

CAUSES OF OXYGEN DEFICIENCY ARE IDENTIFIED IN THE OSHA ACCIDENT DATABASE

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Abstract: Records from the OSHA Accident Database coded as “Oxygen Deficiency” were analyzed and categorized according to the cause into three categories: oxygen displacement, combustion, and respiration for the period from 1/1/2000 to 3/29/2022. There were 107 records from this time frame. Of these, 63 were found to be attributable to the displacement of oxygen by another gas, 23 records due to respiration, 15 entries due to combustion, and 6 records due to something else. The implications for how to address each of these causes are discussed.

Keywords: Respiration, Internal combustion engine, and displacement of oxygen.

1. INTRODUCTION

Workplace injuries continue to occur, and the Occupational Safety and Health Act of 1970 (OSHA) is mandated by law to investigate fatal workplace incidents. It makes a brief synopsis of the investigations available on its Fatality and Catastrophe Investigation Summary webpage (OSHA, 1970a), which is accessible through its Data & Statistics webpage (OSHA, 1970b), much like it does for other fatal workplace accidents. Furthermore, by filing a Freedom of Information Act (FOIA) request with the relevant regional OSHA office, publicly disclosable information from an investigation can be obtained. Users can search the database by entering different parameters on the Fatality and Catastrophe Investigation Summary (OSHA, 1970c), which also contains an alphabetized categorization of accident categories by keyword, including "Oxygen Deficiency." Individual records can, and frequently do, have many keywords connected with them (OSHA, 1970d). The objective of this paper was to identify the principal causes of oxygen deficiency cases investigated by OSHA with the aim of understanding why they occurred and how future instances might be prevented.

2. METHOD

Records with the keyword "Oxygen Deficiency" entered into the database since the 2000 were identified. These (online) records' accident summaries were then downloaded and reviewed. FOIA requests were sent to the appropriate OSHA Area Offices using the inspection numbers from these records. Notations were made when the subject incident had respiration, an internal combustion engine, and oxygen displacement in those accidents where adequate material was supplied in the accident summaries. This information on the oxygen deficiency status was not included in the summary in many cases, but they were included in the records received from OSHA in response to the FOIA request.

3. RESULTS

Table 1 lists the OSHA-assigned Inspection Number, the NAICS code for the employer, and three oxygen deficiency-related characteristics: respiration (R), internal combustion engine (C), and oxygen displacement (D). The inspection numbers are connected to the entries in the Accident database so that the reader can quickly access each one. More than two-thirds of the records were ambiguous on these queries on the status of the oxygen shortage, as the reader will notice. The records are listed in reverse chronological sequence in the OSHA database (most recent records first). The authors decided it would be more useful to examine patterns within industries, so the records are sorted by NAICS code in the table below (OSHA, 1970d).

Table 1. "Oxygen Deficiency"- Coded Accidents with NAICS codes, where (R) Respiration, (C) Internal Combustion Engine, and (D) Oxygen displacement is specified.

Inspection Number	NAICS	Incident Type	Nature of Incident	Date
302572771	626600	R	Confined space	3/21/2000
119947521	950633	D	Manhole entry with confined space	5/22/2000
303423875	418300	D	Manhole entry	6/29/2000
303484208	522300	D	Manhole entry	9/1/2000
304284938	950411	R	Inhalation with a toxic blast	3/15/2001

