampling bag, Non-Dispersive Infrared Method ^[5] 2) Non-Dispersive Infrared Method ^[5]
4	Chlorine	1) Absorption, Ion Chromatographic Method ^[5] 2) Isokinetic, Ion Chromatographic Method ^[5]
5	Copper	Isokinetic, Digestion, Inductively Coupled Plasma Method ^[5]
6	Dioxins	Isokinetic Sampling, Analysis by ISO/IEC 17025 Accredited Laboratory ^[5]
7	Hydrogen Chloride	1) Absorption, Ion Chromatographic Method ^[5] 2) Isokinetic, Ion Chromatographic Method ^[5]
8	Hydrogen Sulfide	Absorption, Iodometric Method ^[5]
9	Lead	Isokinetic, Digestion, Inductively Coupled Plasma Method ^[5]
10	Mercury	1) Isokinetic, Digestion, Cold-Vapor Atomic Absorption Spectrometric Method ^[5] 2) Isokinetic, Digestion, Inductively Coupled Plasma Method ^[5]
11	Opacity	Ringelmann's Method ^[2]
12	Oxides of Nitrogen	1) Absorption, Phenoldisulfonic Acid Method ^[5] 2) Chemiluminescence Method ^[5]
13	Sulfur Dioxide	1) Absorption, Barium-Thorin Titrimetric Method ^[5] 2) UV-Fluorescence Method ^[5]
14	Sulfuric Acid	Isokinetic, Barium-Thorin Titrimetric Method ^[5]
15	Total Suspended Particulate	Isokinetic, Gravimetric Method ^[5]
16	Xylene	Absorption, Gas Chromatographic Method ^[5]

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ภาคอุตสาหกรรม จำนวน 36 รายการ

ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
1	Aldrin	1) Waste Extraction, Gas Chromatographic Method ^[1,4] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18] 3) Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^[14,20]
2	Antimony	1) Waste Extraction, Digestion, Inductively Coupled Plasma Method ^[1,8,13] 2) Waste Extraction, Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[1,8,23] 3) Digestion, Inductively Coupled Plasma Method ^[8,13] 4) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
3	Arsenic	1) Waste Extraction, Digestion, Inductively Coupled Plasma Method ^[1,8,13] 2) Waste Extraction, Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[1,8,23] 3) Digestion, Inductively Coupled Plasma Method ^[8,13] 4) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
4	Barium	1) Waste Extraction, Digestion, Inductively Coupled Plasma Method ^[1,8,13] 2) Waste Extraction, Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[1,8,23] 3) Digestion, Inductively Coupled Plasma Method ^[8,13] 4) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
5	Beryllium	1) Waste Extraction, Digestion, Inductively Coupled Plasma Method ^[1,8,13] 2) Waste Extraction, Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[1,8,23] 3) Digestion, Inductively Coupled Plasma Method ^[8,13] 4) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]

/6 Cadmium...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
6	Cadmium	1) Waste Extraction, Digestion, Inductively Coupled Plasma Method ^[1,8,13] 2) Waste Extraction, Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[1,8,23] 3) Digestion, Inductively Coupled Plasma Method ^[8,13] 4) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
7	Chlordane	1) Waste Extraction, Gas chromatographic Method ^[1,4] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18] 3) Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^[14,20]
8	Chromium	1) Waste Extraction, Digestion, Inductively Coupled Plasma Method ^[1,8,13] 2) Waste Extraction, Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[1,8,23] 3) Digestion, Inductively Coupled Plasma Method ^[8,13] 4) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
9	Cobalt	1) Waste Extraction, Digestion, Inductively Coupled Plasma Method ^[1,8,13] 2) Waste Extraction, Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[1,8,23] 3) Digestion, Inductively Coupled Plasma Method ^[8,13] 4) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
10	Copper	1) Waste Extraction, Digestion, Inductively Coupled Plasma Method ^[1,8,13] 2) Waste Extraction, Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[1,8,23] 3) Digestion, Inductively Coupled Plasma Method ^[8,13] 4) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
11	Cyanide	1) Distillation, Colorimetric Method ^[21,22] 2) Waste Extraction, Distillation, Colorimetric Method ^[1,22]

