Ministry of Labour 2014 Underground Diesel Survey Outcomes

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Ontario Ministry of Labour

Ontario Ministry of Labour
Occupational Health and Safety Branch

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Ministry of Labour mandate

- The MOL's mandate of protecting the health and safety of workers on the job is guided by its Safe at Work Ontario (SAWO) strategy and enforced by workplace compliance to the *Occupational Health and Safety Act* (OHSA) and its Regulations.

- The prevention of work-related injuries and illness is an integral part of maintaining safe and healthy workplaces and a competitive and sustainable economy.

Purpose of the Provincial Survey

The Ontario Ministry of Labour (MOL) surveyed mine operators and mining contractors to obtain information regarding underground diesel fleets and exposure data.

- The information collected from the completed surveys will be a valuable resource in the work undertaken by the Ministry in consultation with the Ventilation and Industrial Hygiene (formerly Diesel) Subcommittee and the Mining Legislative Review Committee (MLRC).
- The information may, for example, help in the review of existing diesel requirements in sections 182, 183, 183.1 and 183.2 of Regulation 854 (Mines and Mining Plants) under the Occupational Health and Safety Act (OHSA), and in determining potential impact of possible recommendations for regulatory amendment that may occur in the future.

Past Surveys Conducted 1990

The Mining Legislative Review Committee (MLRC) first established a Diesel Subcommittee in 1989 to review regulatory requirements related to underground diesel equipment usage.

- In October 1990, the “1990 Ontario Underground Diesel Equipment and Procedure Survey” was published by the Mining Health and Safety Branch of the MOL.

- The survey assisted discussions with the MLRC. As a result of those discussions, diesel requirements in the Regulation for Mines and Mining Plants were changed in 1994.

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Past Surveys Conducted Prior to 2014

Provided information to assist with regulatory changes to:

- Replaced weekly gas tests by the operator with testing at the request of a worker
- Removed prescribed logbooks for each piece of equipment
- Adopted most portions of the standard CAN/CSA M424.2-M90, “Non-Rail-Bound Diesel-Powered Machines for Use in Non-Gassy Underground Mines” into regulation.
- Set an exposure limit for respirable combustible dust (RCD) to a 1.5 mg/m^3 level.

Past Surveys Conducted Prior to 2014

In May 1993, the Diesel Subcommittee was redirected by the MLRC to “look at advancing technology and how it affects volumes of air and testing”.

In 1996 mines were given the opportunity to provide additional information in the form of another Diesel Survey.

As a result, the Diesel Subcommittee supported lowering the fuel sulphur content from 2500 to 500 ppm and highway diesel fuel was allowed in underground mines through amendment of the mining regulation.

Past Surveys Conducted prior to 2014

The information from the 1996 Survey was also used and quoted by the Diesel Emission Evaluation Program (DEEP), a Canadian mining industry research initiative available on line. The objective of DEEP was to develop and coordinate research to reduce exposure to diesel emissions.

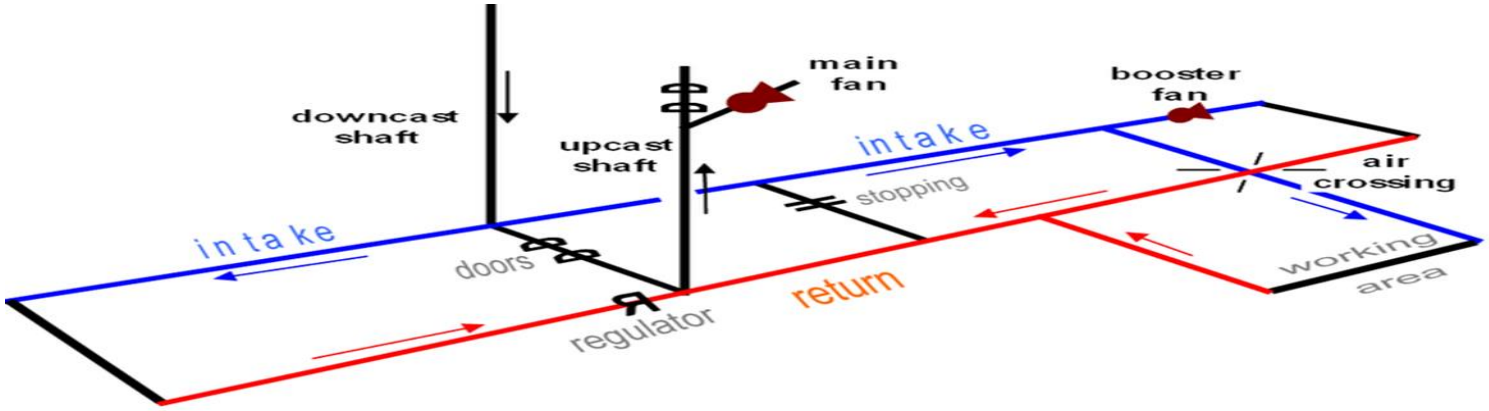

Figure 1.1. Typical elements of a main ventilation system

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Past Surveys Conducted Prior to 2014

In 2001, the Diesel Subcommittee continued with its work concentrating on the improvements to air quality that could be obtained through improved maintenance practices.

As a result the 2002 Diesel Survey was conducted by the MOL with endorsement of the MLRC. A detailed questionnaire was distributed to all mining operations in the province.

Requested information:

- make up of equipment fleets,
- maintenance programs, and
- a request for exposure data of provincial workers in underground mines.

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OVERVIEW 2002 DIESEL SURVEY RESULTS

Survey Fleet Information – Respirable Combustible Dust

- 30 mines provided fleet information; 28 answered questionnaire
- 25 mines submitted 1923 personal exposure samples of underground workers
- only 0.3% or 5 samples exceeded 1.5 mg/m^3 the previous regulated limit.
- 93.3% of samples reported 0.40 mg/m^3; 96.5% reported 0.50 mg/m^3; 98% reported 0.60 mg/m^3.

Highest average concentrations:

- mucking, bolting and shotcreting, 0.2 - 0.3 mg/m^3.

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Ontario Mining Regulation Amendment 2012

RCD Changed Total Carbon

- The flow of air must reduce the time-weighted average exposure of a worker to total carbon to not more than 0.4 milligrams per cubic metre of air; or reduce the time-weighted average exposure of a worker to elemental carbon, multiplied by 1.3, to not more than 0.4 mg/m^3. (subsection 183.1(5))

Exhaust Limit

- In addition, employers are required to ensure that the undiluted exhaust emissions from diesel-powered equipment contain less than 600 parts per million (PPM) by volume of carbon monoxide (down from the previous limit of 1500 PPM). (subsection 182(5))

Testing Procedures Developed in Consultation with JHSC

- Each individual piece of equipment must be tested under consistent conditions so that results from different tests can be compared. (subsection 183.2(1.1))

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Diesel Survey 2014 Survey Overview

Diesel Survey 2014 Survey Overview

In early 2014, all provincially regulated underground mines were asked to supply information about their underground diesel fleet and respond to a questionnaire.

- A similar survey was also sent out to mine contractors .
- These surveys were approved and endorsed by the Mining Legislative Review Committee.
- The suggested date for the completion of the survey was extended several times before the deadline was finally imposed in February of 2015.

Diesel Survey 2014 Survey Outcomes

Highlights:

- 9 fewer mines responded to the 2014 survey compared to the 2002 survey, which represents a 30% decrease in the reported data between the 2002 and 2014 surveys.
- This lower response rate makes it more difficult to make direct comparisons using the 2014 diesel survey results and the data from surveys done in previous years, 2002 and 1996.
- Overall, the decrease in responses received impacted the results and reliability of comparisons.

