

**BREATHABLE AIR SAFETY SYSTEM AND METHOD
HAVING AN AIR STORAGE SUB-SYSTEM**

CLAIMS OF PRIORITY

[0001] This patent application claims priority from:

- (1) U.S. Utility patent application number 11/505,708, titled 'Breathable air safety system and method having at least one fill site' filed on August 16, 2006.
- (2) U.S. Utility patent application number 11/505,597 titled 'Breathable air safety system and method having an air storage sub-system', filed August 16, 2006.
- (3) U.S. Utility patent application number 11/505,599, titled 'Breathable air safety system and method having a fill station' filed on August 16, 2006.
- (4) U.S. Utility patent application number 11/505,525 titled 'Safety system and method of an underground mine' filed on August 16, 2006.
- (5) U.S. Utility patent application number 11/505,538 titled 'Safety system and method of a tunnel structure' filed on August 16, 2006.

FIELD OF TECHNOLOGY

[0002] This disclosure relates generally to the technical fields of safety systems and, in one example embodiment, to a breathable air safety system and method having an air storage sub-system.

BACKGROUND

[0003] A structure may include a horizontal building structure such as a shopping mall, a warehouse, storage and manufacturing facilities, large box stores such as IKEA, Home Depot, a vertical structure such as a high rise building, a mid rise building, and a low rise building, a mine, a subway, a tunnel, and/or a wine cave.

[0004] The tunnel, for example, may be substantially horizontal and have a ratio of the length of the passage to the width of at least two to one. In addition, the tunnel may be completely enclosed on all sides, and the openings may be saved for the length of the covered area causing limited accessibility to the tunnel.

[0005] Providing and maintaining adequate safety in the structure may be of importance. For example, serious or fatal accidents occurring in underground mines in United States over the years may have resulted from an inability to control roofs of

the underground mines. A fatal accident can occur, for example, from falling of even one large rock from the roof of the mine.

[0006] In a case of an emergency situation of the structure, emergency personnel (e.g., a fire fighter, a SWAT team, a law enforcer, and/or a medical worker, etc.) may be deployed onsite of the structure to alleviate the emergency situation through mitigating a source of hazard as well as rescuing stranded civilians from the structure. The emergency situation may include events such as a fire, a chemical attack, a terror attack, a subway accident, a mine collapse, and/or a biological agent attack.

[0007] In such situations, breathable air inside the structure may be hazardously affected (e.g., depleted, absorbed, and/or contaminated). In addition, flow of fresh air into the structure may be significantly hindered due to the structure having enclosed regions, lack of windows, and/or high concentration of contaminants, etc. As a result, inhaling air in the structure may be extremely detrimental and may further result in death (e.g., within minutes). Furthermore, emergency work may often need to be performed from within the structure.

[0008] The emergency personnel's ability to alleviate the emergency in an efficient manner may be significantly limited by the lack of breathable air and/or abundance of contaminated air. A survival rate of stranded civilians in the structure may substantially decrease due to a propagation of contaminated air through out the structure, placing a large number of innocent lives at significant risk.

[0009] As such, the emergency personnel may utilize a portable breathable air apparatus (e.g., self-contained breathable air apparatus) as a source of breathable air during an emergency incident and/or a rescue mission. However, the portable breathable air apparatus may be heavy (e.g., 20-30 pounds) and/or may provide breathable air for a short while (e.g., approximately 15-30 minutes). In the emergency situation, the emergency personnel may need to walk, descend and/or climb to a particular location within the structure to perform rescuing work due to inoperable transport systems (e.g., obstructed walkway, elevators, moving sidewalks, and/or escalators, etc.)

[0010] As such, by the time the emergency personnel reach the particular location, his/her portable breathable air apparatus may be already depleted and may require replenishment (e.g., via a shuttle method or returning back to a previous location for a new portable breathable air apparatus). As a result, precious lives may be lost due to

precious time being lost. An extra supply of portable breathable air apparatuses may be stored throughout the structure so that emergency personnel can replace their portable breathable air apparatuses within the structure. However, supplying structures with spare portable breathable air apparatuses may be expensive and take up space in the structure, thereby causing severe handicap to the ability of emergency personnel to perform rescue tasks.

