

**GEORGIA DEPARTMENT OF COMMUNITY AFFAIRS
COMMUNITY DEVELOPMENT DIVISION
CONSTRUCTION CODES AND RESEARCH**



FINAL REPORT

STATE CODES ADVISORY COMMITTEE CARBON MONOXIDE DETECTORS FOR SCHOOLS TASK FORCE

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Abstract: This final report is based on the results of a Task Force on Carbon Monoxide Detectors for Schools formed by the Georgia Department of Community Affairs (DCA) in conjunction with the Georgia Insurance and Safety Fire Commissioner and the Georgia Department of Education. This report discusses the need for carbon monoxide detection in public and private schools in Georgia, including any conclusions and recommendations formed by the Task Force. The report will also identify if any changes to the state building and fire safety codes are necessary, the reasons why and costs associated with implementing any such changes and if they should be mandatory requirements or voluntary guidelines.

Table of Contents

Executive Summary.....	3
Introduction.....	4
Background and History.....	4
Formation of Task Force.....	4
Charge.....	5
Meetings.....	5
Presentations.....	5
A. Georgia Automatic Fire Alarm Association (AFAA) – CO Detectors.....	5
B. Georgia Emergency Management Association (GEMA) – School Safety.....	6
General Reports.....	7
A. CO Incident at Finch Elementary School.....	7
B. CO Incidents Reported in Schools.....	7
C. Current School Standards and Construction Practices	8
D. CO Legislation	8
Sub-Committee Reports.....	9
1. Effects on Health.....	9
2. CO Sources	11
3. Types of Schools.....	12
4. School Design – Fuel-fired versus Electric Equipment.....	12
5. UL Standards (Underwriters Laboratories).....	12
6. Model Codes.....	14
7. CO Detection Systems.....	14
8. Installation, Testing and Maintenance.....	15
9. Estimated Costs	15
Summary of Data Collected by the Task Force.....	16
Mandatory Regulations versus Voluntary Guidelines.....	17
Voluntary Guidelines.....	17
Training and Education.....	19
Conclusions.....	19
Appreciation.....	20
Attachments.....	20

Executive Summary

The Georgia Department of Community Affairs (DCA) State Codes Advisory Committee (SCAC) in conjunction with the Georgia Insurance and Safety Fire Commissioner and the Georgia Department of Education, are providing this final report on the results of Carbon Monoxide (CO) Detectors for Schools Task Force. This report will discuss the needs and issues for providing CO detectors in new and existing public and private schools in Georgia, including the results and findings provided by the Task Force. The report will also identify if any changes are needed to the state building and fire safety codes, the reasons why and costs associated with implementing any such changes and if they should be mandatory requirements or voluntary guidelines.

Six Talking Points on the Carbon Monoxide (CO) Task Force Results/Findings:

1. The Finch school incident was not due to equipment failure; it was human error.
2. No loss of life has been reported in public or private schools from CO incidents.
3. Loss of life has typically occurred in residential type occupancies used for sleeping.
4. CO detection is not a onetime cost, but rather a continuation of various costs.
5. Not every school system has a problem; e.g. some facilities are total electric.
6. We have applicable code standards that are adopted to address CO detection.

The Task Force heard presentations and received general reports and sub-committee reports from task force members which included various support documentation which is referenced herein and attached. In addition, the following information was collected and submitted for review and consideration:

- ❖ Carbon Monoxide and Schools; CDC (Centers for Disease Control and Prevention)
- ❖ Carbon Monoxide Alarm Considerations for Code Authorities; UL (Underwriters Laboratories)
- ❖ Carbon Monoxide Incidents in Schools by State; NEMA (National Electrical Manufacturers Association)
- ❖ Incidents, Deaths, and In-Depth Investigations Associated with Non-fire Carbon Monoxide from Engine-Driven Generators and Other engine-Driven Tools, 1999-2009; CPSC (Consumer Products Safety Commission)
- ❖ New Code Requirements Expand Carbon Monoxide; Honeywell
- ❖ Non-fire Carbon Monoxide Fact Sheet; NFPA (National Fire Protection Association)
- ❖ Protect Your Family and Yourself from Carbon Monoxide Poisoning; EPA-402-F-96-005
- ❖ Responding to CO Incidents, Guidelines for Fire and Emergency Response Personnel; CPSC
- ❖ Sources of Indoor Air Pollution – Carbon Monoxide; EPA (Environmental Protection Agency)
- ❖ Supplement 3: Carbon Monoxide; 2009 National Fuel Gas Code; NFPA 58 excerpts
- ❖ System-Connected Carbon Monoxide Detectors Application Guide; System Sensor
- ❖ Statement on Carbon Monoxide Detectors in Schools; NEMA

Copies of these documents, articles and brochures, etc. are available from DCA's webpage located at: <http://www.dca.state.ga.us/development/constructioncodes/programs/CarbonMonoxide.asp>

The report concludes with the development of a set of voluntary guidelines which may be utilized by local school districts when assessing the need for and installation of carbon monoxide detection in new and existing school facilities. The task force does not recommend adoption of any new mandatory state regulations or code requirements. There are applicable code standards which are already adopted to address CO detection.

Introduction

The purpose of this report is to investigate the state requirements for installing carbon monoxide (CO) detection in new and existing school facilities. In January 2013, the Department of Community Affairs (DCA), State Codes Advisory Committee (SCAC) formed a Task Force comprised of key Georgia stakeholders. The Task Force reviewed the current state building and fire codes, and other state laws or agency rules and regulations that might apply to the installation of carbon monoxide detectors in schools. After thoroughly examining the problem of providing CO detection in schools, the task force considered all possible options to resolve the problem by either creating mandatory state code regulations or issuing voluntary guidelines for use by local school districts. The Task Force also considered the estimated costs of installing and maintaining CO detection for budgeting purposes.

The final outcome of the Task Force was a set of voluntary guidelines that will be available for local school districts to use to assess the need for and guide the installation of CO detection in their new and existing school facilities. The Task Force also compiled various general and sub-committee reports as summarized herein. Throughout the entire process, the Department closely collaborated with the Office of Insurance and Safety Fire Commissioner and Georgia Department of Education to ensure that a consensus action was achieved by the Task Force which was cost effective and that could be easily implemented by local school systems.