/12 2,4-D...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
12	2,4-D	1) Waste Extraction, Gas Chromatographic Method ^[1,4] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18] 3) Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^[14,20]
13	DDD	1) Waste Extraction, Gas Chromatographic Method ^[1,4] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18] 3) Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^[14,20]
14	DDE	1) Waste Extraction, Gas Chromatographic Method ^[1,4] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18] 3) Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^[14,20]
15	DDT	1) Waste Extraction, Gas Chromatographic Method ^[1,4] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18] 3) Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^[14,20]
16	Dieldrin	1) Waste Extraction, Gas Chromatographic Method ^[1,4] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18] 3) Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^[14,20]
17	Endrin	1) Waste Extraction, Gas Chromatographic Method ^[1,4] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18] 3) Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^[14,20]
18	Heptachlor	1) Waste Extraction, Gas Chromatographic Method ^[1,4] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18] 3) Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^[14,20]
19	Hexavalent Chromium	1) Waste Extraction, Colorimetric Method ^[1,17] 2) Digestion, Colorimetric Method ^[7,17]
20	Lead	1) Waste Extraction, Digestion, Inductively Coupled Plasma Method ^[1,8,13] 2) Waste Extraction, Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[1,8,23] 3) Digestion, Inductively Coupled Plasma Method ^[8,13] 4) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]

/21 Lindane...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
21	Lindane	1) Waste Extraction, Gas Chromatographic Method ^[1,4] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18] 3) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
22	Mercury	1) Waste Extraction, Cold-Vapor Atomic Absorption Spectrometric Method ^[1,15] 2) Waste Extraction, Cold-Vapor Atomic Fluorescence Spectrometric Method ^[1,11] 3) Digestion, Cold-Vapor Atomic Absorption Spectrometric Method ^[15] 4) Digestion, Cold-Vapor Atomic Fluorescence Spectrometric Method ^[11] 5) Direct Thermal Decomposition, Amalgamation and Atomic Absorption Spectrometric Method ^[25]
23	Methoxychlor	1) Waste Extraction, Gas Chromatographic Method ^[1,4] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18] 3) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
24	Mirex	1) Waste Extraction, Gas Chromatographic Method ^[1,4] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18] 3) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
25	Molybdenum	1) Waste Extraction, Digestion, Inductively Coupled Plasma Method ^[1,8,13] 2) Waste Extraction, Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[1,8,23] 3) Digestion, Inductively Coupled Plasma Method ^[8,13] 4) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
26	Nickel	1) Waste Extraction, Digestion, Inductively Coupled Plasma Method ^[1,8,13] 2) Waste Extraction, Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[1,8,23] 3) Digestion, Inductively Coupled Plasma Method ^[8,13] 4) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]

/27 Polychlorinated...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
27	Polychlorinated biphenyls (PCBs)	1) Waste Extraction, Gas Chromatographic Method ^[1,19] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,19] 3) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
28	Pentachlorophenol	1) Waste Extraction, Gas Chromatographic Method ^[1,4] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18] 3) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
29	pH	Electrometric Method ^[16]
30	Selenium	1) Waste Extraction, Digestion, Inductively Coupled Plasma Method ^[1,8,13] 2) Waste Extraction, Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[1,8,23] 3) Digestion, Inductively Coupled Plasma Method ^[8,13] 4) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
31	Silver	1) Waste Extraction, Digestion, Inductively Coupled Plasma Method ^[1,8,13] 2) Waste Extraction, Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[1,8,23] 3) Digestion, Inductively Coupled Plasma Method ^[8,13] 4) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
32	Thallium	1) Waste Extraction, Digestion, Inductively Coupled Plasma Method ^[1,8,13] 2) Waste Extraction, Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[1,8,23] 3) Digestion, Inductively Coupled Plasma Method ^[8,13] 4) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
33	Toxaphene	1) Waste Extraction, Gas Chromatographic Method ^[1,4] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18] 3) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]