FIGURE 1: DIESEL POWERED EQUIPMENT USED UNDERGROUND IN ONTARIO MINES - 2014

EQUIPMENT TYPE	YEAR	NUMBER OF UNDERGROUND DIESEL UNITS					
		0 – 50 BHP	51- 100 BHP	101 – 200 BHP	201 – 300 BHP	+ 300 BHP	TOTAL UNITS
LOAD-HAUL-DUMP UNITS (LHD)	1977	26	278	443	100	9	856
	1985	9	187	257	132	7	592
	1990	34	150	322	278	10	794
	1996	33	110	174	225	34	576
	2002	7	78	117	137	66	405
	2014	1	44	93	82	60	280
HAULAGE VEHICLES (trucks, locos, loaders, etc.)	1977	201	106	63	28	15	413
	1985	49	257	77	20	14	417
	1990	28	90	70	76	20	284
	1996	13	100	46	69	28	256
	2002	0	45	17	55	45	162
	2014	12	60	71	48	77	268
LIGHT DUTY VEHICLES (personnel carriers, drills, utility vehicles, etc.)	1977	233	477	108	4	1	823
	1985	167	458	40	2	0	667
	1990	332	1120	124	6	0	1582
	1996	332	822	249	11	4	1418
	2002	285	704	338	57	1	1385
	2014	303	315	344	41	6	1009
REPORTED TOTALS	1977	460	861	614	132	25	2092
	1985	225	902	374	154	21	1676
	1990	394	1360	516	360	30	2660
	1996	378	1032	469	305	66	2250
	2002	292	827	472	249	112	1952
	2014	316	419	508	171	143	1557

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FIGURE 2: TOTAL HEAVY DUTY DIESEL UNITS PER BHP (LHDs, Haulage Trucks, Locos, Front-end Loaders)

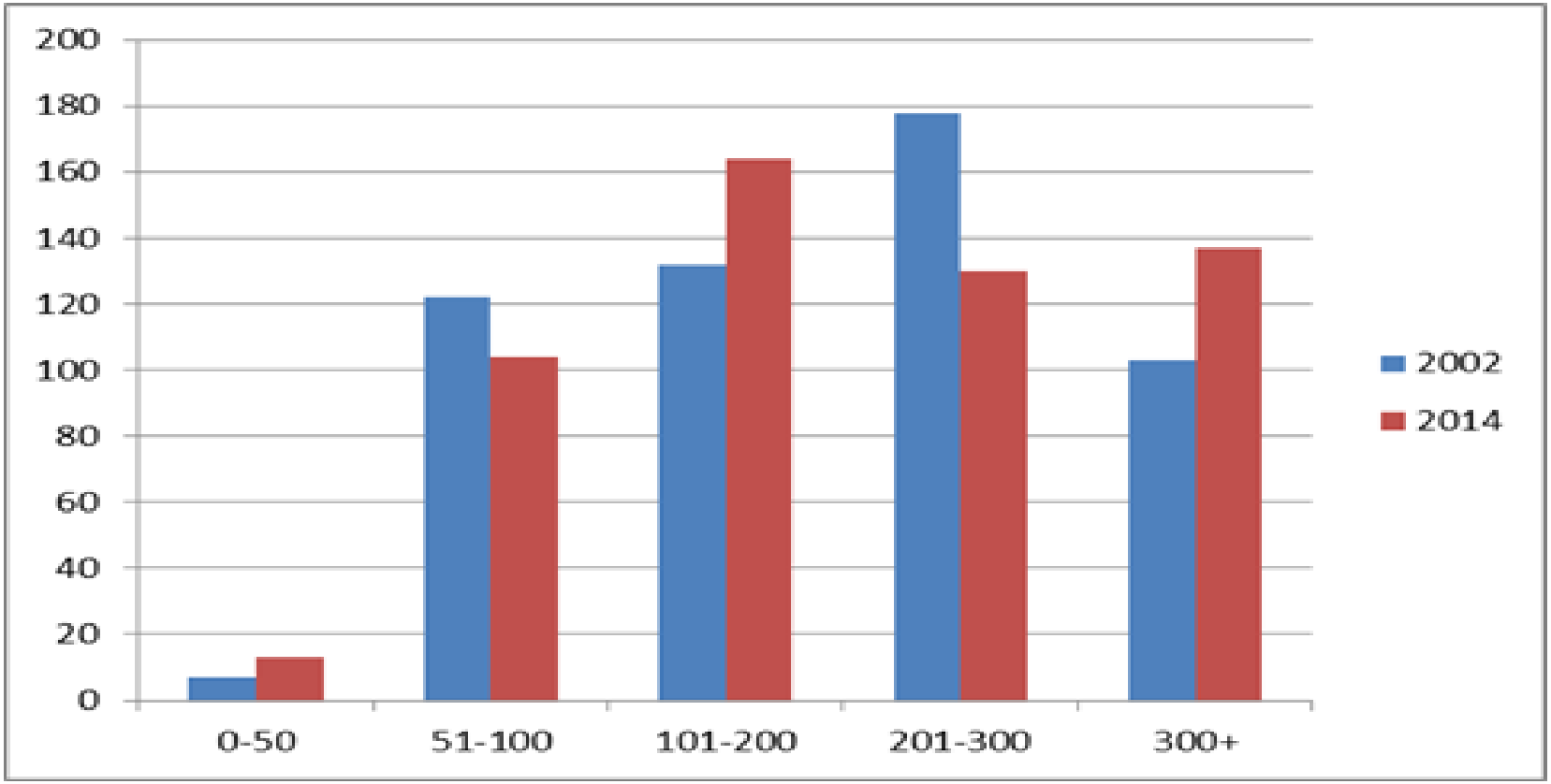
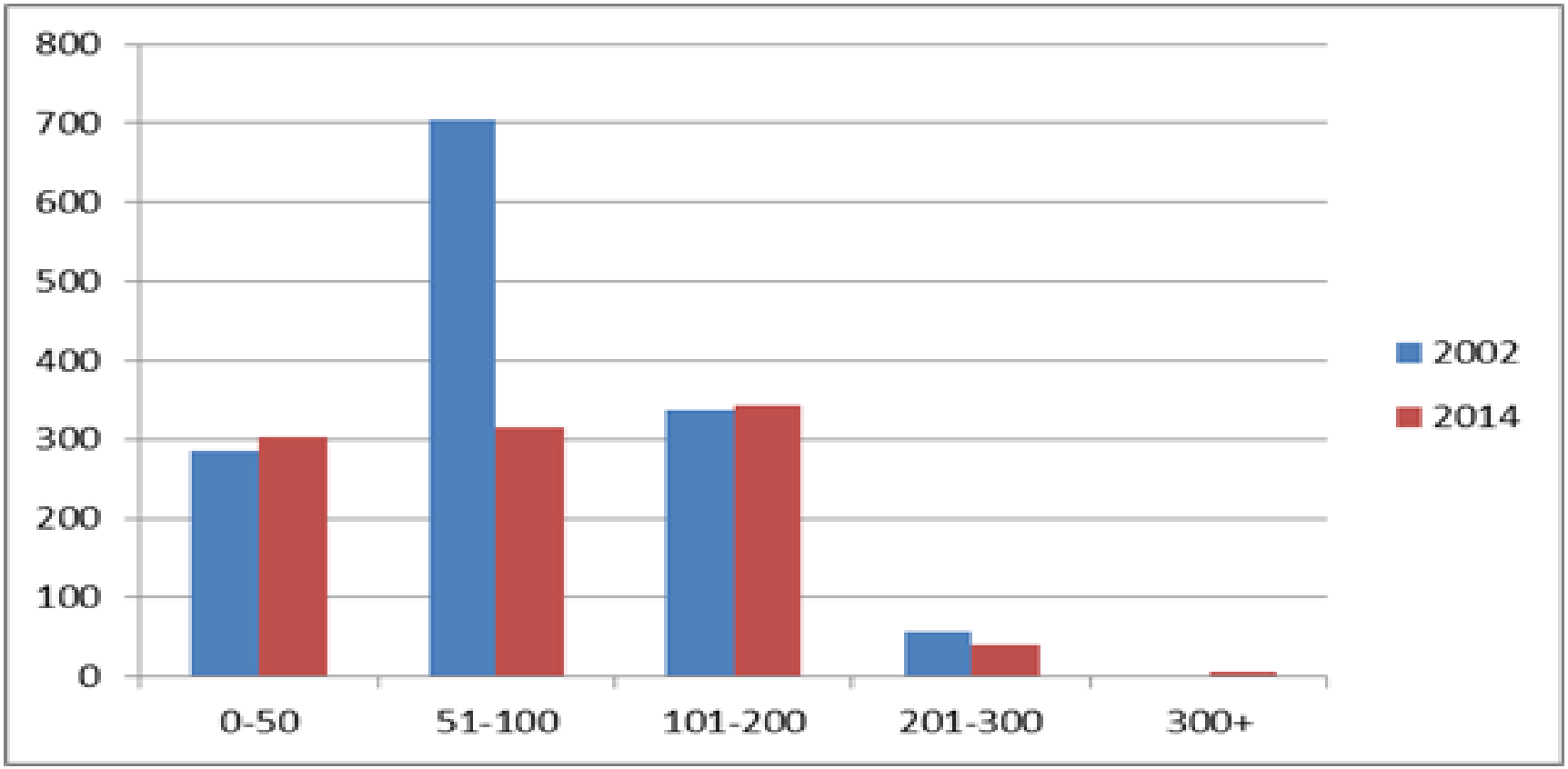