Background and History

In response to the carbon monoxide incident that occurred on Monday, December 3, 2012 at the Finch Elementary School in Atlanta which sickened more than 40 students and staff, Georgia Governor Nathan Deal asked the Department of Community Affairs (DCA) to look at whether the state needs to develop regulations for local school districts to install carbon monoxide detectors in school buildings. Currently, there are no mandatory state requirements for CO detection in new and existing schools in Georgia. In response to the Governor's request, the Department took two steps to address this important issue:

1. The first step taken by the Department was to address the immediate problem of installing and maintaining CO alarms or detectors in existing school facilities. On December 17, 2012, Georgia DCA Commissioner Mike Beatty, Georgia Safety Fire Commissioner Ralph Hudgens and Georgia State School Superintendent Dr. John Barge jointly issued a Carbon Monoxide Detector Advisory to all Georgia School Superintendents. This statewide advisory was intended to provide much needed guidance to local school districts that wished to voluntarily install CO alarms or detectors in their existing facilities as a result of the Finch School incident. (See attachment 1)
2. The second step taken by the Department was the State Codes Advisory Committee formed a Task Force to review the problem and make recommendations (mandatory or voluntary) for any changes to the current state building codes and fire safety standards that may be necessary.

Carbon monoxide emissions can occur in schools where fuel-burning equipment is utilized and vehicles are left idling. Consideration for the safety of our school children and the school's staff is tantamount.

Formation of Task Force

In January 2013, the Department of Community Affairs, State Codes Advisory Committee (SCAC) approved the formation of a 19 member Carbon Monoxide Detectors for Schools Task Force to begin the process of reviewing, debating, and determining if the state needs to develop any mandatory or voluntary regulations for installing CO detectors in new and existing school facilities. (See attachment 2)

The task force membership was comprised of representatives from the following stakeholders:

Office of Insurance and Safety Fire Commissioner (Chairman)
Georgia Department of Community Affairs (Vice Chair)
Georgia Department of Education
Georgia School Superintendents Association
Georgia Independent School Association
Georgia Association of Fire Chiefs
Georgia Fire Inspectors Association
Building Officials Association of Georgia
Georgia State Inspectors Association
Atlanta Gas Light Company
Georgia Power Company
Associated General Contractors of Georgia
Conditioned Air Association of Georgia
Plumbing and Mechanical Association of Georgia
American Council of Engineering Companies Georgia Chapter
American Institute of Architects Georgia Chapter
Georgia Automatic Fire Alarm Association
Construction Suppliers Association of Georgia
Society of Fire Protections Engineers Greater Atlanta Chapter

Charge

The Task Force was charged with two major tasks: 1) assessing the need for carbon monoxide detector requirements in new and existing educational occupancies, and 2) making recommendations to the State Codes Advisory Committee (SCAC) regarding the adoption of any necessary mandatory state code amendments or developing voluntary guidelines. (See attachment 3)

Meetings

The Task Force met five times from January 2013 until June 2013. The meetings were open to the public and any interested parties were invited to attend and participate in the development process. Copies of the public meeting minutes are available on request.

Presentations

The following presentations and other helpful information were submitted for consideration:

A. Georgia Automatic Fire Alarm Association (AFAA) Presentation on CO Detectors

A presentation was made on the types of CO detectors that are available for use on the current market. Highlights of the presentation are as follows: (see attachment 4)

- **How Carbon Monoxide Detectors Work.** There are 3 basic types of detectors: Biomimetic, Metal Oxide Semiconductor, and Electrochemical. Electrochemical is the most common type of detector used. CO detectors cost from \$20 to \$50 depending upon the type of application and intended use. See Table 1 below for comparison of CO detection technologies.

Table 1. Comparison of CO Detection Technologies		
Sensor Technology	Advantages	Disadvantages
Biomimetic	Low cost	High false alarm rate Long recovery after alarm.
Metal Oxide Semiconductor (MOS)	Long life span	High current draw, Expensive Non-selective, sensitive to chemicals and gases other than CO
Electrochemical	Reliable, low field defects	High sensitivity to ammonia-based cleaners
Source: <i>System-Connected Carbon Monoxide Detectors Applications Guide</i> by System Sensor		

- **Residential versus Commercial type CO alarms or detectors.** Residential type detectors are stand alone single station alarms that comply with UL 2034. Commercial type detectors are system connected with supervisory or trouble signal capability. They have modules to signal the control panel and supervising station upon alarm or trouble conditions. Commercial detectors comply with UL 2075 and are tested to UL 2034 for CO sensitivity levels and they must meet NFPA 720 for installation and maintenance.
- **Stand Alone CO Alarms versus System Connected CO Detectors.** Stand Alone CO alarms are self-contained and designed to operate independently without a supervisory station or control panel. System connected CO detection and warning equipment are permanently hard-wired into the building’s primary power system and have a secondary power (battery back-up) source which operates all of the system notification devices in the event of a primary power system failure. System CO detectors are interconnected to supervisory stations and can send a CO alarm or trouble signal to the supervisory station. System type connected CO detectors are also designed to start-up building ventilation systems at lower concentrations and to alarm at higher levels than residential type CO alarms or detectors.
- **Limited Life of System Connected Detectors.** Life expectancy is approximately 6 years. UL requires system connected detectors to send an end-of-life signal to the control panel.
- **Testing, Maintenance and Service of Detectors.** Detectors should be tested and maintained at regular intervals in accordance with NFPA 720 and the manufacturer’s recommendations.

When system connected CO detectors are installed in schools, the CO detection and fire alarm industry recommends installation in accordance with NFPA 720 and the manufacturer’s instructions. **The Task Force recommends using commercial type CO alarms and detectors in schools.**

B. Georgia Emergency Management Association (GEMA) Presentation on School Safety

In accordance with Senate Bill 74 (1999), Georgia schools are required to prepare safety plans. GEMA reviews the safety plans of schools seeking state funding for implementation. Also, GEMA provides training, technical assistance, response training, safety audits, site surveys and exercises.

