

Sampling of DPM Exposures in Metal and Nonmetal Mines in the United States:

Update of Baseline Sampling
and

First Year Enforcement Experience



MDEC 2004

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Mine Safety and Health Administration

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Diesel Particulate Matter Baseline Sampling

- Metal/Nonmetal DPM Rule issued Jan 19, 2001
 - ◆ DPM measured as Total Carbon
 - ◆ Interim exposure limit $400\mu\text{g}/\text{m}^3$ July 19, 2002
 - ◆ Final exposure limit $160\mu\text{g}/\text{m}^3$ July 19, 2006

All dieselized MNM mines sampled; this paper covers:

- Baseline: 1,194 samples from 183 mines sampled prior to October 29, 2003
- Inspector samples: October 30, 2003 through August 31, 2004

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DPM Sampling Train

- SKC Submicron Impactor
(Tandem Quartz-Fiber, Filter)
- Cyclone
- Breast Plate
- Pump



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Sample Analysis

- Total Carbon (DPM surrogate)
 - ◆ $TC = EC + OC$
 - ◆ $TC = EC \times 1.3$
 - ◆ Compliance based on lower of
[EC + OC] or [EC x 1.3]
- MSHA P-13/NIOSH 5040
- Sample - Top Filter
- Control - Tandem Filter

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Number of Mines and Valid Samples by Commodity Group

Commodity	Number of Mines		Number of Valid Samples		Average Number of Valid Samples by Mine	
	3/03	10/03	3/03	10/03	3/03	10/03
Metal	36	40	189	284	5.3	7.1
Stone	109	115	519	689	4.8	6.0
Trona	3	4	15	25	5.0	6.3
Other N/M	23	24	151	196	6.6	8.2
Total	171	183	874	1,194	5.1	6.5

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Number of Valid Samples per Mine for Specific Commodities

Specific Commodity	No. of Mines		No. of Samples		Average Samples per Mine	
	3/03	10/03	3/03	10/03	3/03	10/03
GEMSTONES MINING	1	2	2	5	2.0	2.5
GOLD ORE MINING	17	19	34	87	2.0	4.6
DIMENSION MARBLE MINING	3	3	9	9	3.0	3.0
LIMESTONE	2	2	6	6	3.0	3.0
TALC MINING	1	1	3	3	3.0	3.0
CRUSHED & BROKEN MARBLE MINING	4	4	16	25	4.0	6.3
GYPSUM MINING	2	4	8	29	4.0	7.3
CRUSHED & BROKEN STONE MINING	4	4	23	28	4.6	7.0
CRUSHED & BROKEN LIMESTONE MINING	85	90	413	550	4.9	6.1
CLAY, CERAMIC & REFRACTORY MINERALS MINING	1	1	5	9	5.0	9.0
CONSTRUCTION SAND & GRAVEL MINING	1	1	5	5	5.0	5.0

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Specific Commodity	No. of Mines		No. of Samples		Average Samples per Mine	
	3/03	10/03	3/03	10/03	3/03	10/03
COPPER ORE MINING	1	2	5	11	5.0	5.5
CRUSHED & BROKEN SANDSTONE MINING	1	1	5	5	5.0	5.0
HYDRAULIC CEMENT	1	1	5	5	5.0	5.0
LIME	4	4	20	20	5.0	5.0
TRONA MINING	3	4	15	25	5.0	6.3
DIMENSION LIMESTONE MINING	4	3	22	18	5.5	6.0
LEAD-ZINC ORE MINING	10	10	70	96	7.0	9.6
SALT MINING	14	14	98	122	7.0	8.7
MISCELLANEOUS METAL ORE MINING	1	1	9	9	9.0	9.0
MOLYBDENUM ORE MINING	2	2	19	22	9.5	11.0
PLATINUM GROUP ORE MINING	2	2	20	20	10.0	10.0
POTASH MINING	3	3	30	30	10.0	10.0
SILVER ORE MINING	3	3	32	36	10.7	12.0
AVERAGE OF ALL SAMPLES	171	183	874	1,194	5.1	6.5

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Valid Samples, by Occupation and Commodity Group