FIGURE 3: TOTAL LIGHT DUTY DIESEL UNITS PER BHP

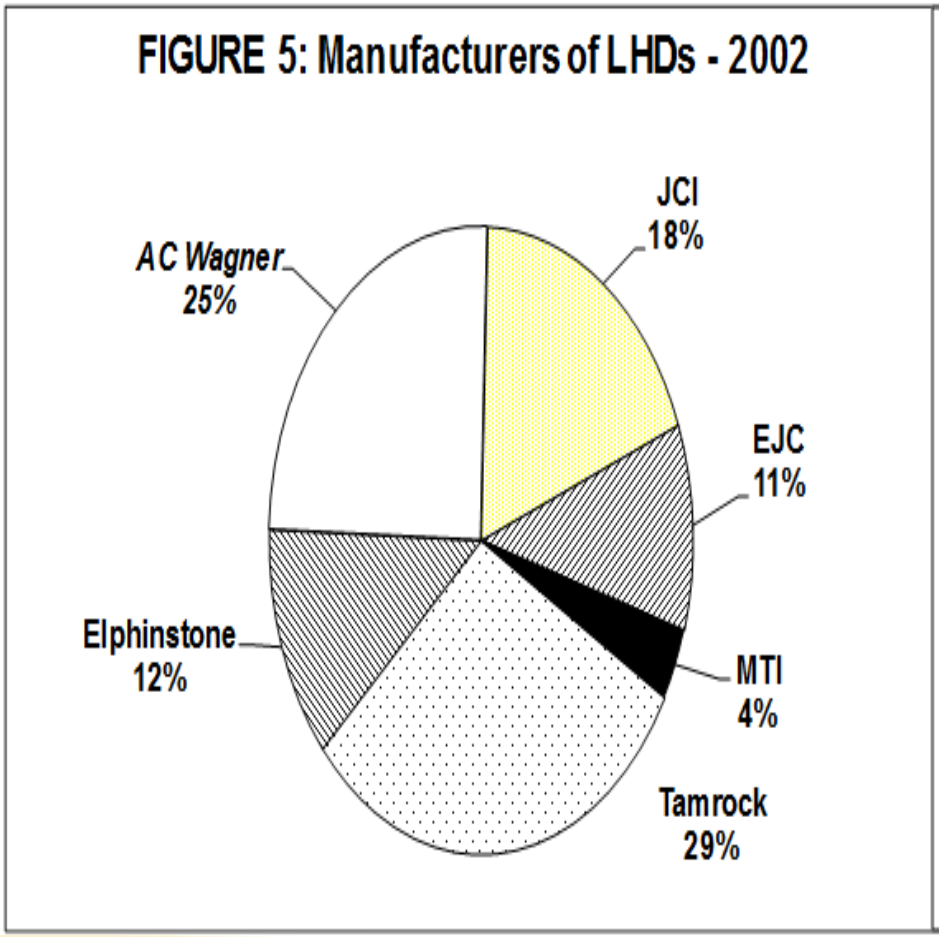


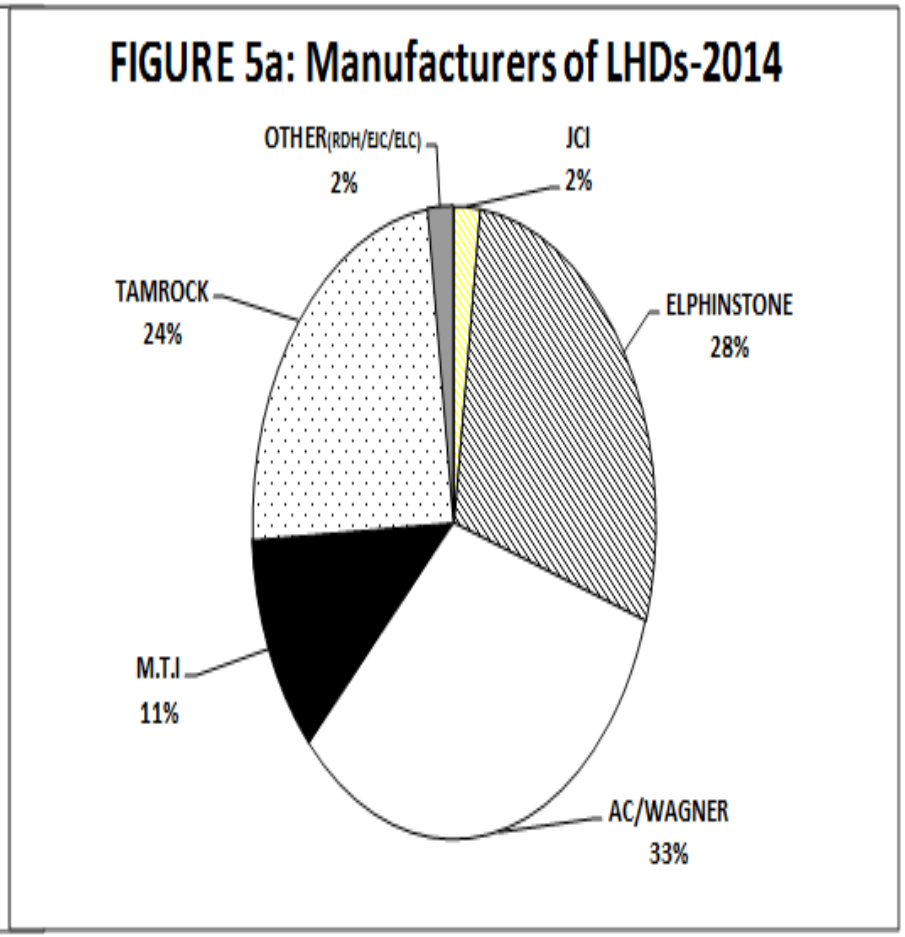
Brake Horsepower

FIGURE 4: DIESEL EQUIPMENT BREAKDOWN BY BRAKE HORSEPOWER 2002 – 2014

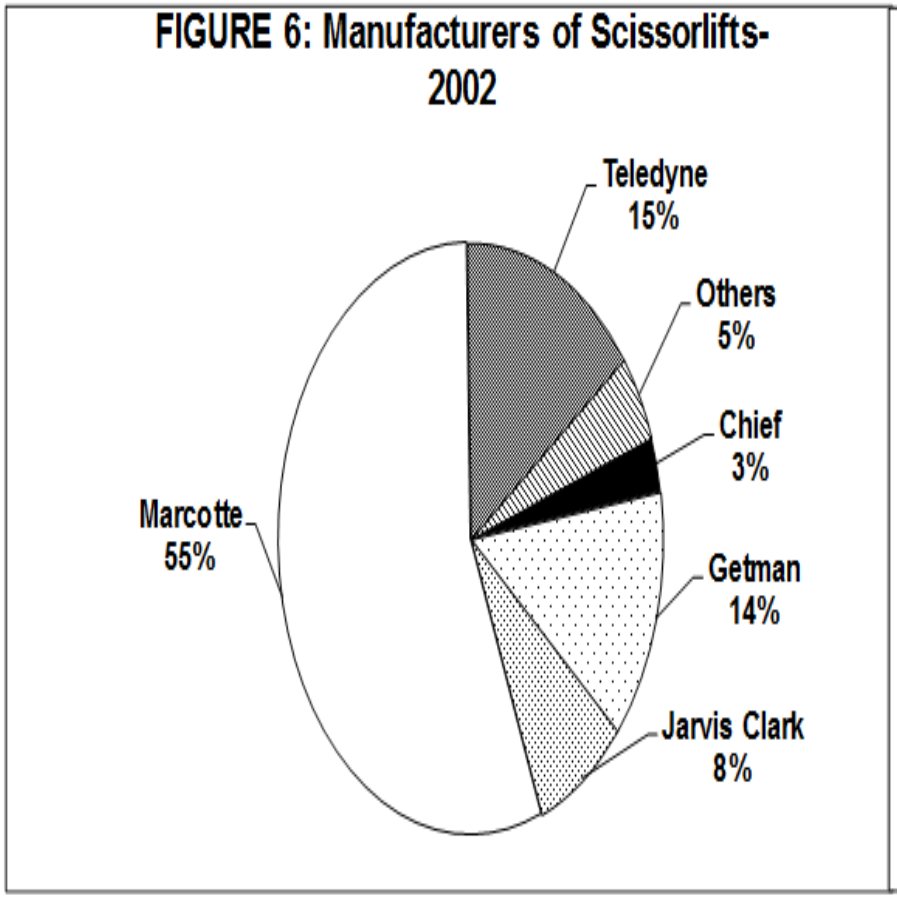
EQUIPMENT TYPE	NUMBER OF UNDERGROUND DIESEL UNITS											
	0 – 50 BHP		51- 100 BHP		101 – 200 BHP		201 – 300 BHP		+ 300 BHP		TOTAL UNITS	
	2014	2002	2014	2002	2014	2002	2014	2002	2014	2002	2014	2002
Bolters			3	57	44	40	2	3			49	100
Boom types	4	1	7	31	15	18	16	9			42	59
Drills	9	10	73	138	52	21	2				136	169
Excavators	7	67		24	1						8	91
Explosive vehicles	3			21	13	10	5	3			21	34