Due to the Finch Elementary School CO incident, the GEMA School Safety Team was asked to look at CO safety in schools. GEMA conducts on-site surveys of existing facilities which includes identifying equipment that produces CO and if CO detectors are installed. A CO leak requires a Hazmat Situation response. The School Safety Team is updating their handout for new construction and making recommendations on additional safety equipment and is planning to add CO detection provisions.

GEMA holds an annual state conference on School Safety where safety responses, maintenance awareness, severe weather, and security measures are shared. The School Safety Team would like to incorporate the Task Force recommendations and findings into their school safety training program and available literature.

General Reports

A. CO Incident at Finch Elementary School

Chairman Dwayne Garriss, State Fire Marshal, made a brief report on the Finch Elementary School CO incident which occurred on December 3, 2012. More than 40 students and staff members were sickened and sent to area hospitals for treatment. However, none were seriously injured. At the time of inspection, the equipment had already been changed or altered following the incident. It is believed that the carbon monoxide leak was not due to direct mechanical failure. It appears that a closed valve caused condensation to build up inside the fuel gas-fired boiler and carbon monoxide gas was formed which bled over into an attached classroom through wall penetrations. The carbon monoxide readings taken at the time in the mechanical room were very high, approximately 1,700 ppm CO which may be deadly. The CO readings in the classrooms were not as high, approximately 170-250 ppm CO which is still dangerous. The fire department responded to the emergency call and the school was evacuated. The existing condensing type boiler has since been replaced with a non-condensate type boiler. As a result of the investigation, **it was determined that the Finch school incident wasn't due to equipment failure; it was human error.**

B. CO Incidents Reported in Schools

Referring to Table 2 below and the National Fire Protection Association's (NFPA), *Non-Fire Carbon Monoxide Incidents Reported in 2005*, approximately 30,000 fire departments in the United States responded to 61,600 incidents. Only 260 incidents that were reported nationally took place in preschool through grade 12 buildings. According to the report, 9 out of every 10 (54,380) non-fire carbon monoxide incidents that were reported took place in the home. **Loss of life typically has occurred in residential type occupancies used for sleeping.**

Occupancy	Non-Fire Incidents
Public Assembly	540
Educational	260
Institutional	160
Mercantile and Office	1,180
Manufacturing	180
Storage	190

Source: *Non-Fire Carbon Monoxide Incidents Reported in 2005* by Jennifer Flynn dated June 2007, revised April 2008. Report by NFPA

According to information provided by the Georgia Office of State Fire Marshal, prior to the Finch Elementary incident on December 3rd, only three non-fire CO incidents have been reported in Georgia schools. Of these, one incident occurred in metro-Atlanta, one in middle Georgia and one in South Georgia. **No loss of life has been reported in public or private schools from CO incidents.**

The National Electrical Manufacturers Association (NEMA) provided a letter in support for the installation of CO detectors in schools (see attachment 5). They also provided two other documents: *Carbon Monoxide Incidents in Schools by State*¹ and *Carbon Monoxide Detection and Schools*².

¹ Source: National Electrical Manufacturers Association (NEMA)

² Source: <http://www.nema.org/Policy/Documents/Carbon%20Monoxide%20Detection%20-%202012.pdf>

C. Current School Standards and Construction Practices

The Georgia Department of Education commented on their rules and regulations regarding school standards and construction practices. All local school districts are required to submit plans and specifications on all new projects and renovations. They must comply with the established life safety codes and the minimum space requirements for programs. Generally, the Department of Education does not perform on-site compliance inspections. Currently, CO monitoring is not required by the State law or Life Safety Codes. Local school districts evaluate if monitoring is needed individually and then make an internal decision whether or not to require CO alarms or detectors.

D. CO Legislation

At the present time, only two US states have adopted mandatory laws requiring CO detection in schools: Connecticut and Maryland. Connecticut requires CO detection in new and existing public school buildings in a room which contains a permanently installed fuel burning appliance effective on January 1, 2012³. Maryland requires CO detection in newly constructed or substantially remodeled public schools containing a fuel fired appliance effective on October 1, 2012.⁴ Maryland's law does not include any specific requirements for detector placement (see attachment 6).

Georgia currently has two proposed bills and one resolution pending in the 2013-2014 regular session which call for mandatory requirements for CO detectors in schools. House Resolution 279, introduced by Representative Sharon Beasley-Teague (D-65th) and others, requests that the State Board of Education and Fulton County Board of Education require the installation of carbon monoxide detectors in schools. (See attachment 7)

Georgia House Bill 23 sponsored by Representative Sheila Jones (D-53rd) and others, would amend Chapter 2 of Title 25 of the Official Code of Georgia Annotated, relating to regulation of fire and other hazards to persons and property generally, so as to require every public and private school to have carbon monoxide detectors. HB 23 was referred to the House Public Safety and Homeland Security Committee for further study. (See attachment 8)

Senate Bill 89 sponsored by Senator Vincent Fort (D-39th) and others, would similarly amend Chapter 2 of Title 25 of the Official Code of Georgia Annotated, relating to regulation of fire and other hazards to persons and property generally, so as to require every public and private school to have CO detectors. Unlike HB 22, SB 89 also requires every early care and education program to have carbon monoxide detectors and warning equipment. SB 89 was also referred to Senate Education and Youth Committee for further study. (See attachment 9)

³ Connecticut House Bill No S326, Public Act No. 11-248, effective January 1, 2012

⁴ Maryland Senate Bill 173, Chapter 38, effective October 1, 2012

Sub-Committee Reports

After a brainstorming session, specific topics were identified for research and discussion. The topics were then assigned to various Sub-committees comprised of task force members who were asked to research the subject and report back their findings. The research topics were identified as follows:

1. Effects on Health
2. CO Sources
3. Types of Schools
4. School Design – Fuel-fired versus Electric Equipment
5. UL Standards
6. Model Codes
7. CO Detection Systems
8. Installation, Testing and Maintenance
9. Estimated Costs

A brief synopsis of each of the Sub-committee reports is provided as follows:

1. Effects on Health

Carbon Monoxide (CO) is an invisible, odorless, tasteless gas. Due to its high toxicity, CO is called the “silent killer”. Many North Americans require medical care each year because of CO poisoning. The following data demonstrates the overall impact of non-fire related incidents from CO exposures:

- Approximately 439 deaths from unintentional non-fire related CO exposure annually⁵.
- On average, 1.5 deaths per million persons. Most deaths typically occur in the home.
- Between 2000 and 2009, 68,316 cases of CO exposure were reported in the US. 2,016 exposures were reported in US schools (119 hospitalized and 28 managed on site).
- No school related Carbon Monoxide deaths have ever been reported.
- Physical effects: headaches, nausea, dizziness, confusion and death.
- Exposure effects: See Table 3 ‘Concentration (ppm CO) and symptoms’.
See Figure 1 ‘Symptoms relating to CO exposure’.