[0011] Furthermore, management, supervisors, personnel, etc., may not regularly inspect the spare portable breathable air apparatuses. With time, the spare portable breathable air apparatuses may experience pressure loss placing the emergency personnel at significant risk when the spare breathable air apparatus is utilized in the emergency situation. The spare portable breathable air apparatuses may also be tampered with, during storage. Contaminants may be introduced into the spare portable breathable air apparatuses that may be detrimental to the emergency personnel.

SUMMARY

[0012] A breathable air safety system and method having an air storage sub-system is disclosed. In one aspect, a safety system of a building structure includes a supply unit of a building structure to facilitate delivery of breathable air from a source of compressed air to an air distribution system of the building structure, a valve to prevent leakage of the breathable air from the air distribution system potentially leading to loss of system pressure, a fill station interior to the building structure to provide the breathable air to a breathable air apparatus at multiple locations of the building structure, a secure chamber of the fill station as a safety shield that confines a possible rupture of an over-pressurized breathable air apparatus within the secure chamber, a distribution structure that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to the multiple locations of the building structure, and an air storage sub-system to provide an additional supply of air to the building structure in addition to the source of compressed air.

[0013] In addition, the safety system may include an air storage tank of the air storage sub-system to provide storage of air that is dispersible to the multiple locations of the building structure. The safety system may further include a plurality of air storage tanks of the air storage sub-system that are coupled to each other through tubes having a looped configuration to increase robustness of the tubes through preventing breakage due to stress. The safety system may also include a booster tank of the air storage sub-system coupled to the air storage tank to store compressed air of a higher pressure than the compressed air that is stored in the air storage tank. In addition, the safety system may include a driving air source of the air storage sub-system to pneumatically drive a piston of a pressure booster to maintain a higher pressure of the air distribution system such that a breathable air apparatus is reliably filled. The driving air source may enable the breathable air to be optimally supplied to the building structure through allowing the breathable air to be isolated from driving the pressure booster.

[0014] The safety system may include an air monitoring system to automatically track and record any of impurities and contaminants in the breathable air of the air distribution system. The air monitoring system may include an automatic shutdown feature to suspend air dissemination to the building structure in a case that any of

impurity levels and contaminant levels exceed a safety threshold. The safety system may also include a pressure monitoring system to continuously track and record the system pressure of the air distribution system. The safety system may further include a pressure switch that is electrically coupled to an alarm system such that the alarm system is set off when the system pressure of the air distribution system is outside a safety range. The pressure switch may electrically transmit a warning signal to an emergency supervising station when the system pressure of the air distribution system is outside the safety range.

[0015] The safety system may include at least one indicator unit of the air storage sub-system to provide status information of the air distribution system including storage pressure, booster pressure, pressure of the compressed air source, and/or the system pressure. The safety system may further include a supply unit enclosure encompassing the supply unit having a weather resistant feature, ultraviolet and/or infrared solar radiation resistant feature to prevent corrosion and/or physical damage.

[0016] The safety system may also include a locking mechanism of the supply unit enclosure to secure the supply unit from intrusions that potentially compromise safety and reliability of the air distribution system. The safety system may further include a robust metallic material (e.g., may be at least substantially 18 gauge carbon steel) of the supply unit enclosure to minimize a physical damage due to various hazards to protect the supply unit from an intrusion and/or damage. In addition, the safety system may include a valve of the supply unit to automatically suspend transfer of breathable air from the source of compressed air to the air distribution system when useful.

[0017] The safety system may further include a safety relief valve of any of the supply unit and the fill station to release the breathable air when a system pressure of the air distribution system exceeds a threshold value beyond the design pressure to ensure reliability of the air distribution system through maintaining the system pressure such that it is within a pressure rating of each component of the air distribution system.