/34 Trivalent Chromium...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
34	Trivalent Chromium	1) Waste Extraction, Digestion, Inductively Coupled Plasma Method; Filtration, Colorimetric Method; Calculation ^(1,8,13,17) 2) Waste Extraction, Digestion, Inductively Coupled Plasma-Mass Spectrometry Method; Filtration, Colorimetric Method; Calculation ^(1,8,17,23) 3) Digestion, Inductively Coupled Plasma Method; Filtration, Colorimetric Method; Calculation ^(8,13,17) 4) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method; Filtration, Colorimetric Method; Calculation ^(8,17,23)
35	Vanadium	1) Waste Extraction, Digestion, Inductively Coupled Plasma Method ^(1,8,13) 2) Waste Extraction, Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^(1,8,23) 3) Digestion, Inductively Coupled Plasma Method ^(8,13) 4) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^(8,23)
36	Zinc	1) Waste Extraction, Digestion, Inductively Coupled Plasma Method ^(1,13) 2) Waste Extraction, Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^(1,23) 3) Digestion, Inductively Coupled Plasma Method ^(8,13) 4) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^(8,23)

ดิน จำนวน 125 รายการ

ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
1	Acenaphthene	Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^(14,20)
2	Acetone	Purge and Trap, Gas Chromatographic/Mass Spectrometric Method ^(27,28)
3	Aldrin	1) Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^(14,20) 2) Soxhlet Extraction, Gas Chromatographic Method ^(16,20)

/4 Anthracene...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
4	Anthracene	Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^(14,20)
5	Antimony	1) Digestion, Inductively Coupled Plasma Atomic Emission Spectrometric Method ^(8,13) 2) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^(8,23)
6	Arsenic	1) Digestion, Inductively Coupled Plasma Atomic Emission Spectrometric Method ^(8,13) 2) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^(8,23)
7	Atrazine	1) Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^(14,20) 2) Soxhlet Extraction, Gas Chromatographic Method ^(16,18)
8	Barium	1) Digestion, Inductively Coupled Plasma Atomic Emission Spectrometric Method ^(8,13) 2) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^(8,23)
9	Benz(a)anthracene	Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^(14,20)
10	Benzene	Purge and Trap, Gas Chromatographic/Mass Spectrometric Method ^(27,28)
11	Benzo(b)fluoranthene	Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^(14,20)
12	Benzo(k)fluoranthene	Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^(14,20)
14	Benzo(a)pyrene	Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^(14,20)
15	Benzo(g,h,i)perylene	Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^(14,20)
16	Beryllium	1) Digestion, Inductively Coupled Plasma Atomic Emission Spectrometric Method ^(8,13) 2) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^(8,23)
17	Bis(2-chloroethyl)ether	Solvent Extraction, Gas Chromatographic/Mass Spectrometric Method ^(14,20)

/18 Bis(2-ethylhexyl)phthalate...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
18	Bis(2-ethylhexyl)phthalate	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
19	Bromodichloromethane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
20	Bromoform	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
21	Butanol	Equilibrium Headspace, Gas Chromatographic/ Mass Spectrometric Method ^[26,28]
22	Butyl Benzyl Phthalate	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
23	Cadmium	1) Digestion, Inductively Coupled Plasma Atomic Emission Spectrometric Method ^[8,13] 2) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
24	Carbazole	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
25	Carbon Disulfide	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
26	Carbontetrachloride	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
27	Chlordane	1) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18]
28	p-Chloroaniline	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
29	Chlorobenzene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
30	Chlorodibromomethane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
31	Chloroform	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
32	2-Chlorophenol	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]