The human body depends on oxygen to convert food to usable energy that allows cells to live and function. Oxygen makes up approximately 21% of the atmosphere, and enters the lungs during breathing. In the lungs it combines with a blood component called hemoglobin. When saturated with oxygen, it is called oxyhemoglobin. After being carried by the bloodstream to the cells of the body, oxyhemoglobin releases oxygen to the body tissues. Carbon monoxide is dangerous because it bonds much more tightly to the hemoglobin than oxygen does. Once hemoglobin combines with carbon monoxide to form carboxyhemoglobin (COHb), its ability to combine with oxygen is completely lost.

As carboxyhemoglobin is formed, the amount of oxygen carried to the cells and organs in the body decreases. Carbon monoxide starves the blood of oxygen, literally causing the body to suffocate from the inside out. When the carboxyhemoglobin concentration reaches a certain level, people may experience headaches or be nauseous, dizzy, confused or unconscious, and ultimately die. How quickly symptoms appear depends upon the concentration, or parts per million (ppm) of carbon

⁵ Source: Unintentional Non-Fire-Related Carbon Monoxide Exposures, United States, 2001-2003; CDC/NEISS-AIP

monoxide in the air and the duration of exposure. A person’s size, age and general health are factors in how quickly the effects of the gas become evident. Children and the elderly are very vulnerable.

Carbon monoxide is generated by incomplete combustion of fuel, such as natural gas, propane, heating oil, kerosene, coal, charcoal, gasoline or wood. This incomplete combustion can occur in a variety of appliances and equipment. The major cause of high levels of CO is faulty ventilation of boilers, furnaces, water heaters, fireplaces, cooking stoves, grills and portable heaters. Other common CO sources include the exhaust from trucks, buses or cars, and gas or diesel powered portable equipment, such as generators, forklift trucks, leaf blowers, weed eaters and floor cleaners.

Faulty or improper ventilation of natural gas and fuel oil fired equipment during the cold winter months accounts for most of the recorded carbon monoxide poisoning cases. Correct operation of any fuel burning equipment requires two key conditions: 1) an adequate supply of air for complete combustion, and 2) proper ventilation of fuel burning appliances.

Table 3 below lists the acute effects produced by carbon monoxide in relation to ambient concentration in parts per million. Referring to Table 2, for an exposure rate of 1,600 ppm CO, the symptoms or physical effects include headache, nausea and dizziness after 20 minutes of exposure. However, loss of consciousness occurs after 1 hour of exposure at 1,000 ppm CO.

Table 3 – Symptoms of CO Exposure Based on Concentration (ppm CO)	
Concentration (ppm CO)	Symptoms
50	No adverse effects with 8 hours of exposure
200	Mild headache after 2–3 hours of exposure
400	Headache and nausea after 1–2 hours of exposure
800	Headache, nausea, and dizziness after 45 minutes of exposure; collapse and unconsciousness after 2 hours of exposure
1,000	Loss of consciousness after 1 hour of exposure
1,600	Headache, nausea, and dizziness after 20 minutes of exposure
3,200	Headache, nausea, and dizziness after 5-10 minutes of exposure; collapse and unconsciousness after 30 minutes of exposure
6,400	Headache and dizziness after 1-2 minutes of exposure; unconsciousness and danger of death after 10-15 minutes of exposure
12,800 (1.28% volume)	Immediate physiological effects; by unconsciousness and danger of death after 1-3 minutes of exposure
Sources: Struttman T, Scheerer A, Prince TS, Goldstein LA (Nov 1998). "Unintentional carbon monoxide poisoning from an unlikely source". The Journal of the American Board of Family Practice 11 (6): 481–484. PMID 9876005; Goldstein M (December 2008). "Carbon monoxide poisoning". Journal of Emergency Nursing: JEN: Official Publication of the Emergency Department Nurses Association 34 (6): 538–542. doi:10.1016/j.jen.2007.11.014. PMID 19022078.	

Figure 1 below explains that the length of time that a person is exposed to carbon monoxide, as well as the concentration level, will directly affect the severity of symptoms. COHb, a complex of carbon monoxide and hemoglobin that can be found in blood cells, is one hazardous result of excess amounts of CO. A concentration level of 50% COHb can cause permanent brain damage or death.