[0018] The safety system may also include a CGA connector and RIC/UAC connector of the supply unit to facilitate a connection with the source of compressed air through ensuring compatibility with the source of compressed air. The safety system may further include an adjustable pressure regulator of the supply unit that is

used to adjust a fill pressure of the source of compressed air to ensure that the fill pressure does not exceed the design pressure of the air distribution system.

[0019] In addition, the safety system may include at least one pressure gauge of the supply unit enclosure to indicate any of the system pressure of the air distribution system and the fill pressure of the source of compressed air and a visible marking of the supply unit enclosure and the fill station enclosure to provide luminescence in a reduced light environment. The safety system may also include another valve of the fill station to prevent leakage of air from the air distribution system potentially leading to a pressure loss of the air distribution system through ensuring that the system pressure is maintained within a threshold range of the design pressure to reliably fill the breathable air apparatus. The safety system may include an isolation valve of the fill station to isolate the fill station from a remaining portion of the air distribution system. The isolation valve may be automatically actuated based on an air pressure sensor of the air distribution system.

[0020] Further, the safety system may include at least one pressure regulator of each of the fill station to adjust a fill pressure to fill the breathable air apparatus and to ensure that the fill pressure does not exceed the pressure rating of the breathable air apparatus potentially resulting in a rupture of the breathable air apparatus. The safety system may also include at least one pressure gauge of the fill station to indicate any of a fill pressure of the fill station and a system pressure of the air distribution system. In addition, the safety system may include a fire rated material and/or a fire rated assembly to enclose the distribution structure such that the distribution structure has the ability to withstand elevated temperatures for a prescribed period of time.

[0021] The safety system may include a sleeve that is at least three times an outer diameter of each of a plurality of pipes of the distribution structure exterior to the fire rated material to further protect the fire rated material from any damage. Both ends of the sleeve may be fitted with the fire rated material that is approved by an authority agency. Further, the safety system may include a robust solid casing of the distribution structure to prevent physical damage to the distribution structure potentially compromising the safety and integrity of the air distribution system.

[0022] In addition, the safety system may include another sleeve at least three times an outer diameter of a pipe of the distribution structure exterior to the robust solid casing to further protect the robust solid casing from any damage. Both ends of

another sleeve may be fitted with the fire rated material that is approved by the authority agency. The safety system may also include a plurality of support structures of each pipe of the distribution structure at intervals no larger than five feet to provide adequate structural support for each pipe. The distribution structure may include any of a stainless steel and a thermoplastic material that is compatible for use with compressed air.

[0023] The safety system may further include an air monitoring system to automatically track and record any of impurities and/or contaminants in the breathable air of the air distribution system. The air monitoring system may include an automatic shut down feature to suspend air distribution to the fill station in a case that any of an impurity level and contaminant concentration exceeds a safety threshold.

[0024] The safety system may also include a pressure monitoring system to automatically track and record the system pressure of the air distribution system. In addition, the safety system may include a pressure switch that is electrically coupled to a fire alarm system of the building structure such that the fire alarm system is set off when the system pressure of the air distribution system is outside a safety range. The pressure switch may electrically transmit a warning signal to an emergency supervising station when the system pressure of the air distribution system is outside the safety range.

[0025] The fill station may have a physical capacity to enclose at least one breathable air apparatus and may include a RIC/UAC connector that expedites a filling process of the breathable air apparatus. The safety system may further include a tamper switch of the locking mechanism of the supply unit enclosure such that an alarm is automatically triggered and a signal is electrically coupled to any of relevant administrative personnel of the building structure and the emergency supervising station when an intrusion of the supply unit occurs. The secure chamber may be certified to be rupture containable according to approved standards. The safety system may also include a selector valve that is accessible by emergency personnel to selectively utilize the source of compressed air to deliver the breathable air to the air fill station.