Occupation	Metal	Stone	Trona	Other N/M	Total
Truck Driver	87	152	0	13	252
Front-end Loader Operator	40	149	6	19	214
Blaster, Powder Gang	12	98	0	24	134
Scaling (mechanical)	1	66	0	13	80
Drill Operator, Rotary	3	63	0	9	75
Drill Operator, Jumbo Perc.	10	19	0	9	38
Mechanic	7	15	0	12	34
Complete Load-Haul-Dump	7	2	0	23	32
Utility Man	6	4	15	4	29
Scaling (hand)	4	20	0	2	26
Mucking Mach. Operator	19	1	0	3	23
Roof Bolter, Rock	5	9	0	7	21
Drill Operator, Rotary Air	1	19	0	1	21
Miner, Drift	16	1	0	0	17
Crusher Oper/Worker	0	13	0	2	15
Miner, Stope	14	0	0	0	14
All Others Combined	52	58	4	55	169
Totals	284	689	25	196	1,194

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Comparison of Results with 400_{TC} µg/m³, Calculating TC by OC+EC or ECx1.3

All Valid Samples October, 2003		EC x 1.3		Total
		< 400 µg/m ³	> 400 µg/m ³	
EC + OC	< 400 µg/m ³	905 (75.8%)	18 (1.5%)	923 (77.3%)
	> 400 µg/m ³	59 (4.9%)	212 (17.8%)	271 (22.7%)
Total		964 (80.7%)	230 (19.3%)	1,194 (100%)

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Occupations With at Least One Sample ≥ 400_{TC} µg/m³

Occupation	Total Samples	Minimum	Median	Maximum
Diamond Drill Operator	1	2,030	2,030	2,030
Ground Control/Timberman	2	368	545	722
Washer Operator	4	353	438	808
Engineer	1	438	438	438
Roof Bolter, Mounted	12	98	335	1,063
Mucking Mach. Operator	23	15	334	872
Miner, Stope	14	100	283	622
Cleanup Man	2	66	283	499
Scoop-Tram Operator	7	14	272	583
Drill Operator, Rotary Air	21	0	240	1,353
Miner, Drift	17	16	228	1,459
Blaster, Powder Gang	134	6	227	1,340

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Occupation	Total Samples	Minimum	Median	Maximum
Belt Crew	8	26	225	502
Roof Bolter, Rock	21	63	223	1,310
Truck Driver	252	0	211	1,581
Shuttle Car Operator, diesel	3	95	201	419
Complete Load-Haul-Dump	32	19	189	824
Drill Operator, Jumbo Percussion	38	5	179	1,098
Drill Operator, Rotary	75	3	171	1,109
Motorman	8	59	168	419
Front-end Loader Operator	214	0	158	2,979
Scaling (mechanical)	80	0	139	1,246
Supervisor, Company Official	13	1	130	856
Utility Man	29	29	94	991
Scaling (hand)	26	18	87	2,013
Mechanic	34	0	84	420

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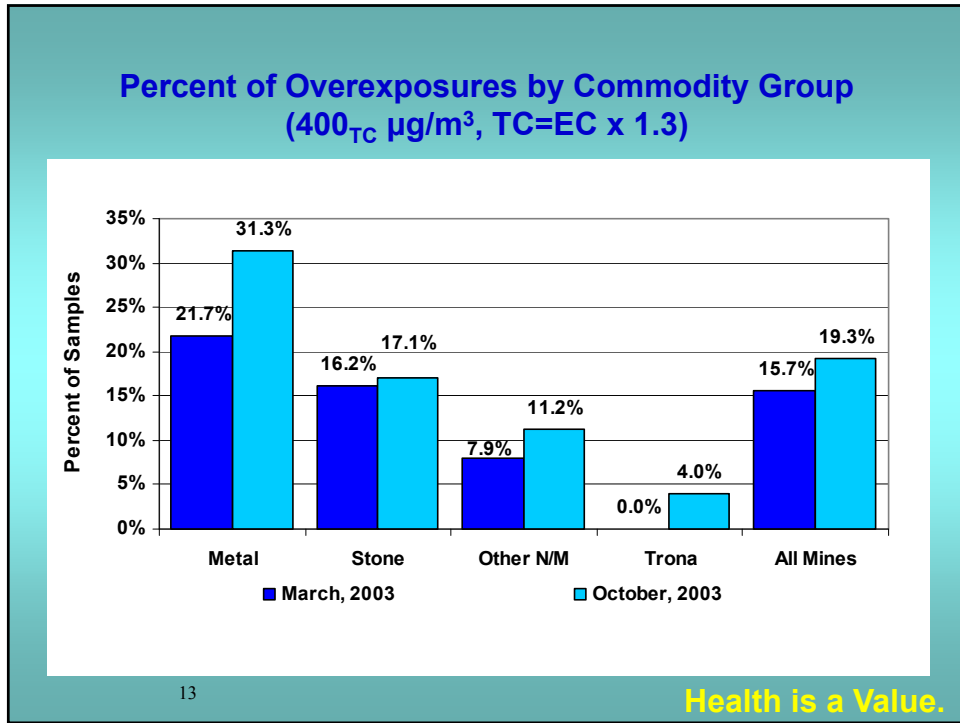
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Baseline Samples by Commodity (TC=EC x 1.3)