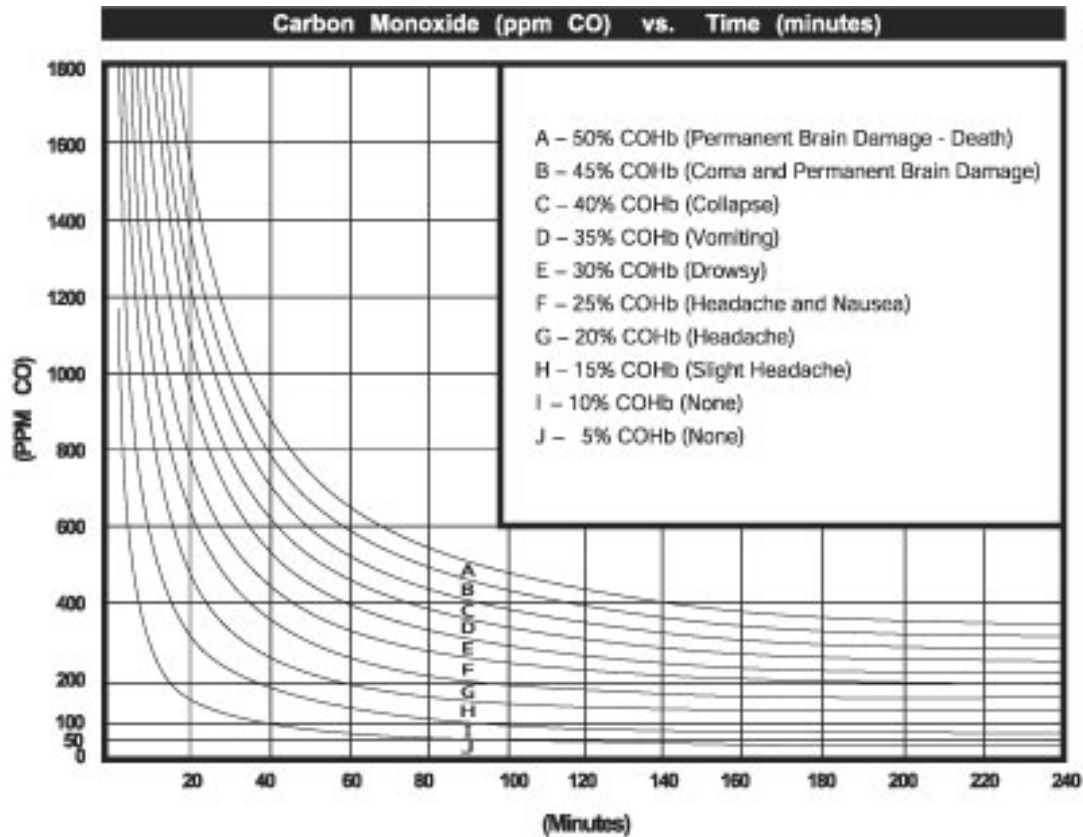


Figure 1 – Carbon monoxide Concentration (ppm CO) Versus Time (Minutes)⁶

Referring to Figure 1, it is important to note the highest level of CO gas detected in the boiler room at the Finch Elementary School was approximately 1,700 ppm CO which is highly dangerous. The level of CO gas detected in classrooms adjacent to the boiler room where children were present was approximately 250 ppm CO, which can cause symptoms of headaches, dizziness and drowsiness.

2. CO Sources

The task force investigated the potential sources of where carbon monoxide gas occurs in schools. CO detection should be considered where fuel-fired equipment and appliances are located and where vehicle emissions are prevalent. Examples of potential CO sources in schools may include:

- Boilers, Water heaters and Furnaces
- Generators (permanent and portable)
- Vehicles idling near exterior doors and windows and air intake vents
- Natural gas and propane fired appliances
 - Gas cooking appliances, e.g. ranges, stoves and ovens
 - Gas dryers, e.g. commercial laundry equipment
 - Chemistry labs, e.g. Bunsen burners
 - Portable heating equipment
 - Gas powered floor polishers
- Lawnmowers
- Weed eaters

⁶ Source: http://www.nadi.com/images/co_ppm_chart.jpg

Idling school buses and parental cars were determined as the biggest sources of CO at schools. The task force recommends that local school districts look closely at where school buses and parental cars are idling at designated school drop-off and pick-up areas to see if there are any building air intakes and if adequate ventilation is provided for enclosed or confined and congested spaces.

3. Types of Schools

Table 3 lists the types of schools and number of facilities that are located in Georgia. Public schools are elementary or secondary schools (K-12) supported by public funds which provide free education for children (ages 5 and up) in a local community or school district. Private schools are secondary or elementary schools that are run and supported by private individuals, a trust or corporation, rather than by a government or public agency. Private schools are funded in whole or in part by charging tuition. The Georgia Independent School Association reported that their association membership includes 160+ private, independent and parochial schools.

Referring to Table 4 below, there are approximately 8,000 public and private schools located in Georgia which includes child care programs, colleges and universities and juvenile institutions.

Type of School	Number of Facilities
Public schools	2,500 public schools (1,224 elementary schools)
Private schools	901
Child care centers	3,829
“Other” child care programs ^b	252
Georgia colleges & universities ^a	177
Dept. of Juvenile Justice	26 facilities in the state with schools
Sources: Georgia School Superintendent Association; Georgia Independent School Association Note a: Classified as Group B (business) occupancies by the state building and fire safety codes. Note b: Other child care programs as identified in the 2012 American Community Survey.	

Georgia colleges and universities are not classified as educational occupancies by the building and fire safety codes. They are classified as Group B (Business) occupancies. Child care centers are classified as day-care occupancies. Other child care programs include kindergarden classes and nursery schools which are incidental to day-care occupancies. The Department of Juvenile Justice operates several state-owned facilities which provide housing and schooling for juvenile offenders.

4. School Design – Fuel-fired versus Electric Equipment

A small amount of schools located within the state are totally electric. However, the majority of schools have gas boilers. Gas cooking equipment in kitchens, when range hoods are not turned on, can contribute to high levels of CO gas. The equipment in fuel-fired systems is typically sealed. Total electric new and existing schools may not need CO detection and warning equipment installed.

5. UL Standards

Underwriters Laboratories (UL), a consensus standards writing organization, develops and publishes various code reference standards. UL 2034, *Standard for Single and Multiple Station Carbon Monoxide Alarms* and UL 2075 *Gas and Vapor Detectors and Sensors* are the current product standards that are referenced in the model building codes for CO detection and warning equipment.

UL 2075 applies to CO detectors intended for monitoring the environment and detectors intended for open area protection and for connection to a compatible power supply or control unit for operation as part of gas detection or emergency signaling systems. UL 2075 also includes provisions for the connection to a source of power and signaling circuits in accordance with the National Electrical Code (NEC).

UL 2034 applies to self-contained (stand-alone) single and multiple-station CO alarms that are intended for protection in ordinary indoor locations of dwelling units. A single station CO alarm operates independently of other alarms. A multiple station CO alarm is essentially a single station unit that can be interconnected to other CO alarms so that the actuation of one unit causes an alarm signal to operate in all interconnected units. UL 2034 listed alarms are intended for residential use only. They are not intended for commercial use or connection to a system control.

It is important to note that the alarm thresholds of UL 2034 for CO alarms and UL 2075 for CO detectors are the same. UL 2075 requires CO detectors to operate within the sensitivity parameters as defined by UL 2034.