[0026] The air storage sub-system may be housed in a fire rated enclosure that is certified to be rupture containable to withstand elevated temperatures for a prescribed amount of time. The safety system may further include a securing mechanism of the

secure chamber of the fill station having a locking function is automatically actuated via a coupling mechanism with a flow switch that indicates a status of air flow to the breathable air apparatus that is fillable in the fill station.

[0027] In another aspect, a method of safety of a building structure includes ensuring that a prescribed pressure of an emergency support system maintains within a threshold range of the prescribed pressure by including a valve of the emergency support system to prevent leakage of breathable air from the emergency support system, safeguarding a filling process of a breathable air apparatus by enclosing the breathable air apparatus in a secure chamber of a fill site of the emergency support system of the building structure to provide a safe placement to supply the breathable air to the breathable air apparatus, and providing a spare storage of breathable air through an air storage tank of an air storage sub-system to store the breathable air that is replenishable with a source of compressed air.

[0028] In addition, the method may include preventing corrosion and physical damage due to weather by incorporating a supply unit enclosure that is weather resistant. The method may further include preventing intrusion of the supply unit potentially compromising the safety and reliability of the breathing emergency support system by incorporating a locking mechanism of the supply unit enclosure. The method may also include minimizing physical damage of various external hazards to protect the supply unit and the fill site from any of an intrusion and damage through utilizing a robust metallic material to the supply unit enclosure.

[0029] The method may include preventing leakage of air from the emergency support system leading to a potential pressure loss of the emergency support system through utilizing a valve of any of the supply unit and the fill site. The method may further include discontinuing transfer of the breathable air from the source of compressed air to the emergency support system through utilizing a valve to the emergency support system. In addition, the method may include automatically releasing the breathable air from the emergency support system when the system pressure of the emergency support system exceeds the prescribed pressure through triggering a safety relief valve of the supply unit and/or the fill site. The method may also include ensuring compatibility of the emergency support system and the source of compressed air of an authority agency through a CGA connector and/or a RIC/UAC connector of the supply unit.

[0030] In addition, the method may include adjusting a fill pressure to ensure that the fill pressure of the source of compressed air does not exceed the prescribed pressure of the emergency support system through a pressure regulator of the supply unit. The method may further include monitoring the system pressure of the emergency support system and/or the fill pressure of the source of compressed air through a pressure gauge of the supply unit enclosure. The method may also include improving accessibility of the supply unit enclosure through providing luminescence in reduced light environment by incorporating a visible marking. In addition, the method may include isolating a fill site from a remaining portion of the emergency support system using an isolation valve of the fill site such that the remaining portion of the emergency support system is utilizable in an emergency situation.

[0031] The method may further include automatically actuating the isolation valve based on an air pressure sensor of the emergency support system. The method may also include adjusting the fill pressure of the fill site to ensure that the fill pressure does not exceed the pressure rating of the breathable air apparatus through a pressure regulator of the fill site. In addition, the method may include monitoring any one of the fill pressure of the fill site and the system pressure of the emergency support system by incorporating the pressure gauge to the fill site.

[0032] The method may further include enabling the distribution structure to withstand elevated temperatures for a period of time using a fire rated material to encase the distribution structure. The method may include preventing the fire rated material from any damage by incorporating a sleeve at least three times an outer diameter of each pipe of the distribution structure exterior to the fire rated material.

[0033] The method may also include preventing physical damage to the distribution structure potentially compromising safety and integrity of the emergency support system by utilizing a robust solid casing of the distribution structure. In addition, the method may include protecting the robust solid casing from any damage using another sleeve at least three times an outer diameter of a pipe of the distribution structure exterior to the robust solid casing.

[0034] The method may also include automatically tracking and recording any impurities and contaminants in the breathable air of the breathing emergency support system through an air monitoring system. The method may further include automatically suspending air dissemination to the fill sites in a case that any of an

impurity level and contaminant concentration exceeds a safety threshold. In addition, the method may include tracking and recording the system pressure of the emergency support system through a pressure monitoring system.