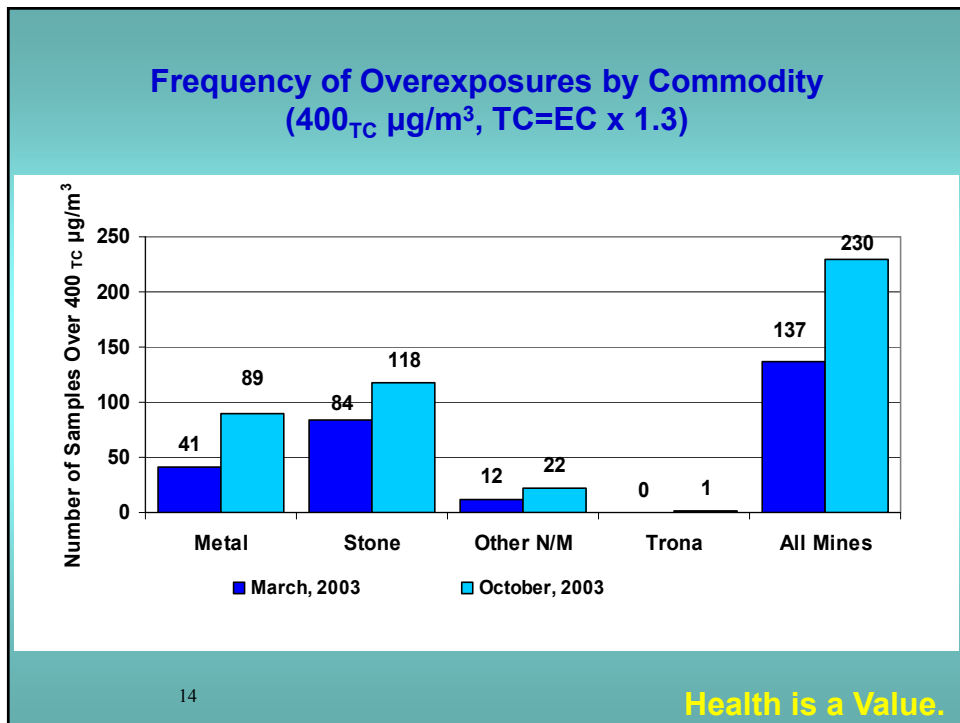
Commodity Group	Number less than 400 _{TC} µg/m ³		Number greater than 400 _{TC} µg/m ³		Total		Percent greater than 400 _{TC} µg/m ³	
	3/03	10/03	3/03	10/03	3/03	10/03	3/03	10/03
Metal	148	195	41	89	189	284	21.7	21.7
Stone	435	571	84	118	519	689	16.2	17.1
Other N/M	139	174	12	22	151	196	7.9	11.2
Trona	15	24	0	1	15	25	0.0	4.0
All Mines	737	964	137	230	874	1,194	15.7	19.3

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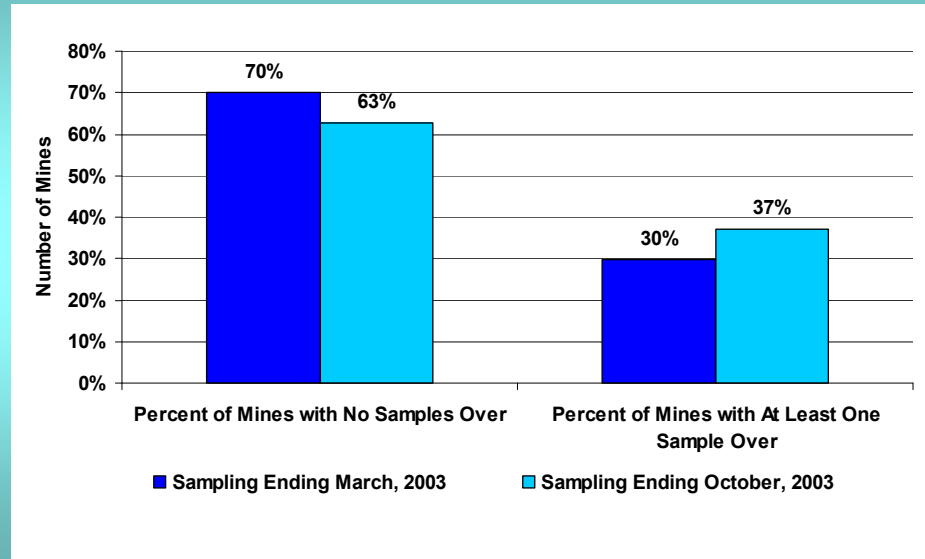