Forklifts	37	63	41	33	14	4					92	100
Trucks	4		16	5	35	8	29	2	16		100	15
Haulage trucks			5	7	7	17		54	61	37	73	115
Locomotives	4		33	38			1				38	38
LHD's	1	7	44	78	93	117	82	138	60	74	280	414
Personnel carriers	151	98	108	145	58	161	4	23			321	427
Scissorlifts			13	147	39	20		2			52	169
Shotcrete Units	3	10		9	17	8	4	7			24	34
Utility vehicles	25	36	58	94	83	48	24	8	5	1	195	187
Other ((grader/welder/ compressor/loader)	68		18		37		2		1		126	
TOTALS	316	297	419	827	508	472	171	249	143	112	1557	1952

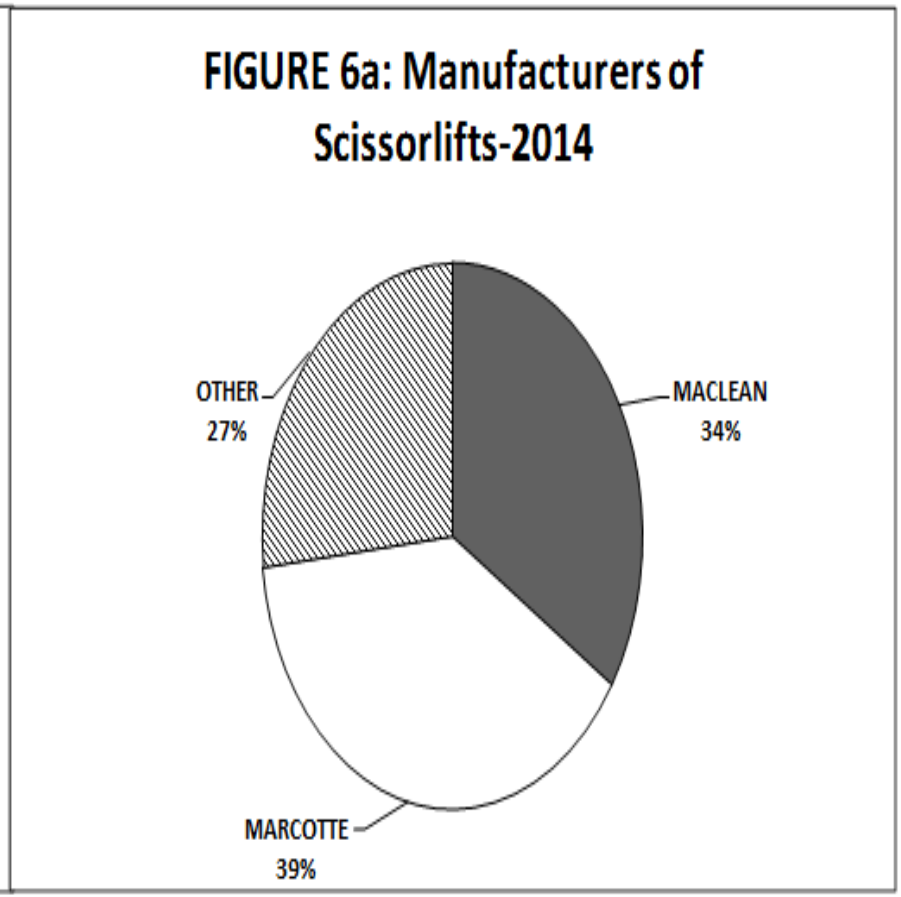
Figures 5 and 5a represent the reported LHD fleet by manufacturer in 2002 and 2014