Inspection Number	NAICS	Incident Type	Nature of Incident	Date
304409436	854910	D	Nitrogen tanks with confined space	6/28/2001
304663727	1055320	D	explosion	8/30/2001
304764228	420600	D	Nitrogen tanks with confined space	10/12/2001
122199441	524500	D	Blast	3/05/2002
125588434	950615	D	Confined space	4/26/2002
115096976	751910	R	H2S	7/09/2002
303989891	419700	D	Manhole entry	8/30/2002
306573528	237110	D	Manhole entry	4/1/2003
306498221	237110	D	Confined space	7/3/2003
305279515	237110	D	Manhole entry	8/14/2003
306421082	112120	D	Overexposures of gases	8/14/2003
307147561	335129	D	Overexposures of gases	12/4/2003
301503694	114111	D	Inhalation with toxic blast	6/29/2004
307534396	238910	D	Manhole entry	7/14/2004
306707894	237110	D	Manhole entry	8/5/2004
308188440	236220	D	Manhole entry	9/15/2004
307072181	332999	D	Inhalation with toxic blast	3/14/2005
308056878	621910	R	Phosgene gas	4/12/2005
308530930	425120	R	Grain suffocation	4/27/2005
307491258	237110	D	Manhole entry	7/28/2005
307353383	237110	D	Manhole entry	8/16/2005
306359688	115114	D	Toxic forming, confined space	9/27/2005
308138825	921140	D	Confined space	10/3/2005
309602738	111331	D	Low O ₂ fruit storage	12/19/2005
309638674	541620	D	Manhole entry	2/17/2006
310123328	484121	D	Confined space	9/14/2006
309425528	311812	D	Manhole entry	10/2/2006

Inspection Number	NAICS	Incident Type	Nature of Incident	Date
310847678	561730	D	Lack of oxygen	4/11/2007
310968086	562998	D	Nitrogen tank	5/12/2007
311032809	236220	D	Manhole entry	5/16/2007
310177456	237110	D	Manhole entry	6/20/2007
310253398	237110	D	Manhole entry	8/2/2007
310986997	562998	D	Nitrogen	8/4/2007
310874060	337110	C	Bread dough	1/14/2008
311372700	331419	D	Confined space	4/3/2008
311374417	311320	R	Tank entry	6/9/2008
311529291	336612	D	Argon welding	1/09/2009
313089153	336414	D	Confined space	6/4/2009
313573594	112310	D	Confined space	7/13/2009
312410632	921140	D	Confined space	7/22/2009
313197634	331111	D	Confined space	8/10/2009
300751039	484220	D	Confined space	8/12/2009
300753209	312130	D	Confined space	4/21/2011
315446385	237110	D	Manhole entry	6/9/2011
315070763	115115	R	Tank entry	7/28/2011
315916288	237110	D	Confined space	10/10/2011
617478.015	238990	D	Confined space	9/7/2012
1098071.015	623312	R	Rail car entry	9/17/2012
45606.015	238120	compressed	Compressed chest	4/25/2013
943092.015	622110	D	Freon exposure	5/23/2013
908661.015	238110	D	Barge confined space	5/23/2013
944119.015	541990	drown	Failing object due to lack of communication	10/23/2013
944892.015	336611	D	Nitrogen in barge tanks	10/28/2013
981715.015	311999	D	Nitrogen tank	6/20/2014
985693.015	213112	D	Thief hatch gas exposure	7/14/2014
1109329.015	213112	D	Manhole entry	12/01/2015

Inspection Number	NAICS	Incident Type	Nature of Incident	Date
1109252.015	562998	R	Rail car entry	10/9/2015
1109252.015	325132	R	Psyllium dust	11/27/2015
1120086.015	922160	D	Superheated combustible products	1/7/2016
1128150.015	541380	D	Confined space	2/24/2016
1129690.015	561210	D	Argon cylinder	3/2/2016
1133906.015	331111	D	Fire in bldg	3/20/2016
1134289.015	236220	R	Railroad tank	3/21/2016
1194961.015	236220	D	confined space	12/1/2016
1197139.015	332420	D	Argon welding	12/14/2016
1206051.015	236210	R	Confined space	1/20/2017
1208280.015	621991	D	Manhole entry	2/6/2017
1281249.015	325998	D	Nitrogen tank	12/5/2017
1302266.015	711110	D	CO2 fogger	3/8/2018
1314415.015	325199	D	Salt scale from submarine TEP tube	5/5/2018
1319214.015	424490	R	Confined space	5/30/2018
1320667.015	237110	D	Manhole entry	6/1/2018
1340270.015	336611	D	Hypobaric	8/20/2018
1342188.015	238220	C	Gas-powered saw	8/27/2018
1345345.015	238910	D	Manhole entry	9/10/2018
1358080.015	333993	R	Confined space	11/5/2018
1389105.015	811310	D	Confined space	3/27/2019
1414056.015	237110	D	Underground vault	7/9/2019
1414585.015	562998	R	Manhole entry	7/11/2019
1421923.015	813910	D	Manhole entry	8/7/2019
1421152.015	561710	R	Manhole entry	8/7/2019
1448201.015	115210	D	Nitrogen tank	11/21/2019
1451517.015	236115	C	Gasoline-powered pressure washer	12/17/2019
1464356.015	484110	R	Confined space	2/20/2020
1472190.015	926140	R	Manhole entry	3/26/2020