UL listed alarms and detectors must pass certain performance tests to verify that they operate reliably under a variety of conditions within a specified response time when exposed to several different CO concentrations. The higher the concentration, the quicker a unit must respond.

Table 5 illustrates the actual alarm thresholds for sensitivity testing based on CO concentration and response time as required by UL 2034.

Table 5 - Alarm thresholds based on CO concentration and response time	
Concentration (ppm CO)	Response Time
30	No less than 30 days
70	60 to 240 minutes
150	10 to 50 minutes
400	4 to 15 minutes

Source: UL 2034, Section 15.1 (b) and Table 38.1

Units are also tested to determine that they do not operate at lower CO concentrations/exposure times so they do not generate nuisance alarms. For example, older CO detection technology has a history of false alarms, e.g. cigarette smoke. UL standards are updated periodically to require performance tests and even different alarms depending on the level of event. One possible suggestion was to require that CO detection and warning equipment installed in schools “must be designed by a registered engineer” who can keep up with any changes in the UL standards, etc. However, hiring a professional engineer will increase the project costs and may not be necessary.

UL 2075 for CO detectors and UL 2034 for CO Alarms are referenced by adoption in the current State Building Code, State Fire Code and the State Minimum Fire Safety Standards. **The Sub-committee determined the state has applicable code standards that are adopted to address CO detection.**

6. Model Codes

There are no mandatory requirements in the current model codes which require CO detectors in educational occupancies or schools. Specifically, this includes the current State Minimum Standard Building and Fire Codes and State Minimum Fire Safety Standards. However, the current State Minimum Standard Residential Code requires that CO alarms must be installed in all one- and two-family dwellings and townhouses.

Effective January 1, 2014, Section [F] 908.7 of the 2012 International Building Code (IBC) and 2012 International Fire Code (IFC) as adopted and amended by the Department of Community Affairs, requires that Group I (Institutional) and Group R (Residential) occupancies located in a building containing a fuel-burning appliance or in a building which has an attached parking garage shall be equipped with single-station carbon monoxide alarms. This applies to newly constructed occupancies that contain sleeping rooms or sleeping areas, such as hotels, motels, dormitories, apartments, hospitals, nursing homes, assisted living facilities, prisons, correctional centers, detention centers, adult and child day care centers and personal care homes. (see attachment 10)

However, IBC Section 908.7.1 permits system connected CO detectors to be installed as a primary form of protection if they are installed and maintained in accordance with NFPA 720 and listed as complying with ANSI/UL 2075 *Gas and Vapor Detectors and Sensors*. Section [F] 1103.9 covers the requirements for CO detection for Group-R and Group-I *existing* occupancies, which is equivalent to the requirements in [F] 908.7 for *newly* constructed occupancies. (See attachment 11)

In addition, NFPA 101, Life Safety Code, as adopted and amended by the State Fire Marshal, could be directly impacted if mandatory provisions were recommended. NFPA 101 applies to both new construction and existing buildings or structures and any such changes must be properly correlated.

Effective January 1, 2014, the 2012 Life Safety Code (NFPA 101) requires CO detection in newly constructed occupancies with sleeping rooms or areas, such as daycare centers, hotels, dormitories and apartment buildings. CO detection is required in these specific occupancies when they contain a permanently installed fuel-burning appliance or they have an attached garage. (See attachment 12) For hotels, dormitories and apartment buildings, NFPA 720 also requires CO alarms or detectors to be installed in certain *non-sleeping* locations, including on the ceiling in rooms containing a permanently installed fuel-burning appliance and centrally located within occupiable spaces served by the first air register from a fuel-burning HVAC system.

The state building and fire codes further stipulate that CO alarms and detection systems shall be installed and maintained in accordance with NFPA 720 *Standard for Installation of Carbon Monoxide (CO) Detection and Warning Equipment* and the manufacturer's instructions. NFPA 720 permits either CO alarms complying with ANSI/UL 2034 *Single and Multiple Station Carbon Monoxide Alarms* or CO detectors complying with ANSI/UL 2075 *Gas and Vapor Detectors and Sensors* to be installed.

However, there are no mandatory provisions in the 2012 IBC or IFC which require that carbon monoxide alarms or detectors must be installed in Group E (Educational) occupancies. Group E occupancies include any buildings, or any portion thereof, used by six or more persons at any one time for educational purposes through the 12th grade (K-12). This also includes day care facilities and places of religious worship providing day care during religious functions.

The Sub-committee determined that the state has applicable code standards that are adopted to address CO detection.

7. CO Detection Systems

The definition of a CO detector is not what the general public would call a detector. A CO detector is a device which senses when CO gas is present at certain levels in a room or area and then communicates the condition to a control panel. Single station alarms are stand-alone devices for residential use with an integral audible alarm. Single station alarms are the type installed in our homes that can be purchased at hardware stores.

NFPA 720 includes provisions for when there is a break in communication and 'trouble' is indicated on the control panel and the event is not reported to the local fire department. Supervisory conditions indicate when there is a need for service or maintenance of the system components and trouble indicates that a device is out of order; not a CO leak. NFPA 720 includes CO levels based on exposure time for detectors and minimal information where they should be installed.

NFPA 72 *National Fire Alarm and Signaling Code*, as adopted and amended by the State Fire Marshal, covers the application, installation, location, performance, inspection, testing, and maintenance of fire alarm systems, supervising alarm stations, public emergency alarm reporting systems, fire warning equipment, emergency communications systems and their components.

NFPA 72 and NFPA 720 are similar, but have different codes for locations/spacing. Notification appliances are addressed in NFPA 720. The notification sound for smoke (three beeps) and CO alarms (four beeps) are different, but very close in sound; such that the general public would not know the difference. Public education and awareness of these subtle sound differences is needed.

Schools may not be able to just add equipment to existing systems, as equipment panels and horns can be different. NFPA 72 establishes the standards for voice systems plus other event notifications. One possibility discussed was to look at indentifying CO hazard areas and provide spot detection. The Sub-committee recommended that any CO detection and warning equipment should be installed in accordance with NFPA 720 and the manufacturer's installation instructions.