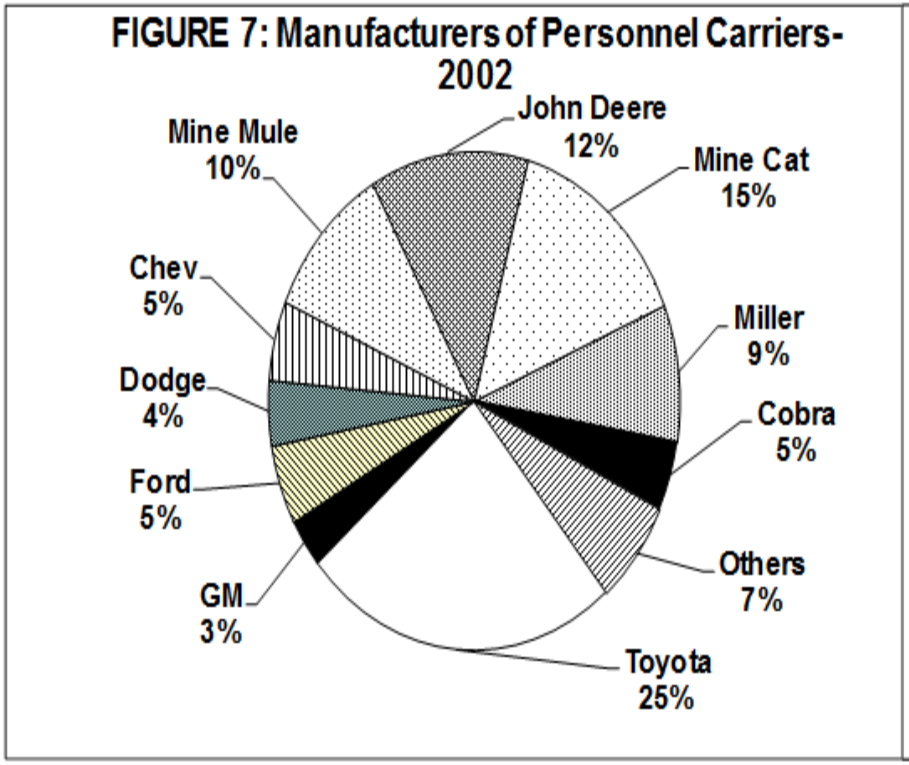


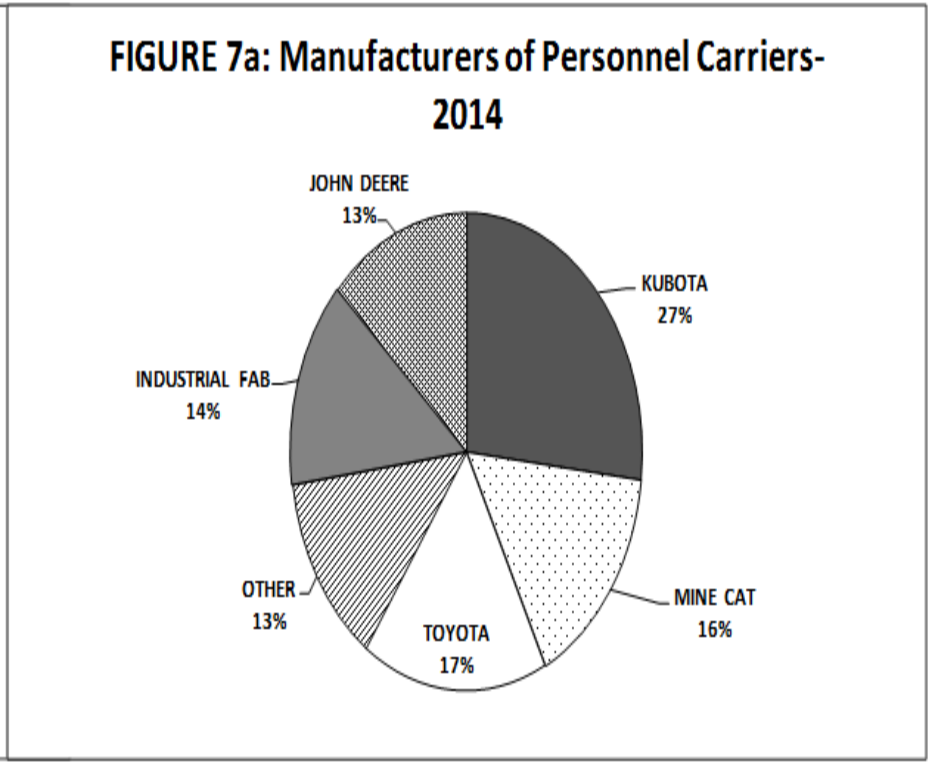
Figures 6 and 6a represent the reported scissor lifts fleet by manufacturer in 2002 and 2014



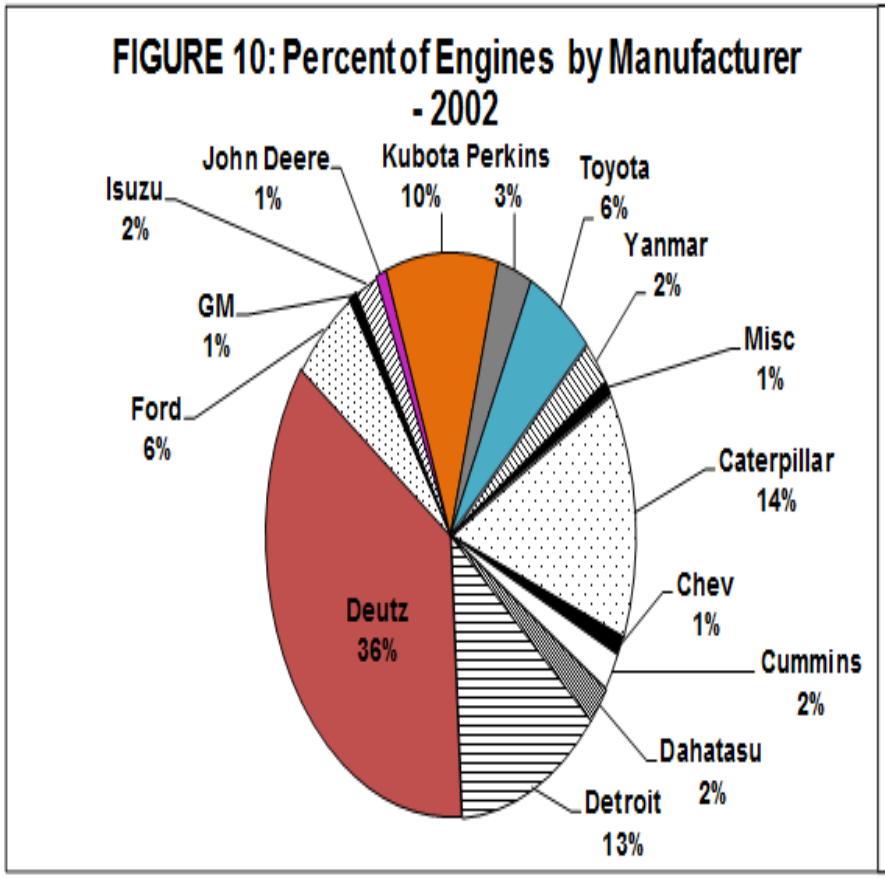


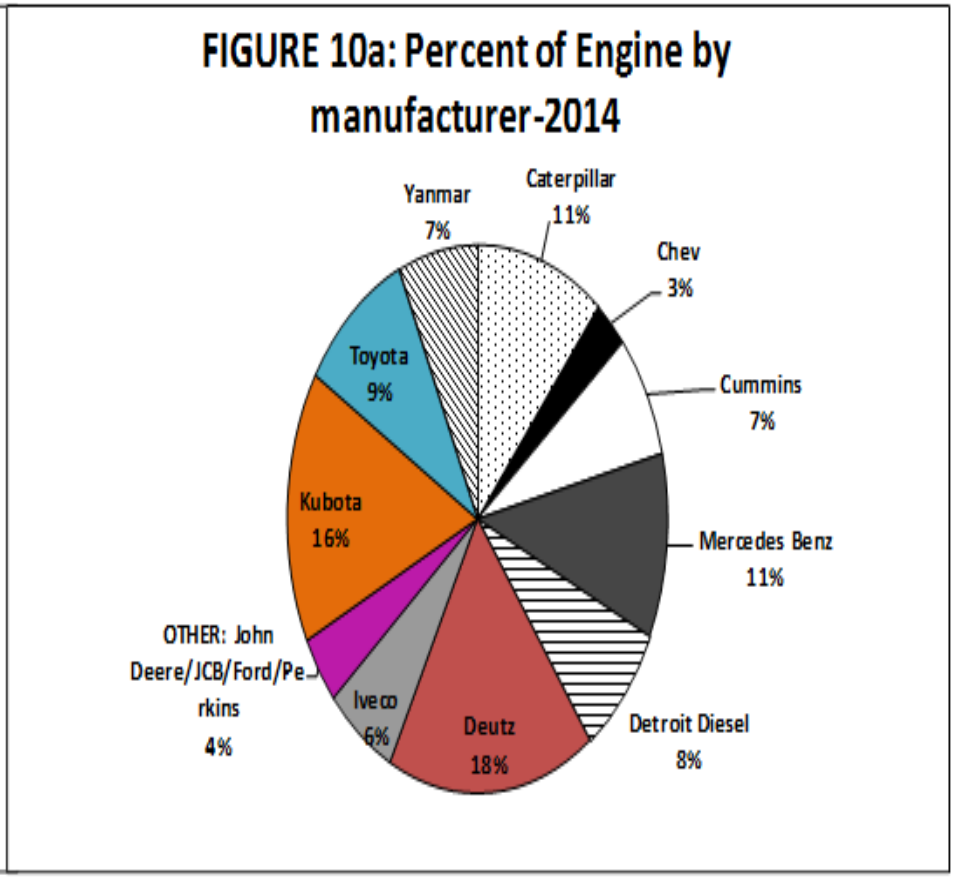
Figures 7 and 7a represent the reported fleet of personal carriers by manufacturer in 2002 and 2014