/33 Chromium...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
33	Chromium	1) Digestion, Inductively Coupled Plasma Atomic Emission Spectrometric Method ^[8,13] 2) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
34	Chromium (III)	1) Digestion, Inductively Coupled Plasma Atomic Emission Spectrometric Method; Filtration, Colorimetric Method; Calculation ^[8,13,7,17] 2) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method; Filtration, Colorimetric Method; Calculation ^[8,23,7,17]
35	Chromium (VI)	Filtration, Colorimetric Method ^[7,17]
36	Chrysene	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
37	Cyanide	Extraction, Distillation, Colorimetric Method ^[21,22,29]
38	2,4-D	1) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18]
39	DDD	1) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18]
40	DDE	1) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18]
41	DDT	1) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18]
42	Dibenz(a,h)anthracene	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
43	Di-n-Butyl Phthalate	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
44	1,2-Dichlorobenzene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
45	1,3-Dichlorobenzene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
46	1,4-Dichlorobenzene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]

/47 3,3-Dichlorobenzidine...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
47	3,3-Dichlorobenzidine	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
48	1,1-Dichloroethane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
49	1,2-Dichloroethane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
50	1,1-Dichloroethylene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
51	cis-1,2-Dichloroethylene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
52	trans-1,2-Dichloroethylene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
53	2,4-Dichlorophenol	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
54	1,2-Dichloropropane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
55	1,3-Dichloropropane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
56	1,3-Dichloropropene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
57	Dieldrin	1) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18]
58	Diethyl Phthalate	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
59	2,4-Dimethylphenol	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
60	2,4-Dinitrophenol	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
61	2,4-Dinitrotoluene	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
62	2,6-Dinitrotoluene	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
63	Di-n-Octyl Phthalate	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]

/64 Endosulfan...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
64	Endosulfan	1) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
65	Endrin	2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18] 1) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
66	Ethylbenzene	2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18] Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
67	Fluoranthene	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
68	Fluorene	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
69	Heptachlor	1) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18]
70	Heptachlor Epoxide	1) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18]
71	Hexachlorobenzene	1) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18]
72	Hexachloro-1,3-butadiene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
73	n-Hexane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
74	α-HCH	1) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18]
75	β-HCH	1) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18]
76	γ-HCH	1) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18]

/77 Hexachlorocyclopentadiene...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
77	Hexachlorocyclopentadiene	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
78	Hexachloroethane	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
79	Indeno(1,2,3-cd)pyrene	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
80	Isophorone	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
81	Lead	1) Digestion, Inductively Coupled Plasma Atomic Emission Spectrometric Method ^[8,13] 2) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
82	Manganese	1) Digestion, Inductively Coupled Plasma Atomic Emission Spectrometric Method ^[8,13] 2) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
83	Mercury	1) Digestion, Cold-Vapor Atomic Absorption Spectrometric Method ^[15] 2) Digestion, Cold-Vapor Atomic Fluorescence Spectrometric Method ^[11] 3) Direct Thermal Decomposition, Amalgamation and Atomic Absorption Spectrometry Method ^[25]
84	Methanol	Equilibrium Headspace, Gas Chromatographic/ Mass Spectrometric Method ^[26,28]
85	Methoxychlor	1) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18]
86	Methyl Bromide	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
87	Methylene Chloride	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
88	2-methylphenol	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
89	2-Methylnaphthalene	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
90	Methyl Tert-Butyl Ether	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]