8. Installation, Testing and Maintenance

NFPA 720 should be referenced for the installation, testing and maintenance of CO alarms and detectors. Boiler inspections are required by NFPA 54 *National Fuel Gas Code* as adopted and amended by the State Fire Marshal's Office. NFPA 54 covers the installation and operation of fuel gas piping systems, appliances, equipment, and related accessories, with rules for piping systems materials and components, piping system testing and purging, combustion and ventilation air supply, and venting of gas-fired appliances and equipment. The state also has regulations regarding the installation and inspections of boilers and a caution was added that there are safeguards in place. If a school system maintains their equipment properly, then there may never be a problem.

9. Estimated Costs

The Sub-committee determined that each school building or structure is unique in its design. There is no standard school building structure and no one specific cost estimate will cover the 8,000+ existing school facilities in the state. The amount of existing fuel burning equipment present, along with other factors, will determine the need for CO detection and warning equipment. Therefore, it was not practical or reasonable to estimate the costs of retrofitting existing school facilities on a cost per square foot basis. Instead, actual school facilities were examined as case studies to obtain real cost estimates. Refer to the Estimated Costs Report for more details. (See attachment 13)

Each existing or new school structure must be evaluated individually to determine the need for proper monitoring. The design of new structures could incorporate the proper monitoring, but installation costs most likely will be less since the installation will be part of the total construction process and cost. Retrofitting a typical middle school may require 15 CO detectors and a typical high school may require 45 CO detectors. Control panels must be compatible or they must be upgraded.

Two proposals were considered. Proposal 1 is to install stand alone CO alarms in existing school buildings where the existing fire alarm control panel will not support connectivity of detectors. The total cost of this system is \$3,360 or \$168 per unit for materials and labor. Proposal 2 is to install system monitored CO detectors in existing school buildings supervised by an existing fire alarm control panel. The total cost of this system is \$7,500 or \$375 per unit for materials and labor. Proposal 2 assumes the existing control panel will accept the module to monitor the CO detectors. It is conceivable that costs to modify a panel to accept this module could cost \$10,000.

Other options that were explored were connecting the new CO detectors to an existing fire alarm panel or energy management system and how to phase in the requirements over time which would help local school district budgets. CO detection is not a onetime cost, but rather a continuation of various costs. Since the life span of CO devices is only 6 years, consideration should be given to replacement of worn-out detectors and how this will affect existing facilities and budgets.

The Sub-committee recommended Proposal 1 to install stand alone CO alarms that are not interconnected to the existing fire alarm control panel as the most cost effective and practical case study example. The installation of System Connected CO detectors as suggested in Proposal 2 may involve the heavy retrofitting of existing facilities which is often more labor intensive and costly.

Summary of Task Force Results/Findings

The following is a summary of the significant results and findings that were made by the Task Force:

- Carbon Monoxide (CO) is an invisible, odorless, tasteless gas. Due to its high toxicity, CO is called the “silent killer”. The physical health effects that are caused by CO poisoning include: headaches, nausea, dizziness, confusion and death. No school non-fire related CO deaths have been reported nationally. No CO deaths have ever been reported in Georgia schools.
- Potential CO sources in schools include: fuel-fired boilers, water heaters, furnaces, generators (permanent and portable), natural gas and propane appliances, kitchen cooking equipment, idling buses and cars, portable heaters, leaf blowers and weed eaters.
- There are approximately 8,000+ existing school facilities in Georgia. This includes public, private, independent and parochial, primary and secondary schools, child care and adult day care programs, state and private colleges or universities and juvenile detention institutions.
- Some schools are total electric and do not need CO detection systems. However, the vast majority have fuel-burning equipment that may need CO detection and warning equipment.
- UL 2034, *Standard for Single and Multiple Station Carbon Monoxide Alarms* and UL 2075 *Gas and Vapor Detectors and Sensors* are the current product standards that are referenced in the model building codes and fire safety standards for CO detection and warning equipment.
- There are no mandatory regulations in current state law, building construction codes, fire and life safety standards, or other state agency rules and regulations which require the installation of CO alarms or detectors in new and existing school facilities. The state currently has applicable code standards that are adopted which address CO detection.

- There is a difference between CO alarms and detectors. CO detectors are system connected devices for commercial use that sense CO gas and communicate with a control panel. Single station CO alarms are stand-alone devices for residential use with an integral audible alarm.
- NFPA 720 as adopted and amended by the State Fire Marshal (SFM) should be referenced for the installation, testing and maintenance of CO alarms and detectors.
- The Office of State Fire Marshal (SFM) currently has adopted rules and regulations that apply to the installation and inspection of new and existing boilers and pressure vessels.
- Installation of CO detection and warning equipment should be considered where fuel-fired equipment and appliances are located and where vehicle emissions are prevalent.
- Some schools may not be able to add equipment to existing systems, as the equipment panels, CO detectors and horns (visual/audible warning equipment) may not be compatible.
- Each school building is unique in its design and no one specific cost estimate will cover all of the types of school facilities in Georgia. The amount of existing fuel burning equipment and other factors, will determine the need and cost for CO detection and warning equipment.
- The estimated cost to install system monitored CO detectors in existing school buildings supervised by an existing fire alarm control panel is \$7,500 or \$375 per unit for materials and labor. Upgrading an existing control panel to accept the modules to monitor CO detectors is \$10,000 or more depends upon the system design and the cost of installation.
- The estimated cost to install stand alone CO alarms in existing school buildings where the existing fire alarm control panel will not support connectivity of detectors is \$3,360 or \$168 per unit for materials and labor. Single station alarms are very practical and cost effective.

Mandatory Regulations versus Voluntary Guidelines

A poll was taken of the Task Force members in order to determine if mandatory regulations should be adopted by the state or if voluntary guidelines should be recommended for implementation by local school districts. The consensus of the task force was that legislative action or adoption of mandatory regulations may not be the best way to solve the problem. The Task Force determined the best possible solution was development of a set of voluntary guidelines which local school districts could use to assess the need for and guide the installation of CO detection in new and existing facilities.