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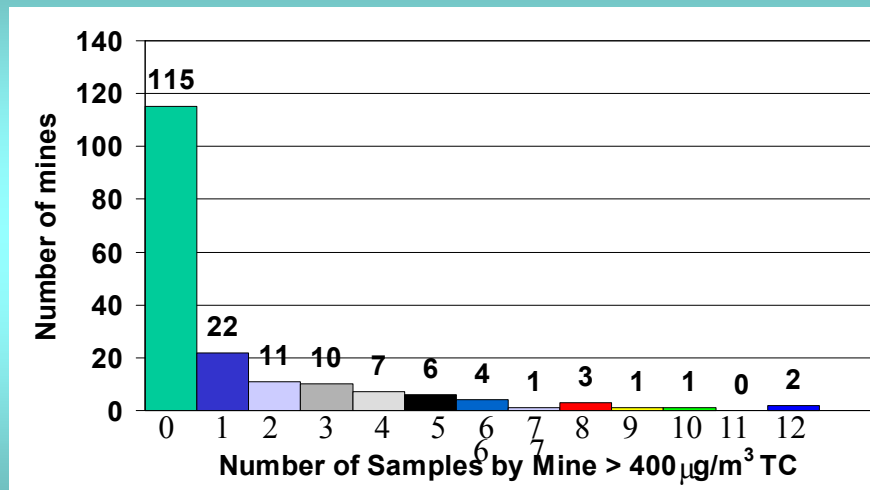
Percent of Mines Having at Least One Sample $\geq 400_{TC} \mu\text{g}/\text{m}^3$



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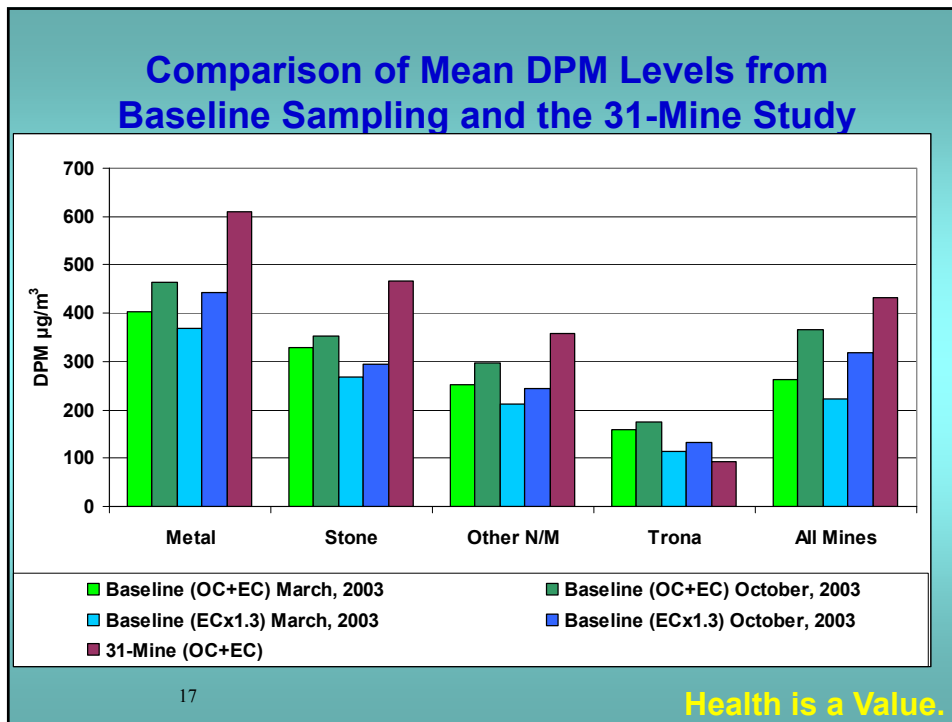
Number of Mines by the Amount of Overexposures Samples for that Mine (TC=EC x1.3)