/91 Naphthalene...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
91	Naphthalene	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
92	Nickel	1) Digestion, Inductively Coupled Plasma Atomic Emission Spectrometric Method ^[8,13] 2) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
93	Nitrobenzene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
94	N-Nitrosodiphenylamine	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
95	N-Nitrosodi-n-propylamine	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
96	Polychlorinated Biphenyls - Aroclor 1016 - Aroclor 1221 - Aroclor 1232 - Aroclor 1242 - Aroclor 1248 - Aroclor 1254 - Aroclor 1260 - 2,2',5'- Trichlorobiphenyl - 2,2',5,5'- Tetrachlorobiphenyl - 2,2',4,5,5'- Pentachlorobiphenyl - 2,3,3',4,4',5- Pentachlorobiphenyl - 2,2',3,4,4',5- Hexachlorobiphenyl - 2,2',4,4',5,5'- Hexachlorobiphenyl - 2,2',3,4,4',5,5'- Heptachlorobiphenyl	Solvent Extraction, Gas Chromatographic Method ^[14,19]

/97 Pentachlorophenol...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
97	Pentachlorophenol	Soxhlet Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[16,18]
		Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
98	Phenanthrene	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
99	Phenol	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
100	Pyrene	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
101	Selenium	1) Digestion, Inductively Coupled Plasma Atomic Emission Spectrometric Method ^[8,13] 2) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
102	Silver	1) Digestion, Inductively Coupled Plasma Atomic Emission Spectrometric Method ^[8,13] 2) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
103	Styrene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
104	1,1,2,2-Tetrachloroethane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
105	Tetrachloroethylene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
106	Toluene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
107	Toxaphene	1) Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20] 2) Soxhlet Extraction, Gas Chromatographic Method ^[16,18]
108	TPH (C ₅ -C ₈)	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
109	TPH (C ₈ - C ₁₆)	Solvent Extraction, Gas Chromatographic Method ^[9,14]
110	TPH (C ₁₆ - C ₃₅)	Solvent Extraction, Gas Chromatographic Method ^[9,14]
111	1,2,4-Trichlorobenzene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]

/112 1,1,1-Trichloroethane...

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ลำดับที่	สารมลพิษ	วิธีวิเคราะห์
112	1,1,1-Trichloroethane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
113	1,1,2-Trichloroethane	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
114	Trichloroethylene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
115	2,4,5-Trichlorophenol	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
116	2,4,6-Trichlorophenol	Solvent Extraction, Gas Chromatographic/ Mass Spectrometric Method ^[14,20]
117	1,3,5-Trimethylbenzene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
118	Vanadium	1) Digestion, Inductively Coupled Plasma Atomic Emission Spectrometric Method ^[8,13] 2) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]
119	Vinyl Acetate	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
120	Vinyl Chloride	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
121	m-Xylene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
122	o-Xylene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
123	p-Xylene	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
124	Xylene (Total)	Purge and Trap, Gas Chromatographic/ Mass Spectrometric Method ^[27,28]
125	Zinc	1) Digestion, Inductively Coupled Plasma Atomic Emission Spectrometric Method ^[8,13] 2) Digestion, Inductively Coupled Plasma-Mass Spectrometry Method ^[8,23]

/เอกสารอ้างอิง...