Voluntary Guidelines

The basis for the Voluntary Guidelines was the original CO Advisory that was issued to all local school superintendents in December 2012. (See attachment 1) The Voluntary Guidelines are intended to replace the original CO Advisory.

The task force worked closely with all of the stakeholders involved to complete a consensus document. Emphasis was placed in the guidelines on: 1) Assessment (performed by schools), 2) Process, and 3) Action. The final draft of the Voluntary Guidelines incorporated comments and suggestions from the Office of Insurance and Safety Fire Commissioner and Georgia Department of Education.

(See attachment 14)

The task force strongly recommends the assessment of each new and existing facility and facilities currently in the design phase, to recognize and evaluate the potential sources of Carbon Monoxide (CO).

If it is determined from the assessment that CO detection is needed, then consideration should be given to the type and location of detection devices to be utilized to achieve the desired coverage results. Regardless of the assessment outcome, school systems should ensure that the following conditions are met:

- All fuel burning boilers have been inspected annually as required by law.
- All other fuel burning equipment is inspected and serviced regularly as recommended by the manufacturer.
- Provide training for school service personnel on proper maintenance and equipment operation.
- Review existing emergency procedures for building evacuation.
- School personnel are familiar with the symptoms of CO poisoning.
- School personnel are familiar with and aware of the emergency plan of action when symptoms of CO poisoning are observed.

If a local school district (public or private) determines that carbon monoxide detection is needed, the following voluntary guidelines may be used for installing CO detection systems or individual alarms:

- Utilize appropriate CO equipment for the application. There is a difference between residential and commercial detectors.
- CO warning equipment (detectors and/or alarms) should be commercial type and installed by qualified persons.
- CO warning equipment (detectors and/or alarms) should be listed as complying with Underwriters Laboratories Standards UL 2034 – *Standard for Single and Multiple Station Carbon Monoxide Alarms* and UL 2075 – *Gas and Vapor Detectors and Sensors* or other approved equal.
- NFPA 720 – *Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment* is an adopted standard by the Safety Fire Commissioner to provide design criteria, installation, testing and maintenance standards.
- If CO equipment is installed, it must be tested, inspected and maintained in accordance with the manufacturer’s instructions and the applicable standard.
- Consideration should also be given to the following:
 - Having CO detection in the same room containing permanently installed fuel-fired equipment;
 - Having a remote alarm located outside rooms containing CO detectors near the primary entrance door;
 - Having a warning sign posted at all entrances to the rooms containing fuel-fired equipment indicating that a CO detector is in-use and located inside the space;
 - Having notification of detection of CO given as prescribed by the applicable codes and standards.

When CO gas emissions are suspected in a building, the local gas provider should be contacted to test the air for carbon monoxide emissions or the local fire department can perform a safety inspection.

The recommended Voluntary Guidelines were approved by the Task Force in June 2013 and by the State Codes Advisory Committee (SCAC) in July 2013.

Training and Education

The need to enhance staff training and provide additional educational resources on the proper operation, testing and maintenance of fuel-burning equipment that produces CO is also very important. The Task Force highly recommended that appropriate CO educational training should be incorporated into any state and local safety training programs and the facility management policies of school districts.

Conclusions

After careful consideration of all the information that was reported, collected and reviewed by the Task Force, the final outcome was a set of Voluntary Guidelines which may be used by local school districts to assess the need for CO detection and warning equipment in their new and existing school facilities.

Six Talking Points on the Carbon Monoxide (CO) Task Force Results/Findings:

1. The Finch school incident wasn't due to equipment failure; it was human error.
2. No loss of life has been reported in public or private schools from CO incidents.
3. Loss of life has typically occurred in residential type occupancies used for sleeping.
4. CO detection is not a onetime cost, but rather a continuation of various costs.
5. Not every school system has a problem; e.g. some facilities are total electric.
6. We have applicable code standards that are adopted to address CO detection.

The Task Force determined that adequate code provisions and standards are available in the current adopted state building codes and fire safety standards which may be voluntarily utilized when designing, installing and maintaining CO detection and warning equipment in new and existing school facilities. Therefore, the Task Force does not recommend the adoption of any new state legislation or mandatory code requirements that would require CO alarms or detectors to be installed in new or existing schools.

Throughout the Task Force process, the Department closely collaborated with the Georgia Insurance and Safety Fire Commissioner and the Georgia Department of Education to ensure that a consensus action was achieved by the Task Force which was cost effective and could be easily implemented by local school systems statewide. Education of school administration and maintenance staff was also strongly suggested.

Upon final approval, the Department will coordinate distribution of the Voluntary Guidelines with the related state agencies and interested parties. Copies of the Final Task Force Report will be available upon request. A copy of the Voluntary Guidelines may be downloaded from DCA's webpage located at: <http://www.dca.state.ga.us/development/constructioncodes/programs/CarbonMonoxide.asp>

For questions and further assistance regarding the information included in this report, please contact:

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The Department would like to sincerely thank the following members that volunteered their time and efforts to participate and serve on this important Task Force:

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Windell Peters, Vice Chairman; State Codes Advisory Committee

David Adams; Georgia Fire Inspectors Association
Ron Anderson; Georgia State Inspectors Association
Marty Bergstrom; Georgia Power Company
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Chuck Mailoux; Construction Suppliers Association of Georgia
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Attachments

1. Carbon Monoxide Detector Advisory
2. Task Force Members List
3. Task Force Charge
4. *System Connected Carbon Monoxide Detectors Application Guide* by System Sensor
5. Statement by NEMA Supporting the Installation of CO Detectors in Schools
6. *US Carbon Monoxide Legislation* by System Sensor
7. HR 279 by Rep. Sharon Beasley-Teague (D-65th)
8. HB 23 by Rep. Sheila Jones (D-53rd)
9. SB 89 by Sen. Vincent Fort (R-35th)
10. Section 908.7 'Carbon monoxide alarms', International Building Code, 2012 Edition
11. Section 908.7 and 1103.9 'Carbon monoxide alarms', International Fire Code, 2012 Edition
12. *New Code Requirements Expand CO Detectors* by Honeywell Life Safety
13. Estimated Costs Report
14. Voluntary Guidelines for Carbon Monoxide Detectors for New and Existing Schools

End of Report