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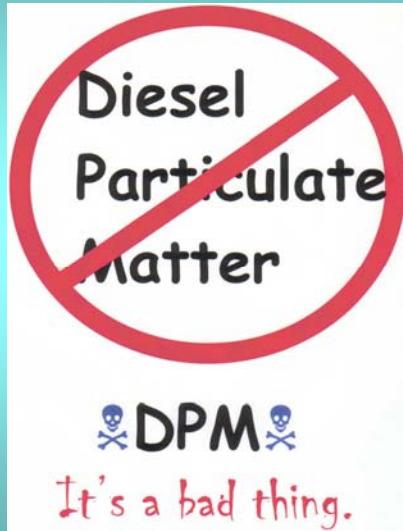


Conclusions from Baseline Sampling

- DPM levels (mean values) for October end date are higher than for March.
- Both appear to be consistently lower than in 31-Mine Study
- Possible reasons:
 - Continual upgrading to low-emission engines/equipment
 - Ventilation upgrades since 31-Mine Study
 - Alternative fuel blends used at some mines
 - 31-Mine Study did not sample inside enclosed cabs if equipment operator was a smoker
 - 31-Mine Study not representative of industry as a whole

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First Year Compliance Experience

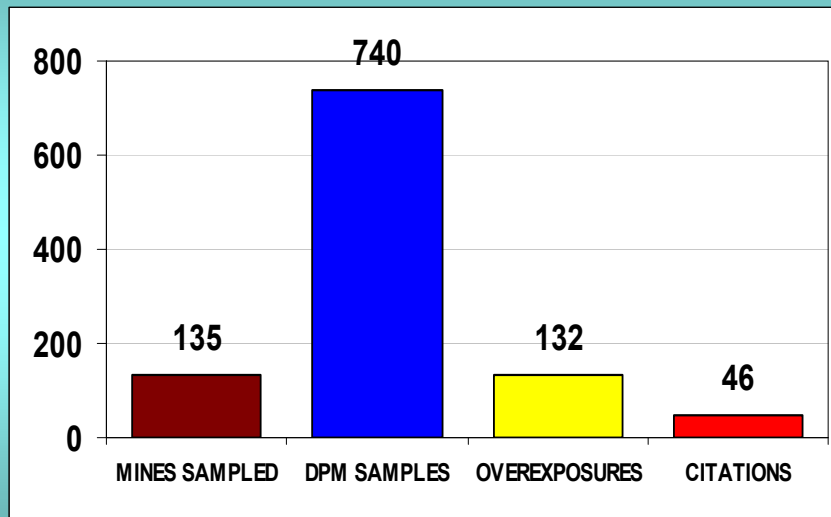


- Samples analyzed and reported 10/29/03 through 8/31/04
- Enforcement actions taken during same period

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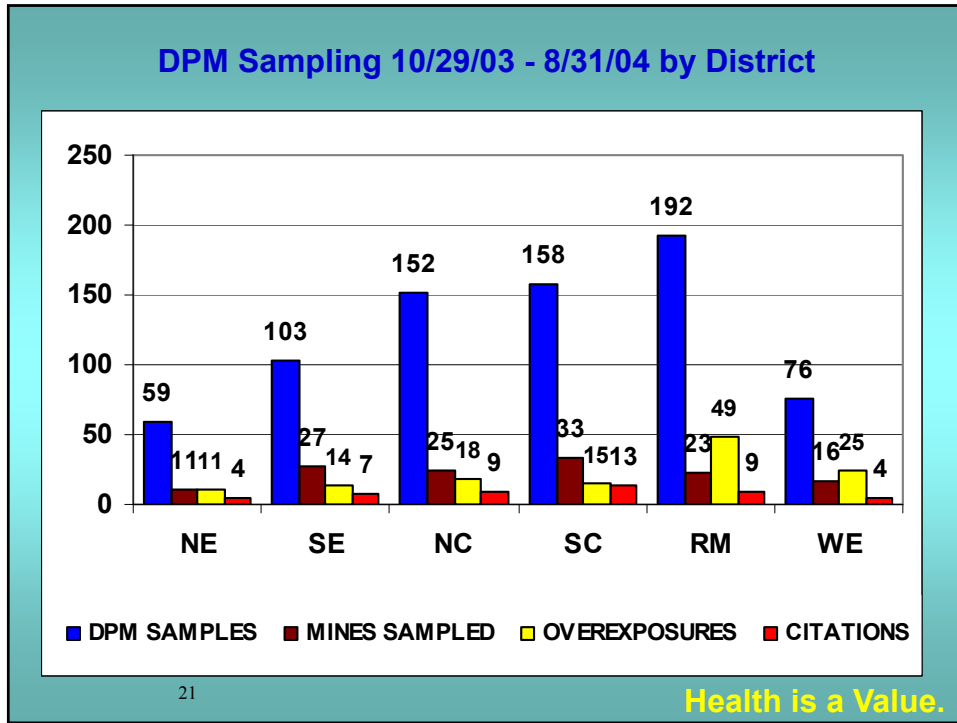
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DPM Sampling 10/29/03 - 8/31/04