Inspection Number	NAICS	Incident Type	Nature of Incident	Date
1475445.015	488210	R	Nitrogen in barge tanks	5/12/2020
1482885.015	562998	D	Manhole entry	7/10/2020
1485796.015	237110	H2S	Overexposures of gases	7/27/2020
1488084.015	488210	D	Tank car entry	8/13/2020
300509015	112600	D	Confined space	8/16/2000
1489694.015	237110	D	Manhole entry	8/25/2020
1493682.015	924120	C	Wildfire	9/18/2020
1499838.015	621111	C	Fire in bldg	10/27/2020
122185135	626300	D	Nitrogen in supplied air	12/1/2020
1504589.015	424470	D	Nitrogen in supplied air	12/1/2020
1513081.015	312130	D	Wine tank	2/01/2021
1513695.015	332312	D	Nitrogen in supplied air	2/5/2021
1515576.015	562920	R	Confined space	2/19/2021
1516768.015	484121	D	Nitrogen tank	2/22/2021
1515758.015	486990	R	Tank struck due to overexposure	2/22/2021
1520603.015	484110	R	Confined space	3/19/2021
1530065.015	325199	D	methylene chloride	3/29/2021

4. DISCUSSION

This investigation reveals possible causes of the accident in which OSHA coded a record as being connected to respiration, internal combustion engines, and oxygen displacement. Although the data in the OSHA Accident Database is insufficient to conduct a formal Root Cause Analysis of why each oxygen deficiency occurred, the reader is directed to the 107 individual cases for the reasons for the oxygen deficiency, as well as the possible corrective measures. Some records were ambiguous as to whether the fatality was due to displacement of oxygen or to the presence of a toxic vapors such as hydrogen sulfide or methylene chloride. It is notable that of the 107 records, 26 of the summaries specifically mentioned “manhole” and 28 records specifically included the words “confined space”. It is also notable that there were 13 accident summaries in which “nitrogen” was specifically mentioned.

These results suggest a renewed training emphasis on the recognition of confined spaces hazards. While it may not be possible to determine for an otherwise untrained worker to determine whether a particular

enclosed space is in fact a *permit-required confined space* (PRCS) by simple observation, it should be possible to train supervisors and workers to determine if a space is a *confined space* (Pettit and Linn, 1987) as defined by OSHA (large enough for a person to enter, limited means of entry or exit, & not intended for continuous human occupancy¹). Once an enclosed area is identified as a “confined space”, that recognition can trigger further investigation to determine if the space is a PRCS requiring further precautions prior to entry (Manwaring and Conroy, 1990). Other methods of hazard control from low oxygen environments include training and awareness on the presence of nitrogen used to prevent oxidation. There 14 instances in the OSHA Accident summaries which identified nitrogen as the displacing gas, but two of those instances involved a misconnection of supplied air in which airlines were mistakenly connected to nitrogen tanks. The misconnected air supply lines would be best addressed simply by making the connections between the supplied airline and the nitrogen tanks incompatible. The remaining records which indicated nitrogen was a displacing gas were instances where its nitrogen was used to keep oxygen from oxidizing perishable items or to prevent fire in a space with flammable vapors. These are more challenging cases, as the displacing gas is necessary, but additional training for workers is therefore needed. Somewhat surprisingly, only a single instance of a low oxygen environment being attributed to a combustion process was noted in this set of records. That case involved the use of a gasoline powered saw in an enclosed space.

5. REFERENCES

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