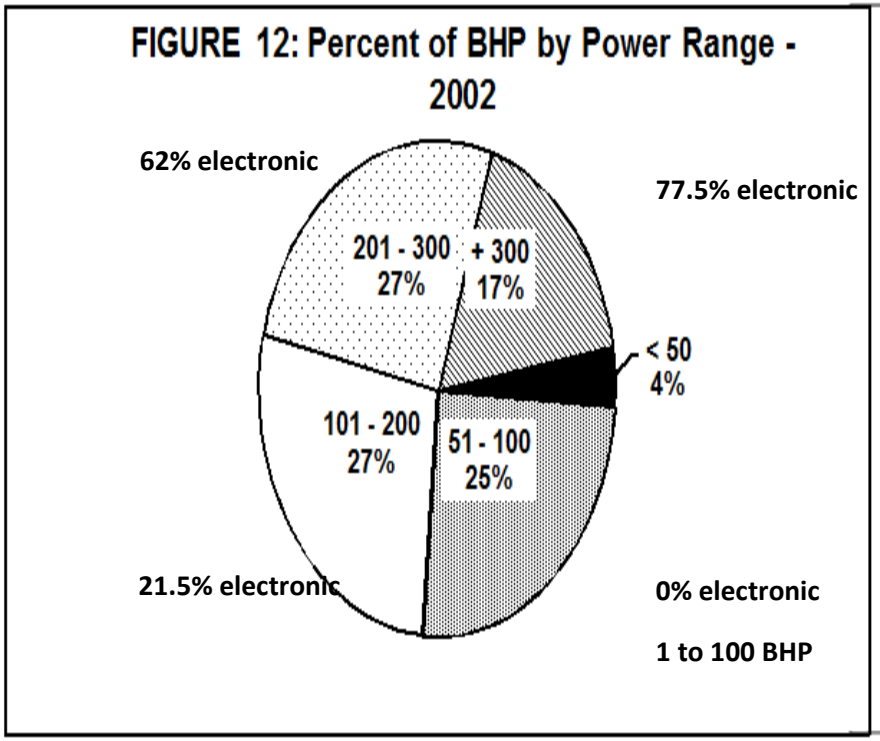


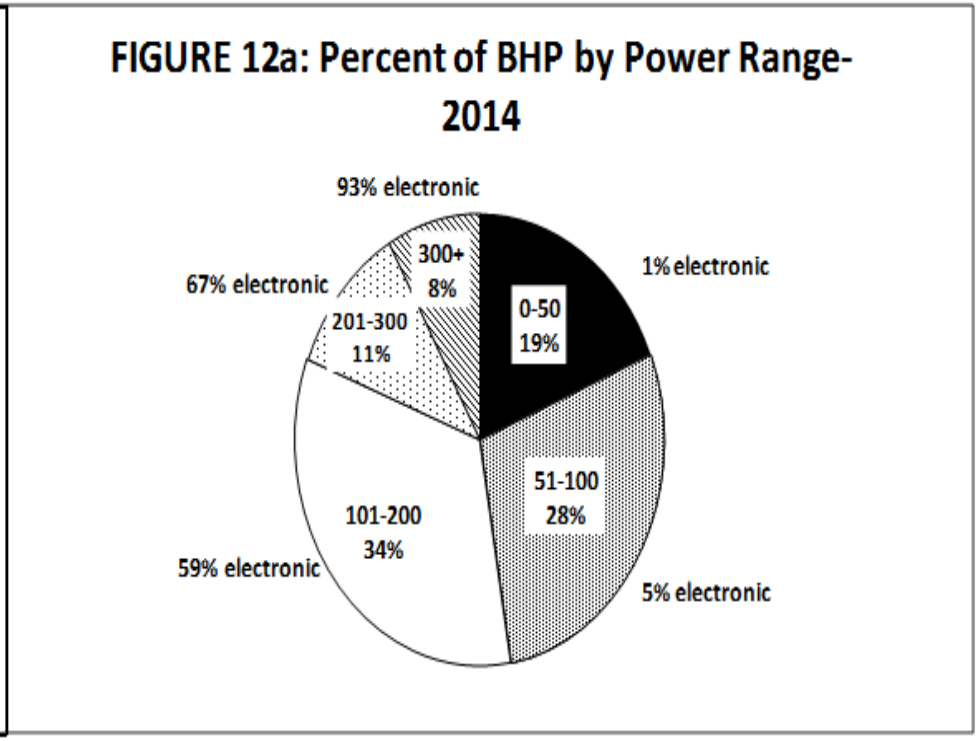
Figures 10 and 10a represent the reported fleet by engine manufacturer 2002 and 2014





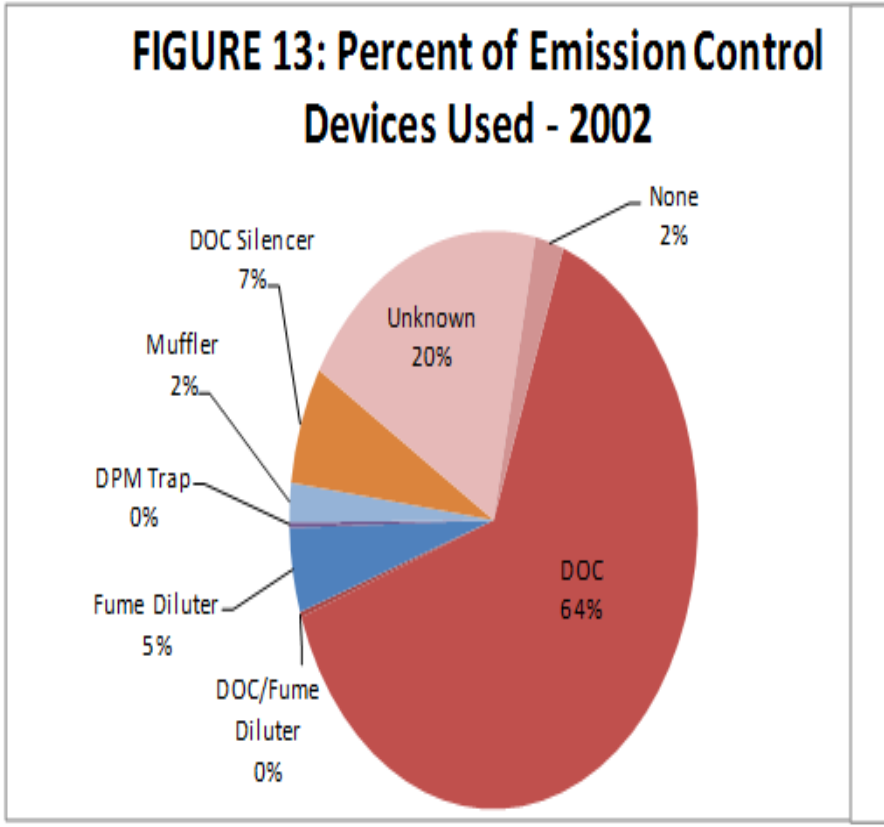
Figures 12 and 12a represent the percent of electronic engines used in each horsepower range

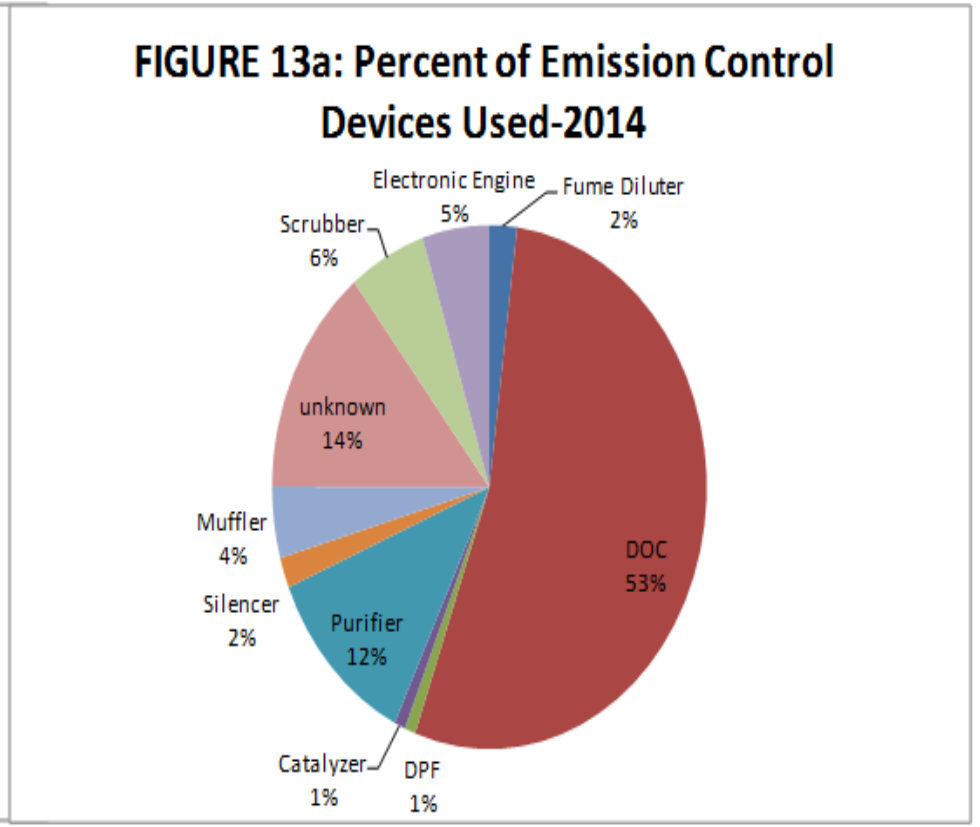




- In 2002, electronically powered engines used in Ontario mines represented 36% of installed horsepower.
- Based on the reported data from 2014, electronically powered engines made up 36.5% of installed horsepower, representing an overall change of less than 1%, or 0.5% overall.