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Samples by Commodity

Commodity	No. of Mines	Total Samples	Both Over	TC=EC*1.3		
				Minimum	Median	Maximum
Platinum Group Ore	2	90	41	0	393	1795
Gold Ore	14	57	20	0	330	1122
Lead-Zinc Ore	4	22	7	0	315	529
Misc. Nonmetallic Minerals NEC	1	3	0	60	297	369
Silver Ore	3	16	3	77	287	735
Gypsum	5	32	5	50	247	706
Gemstones	1	2	0	146	159	172
Crushed, Broken Limestone NEC	70	329	47	0	157	1058
Salt	13	93	7	0	149	510
Dimension Marble	2	8	0	0	143	249
Crushed, Broken Marble	2	7	0	38	139	271

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Commodity	No. of Mines	Total Samples	Both Over	TC=EC*1.3		
				Minimum	Median	Maximum
Uranium-Vanadium Ore	1	3	0	120	127	163
Lime	3	19	0	27	124	233
Molybdenum Ore	2	18	1	21	120	519
Potash	3	14	1	47	83	579
Crushed, Broken Stone NEC	2	5	0	25	80	277
Misc. Metal Ore NEC	1	3	0	66	67	102
Clay, Ceramic, Refractory Minerals	1	6	0	29	44	80
Trona	4	9	0	18	44	318
Copper Ore NEC	2	4	0	0	0	0
Totals	136	740	132	0	178	1795

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Occupations with Overexposures

Occupation	Both Over	Total	TC=EC*1.3		
			Minimum	Median	Maximum
Mucking Machine Operator	16	25	30	517	1164
Miner, Drift	4	7	291	464	885
Miner, Stope	3	5	110	435	992
Cleanup Man	2	4	81	388	469
Drill Helper	3	6	57	349	834
Drill Operator, Rotary Air	2	13	66	349	479
Cement/Concrete Man	1	2	144	332	519
Roof Bolter, Rock	5	19	18	298	1003
Drill Operator, Jackleg/Stoper	2	11	0	286	510

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Occupation	Both Over	Total	TC=EC*1.3		
			88	282	579
Complete Load-Haul-Dump	8	32	22	258	1795
Roof Bolter, Mounted	1	6	44	243	515
Blaster, Powder Gang	10	69	0	190	889
Truck Driver	35	172	0	178	949
Scaling (mechanical)	7	54	17	157	647
Drill Operator, Jumbo Perc.	4	32	25	154	520
Drill Operator, Rotary	8	42	0	152	1058
Front-end Loader Operator	17	120	0	150	945
Scaling (hand)	1	5	66	145	740
Laborer, Bullgang	1	5	35	124	454

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Occupations with No Overexposures

Occupation	Total	Minimum	Median	Maximum
Slusher Operator	2	392	392	392
Washer Operator	1	297	297	297
Nipper, Supply Man	3	111	269	343
Sampler, Dust	2	170	245	320
Miner, Raise	3	72	245	269
Cutting Mach Operator	7	0	219	276
Ground Control/Timberman	4	0	191	335
Bobcat Operator	1	182	182	182
Surveyor	5	45	172	375
Mason	1	155	155	155
Bulldozer Operator	1	152	152	152
Motorman	4	36	146	346
Stone Polisher/Cutter	4	129	143	154
Supervisor, Co. Official	12	17	131	289
Oiler, Greaser	3	59	130	351
Road Grader Operator	3	20	126	330
Crusher Oper/Worker	8	52	117	188
Utility Man	9	36	105	315
Tractor Operator	5	19	94	256
Mechanic	14	14	92	309
Diamond Drill Operator	3	15	92	308
Belt Crew	1	68	68	68
Cutting Mach Helper	1	61	61	61
Forklift Operator	2	22	61	99
Skip tender	2	31	57	83
Backhoe Operator	1	46	46	46
Hoist Operator	1	43	43	43
Chute Blaster	2	21	26	32

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