เอกสารอ้างอิง

1. กระทรวงอุตสาหกรรม. ประกาศกระทรวงอุตสาหกรรม, พ.ศ. 2548. เรื่องการกำจัดสิ่งปฏิกูลหรือวัสดุที่ไม่ใช้แล้ว. ราชกิจจานุเบกษา. 25 มกราคม 2549. เล่มที่ 123 ตอนพิเศษ 11ง.
2. กระทรวงอุตสาหกรรม. ประกาศกระทรวงอุตสาหกรรม, พ.ศ. 2549. เรื่อง กำหนดค่าปริมาณเขม่าควันที่เจือปนในอากาศที่ระบายออกจากปล่องของหม้อน้ำโรงสีข้าวที่ใช้แก๊สเป็นเชื้อเพลิง. ราชกิจจานุเบกษา. 4 ธันวาคม 2549. เล่มที่ 123 ตอนพิเศษ 125จ.
3. สมาคมวิศวกรรมสิ่งแวดล้อมแห่งประเทศไทย. คู่มือวิเคราะห์น้ำเสีย. พิมพ์ครั้งที่ 4. กรุงเทพฯ: เรือนแก้วการพิมพ์, 2547.
4. APHA, AWWA, WEF. Standard Methods for the Examination of Water and Wastewater. 22nd. Washington, DC: APHA, 2012.
5. United States Environmental Protection Agency. Standards of Performance for New Stationary Sources. 40 CFR 60 Appendix A, 2013.
6. United States Environmental Protection Agency. Determination of Total Kjeldahl Nitrogen by Semi Automate Colorimetric. Method 351.2, 1993.
7. United States Environmental Protection Agency. Alkaline Digestion for Hexavalent Chromium. SW-846 Method 3060A, 1996.
8. United States Environmental Protection Agency. Acid Digestion of Sludges and Sediments and Soils. SW-846 Method 3050B, 1996.
9. United States Environmental Protection Agency. Non Halogenated Organics Using GC/FID. SW-846 Method 8015B, 2003.
10. United States Environmental Protection Agency. Soil and Waste pH. SW-846 Method 9045D, 2004.
11. United States Environmental Protection Agency. Mercury in Sediment and Tissue Sample by Atomic Fluorescence Spectrometry. SW-846 Method 7474, 2007.
12. United States Environmental Protection Agency. Mercury in Water by Oxidation, Purge and Trap, CVAFS. Method 1631, 2002.
13. United States Environmental Protection Agency. Inductively Coupled Plasma-Atomic Emission Spectrometry. SW-846 Method 6010B, 1996.
14. United States Environmental Protection Agency. Micro Scale Solvent Extraction (MSE). SW-846 Method 3570, 2002.
15. United States Environmental Protection Agency. Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique). SW-846 Method 7471B, 1994.
16. United States Environmental Protection Agency. Soxhlet Extraction. SW-846 Method 3540C, 1996.

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17. United States Environmental Protection Agency. Chromium, Hexavalent (Colorimetric). SW-846 Method 7196A, 1992.
18. United States Environmental Protection Agency. Organochlorine Pesticides by Gas Chromatography. SW-846 Method 8081B, 2007.
19. United States Environmental Protection Agency. Polychlorinated Biphenyls (PCBs) by Gas Chromatography. SW-846 Method 8082, 2007.
20. United States Environmental Protection Agency. Semivolatile Organic Compounds by Gas Chromatographic/Mass Spectrometric. SW-846 Method 8270D, 2014.
21. United States Environmental Protection Agency. Cyanide Extraction Procedure for Solids and Oil. SW-846 Method 9013A, 2004.
22. United States Environmental Protection Agency. Total and Amenable Cyanide: Distillation. SW-846 Method 9010C, 2004.
23. United States Environmental Protection Agency. Inductively Coupled Plasma-Mass Spectrometry. SW-846 Method 6020A, 2007.
24. United States Environmental Protection Agency. Determination of Metals and Trace Element in Water and Wastes by Inductively Coupled plasma-Atomic Emission Spectrometry. SW-846 Method 2007, 1994.
25. United States Environmental Protection Agency. Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry. SW-846 Method 7473, 2007.
26. United States Environmental Protection Agency. Volatile Organics in Soil and Other Solid Matrices Using Equilibrium Headspace Analysis. SW-846 Method 5021, 2014.
27. United States Environmental Protection Agency. Closed System Purge and Trap and Extraction for Volatile Organics in Soil and Waste Samples. SW-846 Method 5035A, 2002.
28. United States Environmental Protection Agency. Volatile Organic Compounds by Gas Chromatographic/Mass Spectrometric (GC/MS). SW-846 Method 8260B, 1996.
29. United States Environmental Protection Agency. Titrimetric and Manual Spectrophotometric Determinative Method for Cyanide. SW-846 Method 9014, 1996.

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