Figures 13 – Emission/Exhaust Devices 2002 - 2014





WORKER EXPOSURE TO DIESEL EXHAUST

On June 12, 2012, the International Agency for Research on Cancer (IARC), classified diesel engine exhaust as carcinogenic.

Subsection 183.1(5) of Reg. 854 requires a flow of air that must reduce a time-weighted average exposure of a worker to total carbon to not more than 0.4 m/m3 of air or reduce the TWA exposure to elemental carbon, multiplied by 1.3, to not more than 0.4 mg/m^3 per cubic metre of air.

As part of the 2014 survey, mines were asked to provide the last two years of sampling data. 21 mines responded, with 18 providing sampling results.

(Note: Total Carbon = Organic plus Elemental Carbon)

TC = OC + EC

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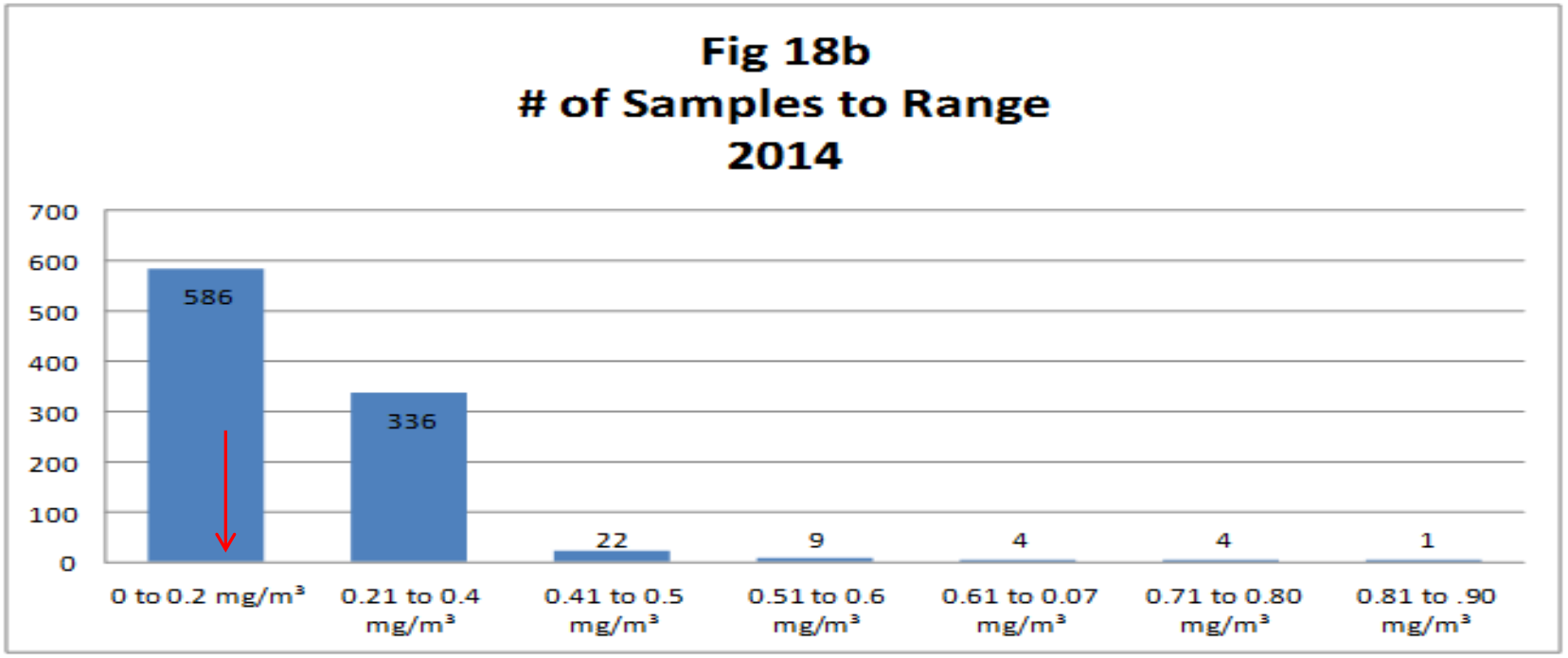
FIGURE 15/ 16: Number of RCD/NIOSH Samples – by Mine

Number of Mines	Number of NIOSH Samples Taken Over 2 Years
11	0-50
7	51 - 100
3	101 – 200

NIOSH Concentrations Underground Mines



- Note MSHA Limit - Red Arrow 160 µg/m^3 Total Carbon Exposure Limit
- Ontario limit currently 400 µg/m^3 Total Carbon

Mine Operators Reported 40 over exposures or 4.16% of 962 total

- 1923 exposure samples reported in 2002 compared to 962 in 2014

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FIGURE 18a: 2014 Reported Workplace Concentrations - NIOSH By Job Task

Task or Job	No. of Samples	Number of Samples By Range of RCD Concentrations(2002)/ NIOSH TC(2014) – mg/m^3																							
		0 to 0.2			0.21 to 0.4			0.41 to 0.5			0.51 to 0.6			0.61 to 0.7			0.71 to 0.8			0.81 to 0.9					
	2002	2014		2002	2014		2002	2014		2002	2014		2002	2014		2002	2014		2002	2014		2002	2014		2002	2014	
	RCD	RCD	NIOSH	RCD	RCD	NIOSH	RCD	RCD	NIOSH	RCD	RCD	NIOSH	RCD	RCD	NIOSH	RCD	RCD	NIOSH	RCD	RCD	NIOSH	RCD	RCD	NIOSH	RCD	RCD	NIOSH
Blasting	50	2	1	46	1	1	3	1								1											
Bolting	97	3	37	80	1	10	14	2	23	2		3	1						2		1						
Diamond Drilling	22		14	21		10	1		4																		
Drill – Develop	206	12	30	149	8	9	46	4	20	8			3		1												
Drill – Production	104		17	80		14	16		3	4			3												1		
Drill - Raisebore	7			5			1			1																	
Electrician	39		14	34		11	5		3																		
Equip Operator	50	17	226	40	16	137	8	1	77	2		6			2			2			2						
Haulage	239	4	47	196	2	33	35	2	9	4		4	3		1				1								
Mechanic	192	1	118	185	1	33	5		83	1		2							1								
Mucking	359	12	32	174	7	23	126	3	5	33	2	1	11		3	4			6						5		
Other Tasks	68	35	165	54	24	133	14	6	28		3	4		2													
Rockbreaker	29		8	18		7	10		1	1																	
Service Crew	146	7	166	117	3	90	28	4	70	1		1			2			2									1
Shaft Service	32		2	32		2																					
Shotcreting	35	2	13	8	1	11	17	1	2	4			6														
Staff	39		70	27		60	12		8			1									1						
Supervision	40	2	2	36	2	2	2			1			1														
Totals	1754	97	962	1302	66	586	343	24	336	62	5	22	28	2	9	5		4	10		4	6		1			

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Highest reported Average Exposure Concentrations

Results by job task. The highest average worker concentrations reported between 0.21 – 0.4 mg/m^3 by job task.

Task Description:

1. Mechanics: 83 of 118 samples in the highest range (70.3%)
2. Development Drillers: 20 of 30 samples in the highest range (66.7%)
3. Bolting: 23 of 37 samples in the highest range (62.2%)
4. Service crew: 70 of 166 in the highest range (42.2%)
5. Equipment operators: 77 of 226 samples in the highest range (34%)

Mine Operator Preventive Maintenance

- The Diesel Subcommittee recognized that regular engine maintenance is a large contributor in controlling emissions. The survey included a number of questions to determine the degree of control that the mines have over maintenance.

- The median time between planned maintenance (PM) was 250 hours for 14 of the 21 mines reporting. The other 7 mines conduct their planned maintenance at the following intervals: monthly (5 mines), and 400 hours (2 mines).

Mine Operator Preventive Maintenance

Engine Tuning

- The median time between engine tune-ups was 2000 hours for 9 of the 21 mines.
- Two mines conducted engine tune-ups at a median time of 1000 hours, while one reported at 2500 hours and another at 6000 hours.
- Three others indicated that engine tune-ups were done only as required.
- Five mines reported not doing engine tune-ups at all.

Maintenance

Who Performs Service:

- Licensed Mechanics at 20 of the 21 reporting mines.
- Apprentice mechanics reported by 5 operators.

The main reasons for bringing the equipment to the shop was operator dissatisfaction with their equipment, such as emissions, loss of power, or rough running.

Once the equipment gets to the shop, the main reason for an engine overhaul is through planned maintenance, emissions and/or excessive oil consumption.

Diesel Fuel

Section 182(4) was changed in 2015 and now requires “The fuel used in a diesel engine shall conform to the Canadian General Standards Board National Standard of Canada CAN/CGSB 3.517-2013 “Diesel Fuel”.

Of the 21 mines responding to the 2014 survey:

- 45,868,093 litres of diesel fuel was used in the underground mines
- 1 mine reported periodically analyzing the fuel supplied and suggested that a fluctuation in the sulphur content varied from between 7 to 500 ppm.
- No Bio Diesel was reported used.

Diesel Fuel

- 7 mines reported using the CAN/CGSB-3.517-93, “Automotive Low Sulphur Diesel Fuel”.
- 14 mines reported using the CAN/CGSB-3.16-99 “Mining Diesel Fuel” which is no longer manufactured or readily available.

As of 2015, these standards are no longer referenced in Regulation 854 (Mines and Mining Plants).

Mine Contractors Surveyed

For the first time, mine contractors operating equipment in provincial mines were also asked to take part and complete a diesel survey for the equipment in their fleet.

- Six mine contractors operating equipment in the province completed the survey. Of the six respondents, one reported no underground equipment operating at the time the survey was filled out.
- Responses accounted for approximately 662 pieces of diesel equipment operating in Ontario's underground mines.
- Represents about 30% of the equipment in operation underground at the time the survey was completed.

Equipment Fleet Reported

Responses indicated that there are 662 pieces of contractor equipment in operation. Detailed information was provided for 289 pieces of equipment.

- The make up or range of equipment was similar to mine operators, and included personnel carriers less than 100 BHP to larger equipment such as haul trucks and LHDs up to 500 BHP.
- The information from the contractors' survey accounted for an additional 23,856 BHP.
- The responses showed that of the total fleet approximately 7% of the equipment was rented or leased, with the other 93% being owned by the mine contractors.

Equipment Fleet Reported

EQUIPMENT TYPE	NUMBER OF UNDERGROUND DIESEL UNITS (contractors)					
	0 – 50 BHP	51- 100 BHP	101 – 200 BHP	201 – 300 BHP	+ 300 BHP	TOTAL UNITS
	2014	2014	2014	2014	2014	2014
Bolters		10	5			15
Boom types			6	4		10
Excavators	3					3
Explosive vehicles			1			1
Forklifts	20	2				22
Jumbo	1	21	1			23
Trucks	1		7			8
Haulage trucks					9	9
LHD's		25	7	9	19	60
Personnel carriers	21	8	18			47
Scissorlifts	2	10	19			31
Tractors		16				16
Utility vehicles	1		17	1		19
Other (grader/welder/ compressor/loader)	17	1	3			21
TOTALS	66	93	84	14	28	285

Contractor Equipment Distribution

Figure 28: Manufacturers LHDs - 2014 (contractors)

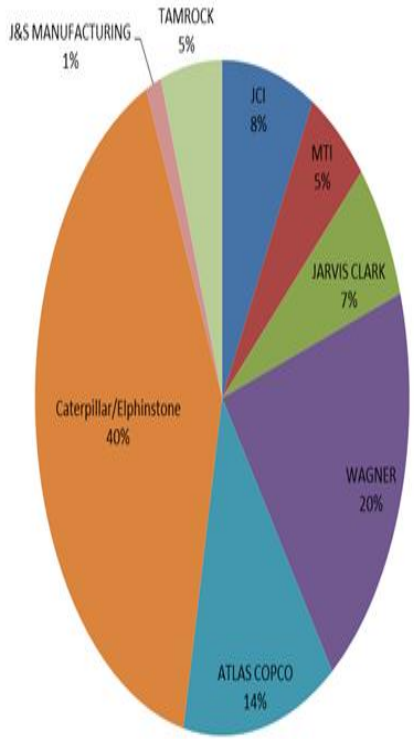


Figure 27: Manufacturers of Scissorlifts - 2014 (contractors)

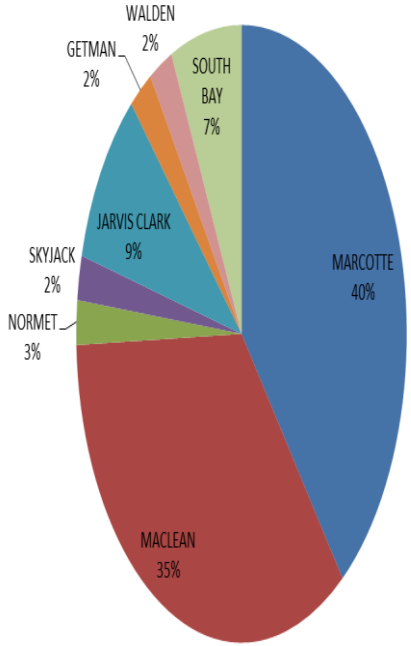
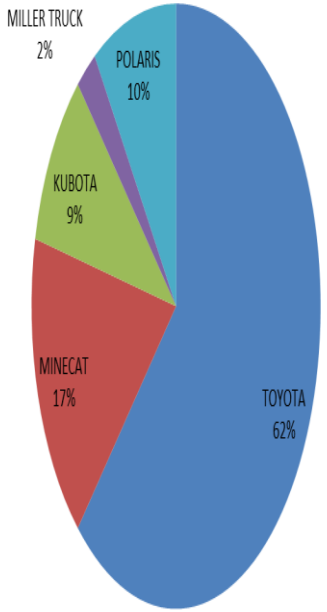


Figure 26: Manufacturers of Personnel Carriers - 2014 (contractors)



Diesel Fuel

- Mine contractors receive fuel from the mine owner and fuel was not purchased for use at the site or stored separately.

- Based on the reported information, quality control remained with the mine owners to ensure fuel deliveries were of proper grade and sulphur content.

- Contractors were also asked about the use of Bio Fuel in their underground equipment. Based on what was reported, no Bio Diesel was reported being used.

Emission Control & Tail Pipe Emission Testing

Six responding contractors;

- two provided information on emission control devices being used on diesel equipment;
- the two respondents reported that all their diesel equipment contained a diesel oxidation catalyst only and;
- no diesel particulate filters were reported as being used.

Tail Pipe Testing;

- 4 mine contractors identified the use of handheld electronic gas analyzers for tailpipe testing while the other still used stain tubes.
- None of the reports suggested any assessment of the diesel particulate matter (DPM) concentration was taking place at the tail pipe.

DISCUSSION

There were seven fewer mines reporting in 2014 than in 2002 although the number of operating mines was similar in both years.

- This discrepancy may account for the reduction in the total number of diesel equipment units reported underground, which was down from 1952 in 2002 to 1557 reported in 2014.

- Based on the reported data there has been little movement to utilize newer engine Tier ratings or engine emissions control technology to reduce diesel emissions from equipment operated underground.

- The number of diesel units decreased from 2250 units in 1996 to 1952 in 2002 and down to 1557 in 2014, but again this most recent number is based on fewer respondents than in previous surveys.

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Thank you Questions ?

After the Conference;

Contact the Provincial Coordinator's Office, Ministry of Labour Operations Division 159 Cedar Street, Sudbury, (Ontario) P3E 6A5

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