[0035] The method may further include electrically coupling the pressure monitoring system and a fire alarm system of the building structure such that the fire alarm system is automatically triggered through a pressure switch when the system pressure of the emergency support system is outside a safety range. In addition, the method may include electrically transmitting a warning signal to an emergency supervising station when the system pressure of the emergency support system is below a prescribed level through the pressure switch.

[0036] The method may further include automatically triggering an alarm and electrically coupling a signal to any of relevant administrative personnel of the building structure and the emergency supervising station when an intrusion of the supply unit occurs through a tamper switch of the locking mechanism of the supply unit enclosure. The method may also include increasing pressure of the breathable air stored in the air storage tank through a pressure booster to increase a pressure of the breathable air compared to the pressure of the breathable air in a plurality of air storage tanks to ensure that the emergency support system constantly has a supply of breathable air that has enough pressure to fill the breathable air apparatus.

[0037] In addition, the method may include conserving a supply of breathable air in the air storage tank through utilizing a driving air source to drive the pressure booster. The method may include designating the prescribed pressure of the emergency support system based on a municipality code that specifies a pressure rating of the breathable air apparatus that is used in an authority agency of a particular geographical location.

[0038] In yet another aspect, a building structure includes a first set of walls extending vertically and horizontally enclosing an area of land such that the area of land is in an internal region of the building structure, a second set of walls that divide the internal region of the building structure in any of a horizontal and vertical direction into rooms displaced any of horizontally and vertically from one another, a supply unit adjacent to a particular wall of the first set of walls to facilitate delivery of breathable air from a source of compressed air to an emergency support system of the building structure, a fill station of the internal region of the building structure to

provide the breathable air to a breathable air apparatus at multiple locations of the building structure, a secure chamber of the fill station as a safety shield that confine a possible rupture of an over-pressurized breathable air apparatus within the secure chamber, a distribution structure that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to the multiple locations of the building structure, and an air storage sub-system to provide an additional supply of air to the building structure in addition to the source of compressed air.

[0039] The building structure may also include an air monitoring system to automatically track and record any of impurities and contaminants in the breathable air of the air distribution system. The building structure may further include an air pressure monitor that is electrically coupled to an alarm such that the alarm is set off when the system pressure of the air distribution system is outside a prescribed threshold range. In addition, the building structure may include a physical enclosure of the fill station exterior to the secure chamber of the fill station that provides additional protection to the fill station from an elevated temperature and/or physical impact.

[0040] In a further aspect, a safety system of a tunnel structure includes a supply unit of a tunnel structure to facilitate delivery of breathable air from a source of compressed air to an air distribution system of the tunnel structure, a valve to prevent leakage of the breathable air from the air distribution system potentially leading to loss of system pressure, a fill site interior to the tunnel structure to provide the breathable air to a breathable air apparatus at multiple locations of the tunnel structure, and a distribution structure that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the tunnel structure.

[0041] In yet a further aspect, a safety system of a building structure includes a supply unit of a building structure to facilitate delivery of breathable air from a source of compressed air to an air distribution system of the building structure, a valve to prevent leakage of the breathable air from the air distribution system potentially leading to loss of a system pressure, a fill station interior to the building structure to provide the breathable air to a breathable air apparatus at multiple locations of the building structure, a secure chamber of the fill station as a safety shield that confines a

possible rupture of an over-pressurized breathable air apparatus within the secure chamber, and a distribution structure that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure.

[0042] In another aspect, a method of safety of a building structure includes ensuring that a prescribed pressure of an emergency support system maintains within a threshold range of the prescribed pressure by including a valve of the emergency support system to prevent leakage of breathable air from the emergency support system, safeguarding a filling process of a breathable air apparatus by enclosing the breathable air apparatus in a secure chamber of a fill site of the emergency support system of the building structure to provide a safe placement to supply the breathable air to the breathable air apparatus, and maintaining the prescribed pressure of the emergency support system such that a system pressure is compatible with the breathable air apparatus through a distribution structure that is rated for use with compressed air that couples the supply unit and fill site to transfer breathable air of the source of compressed air to the fill site.

[0043] In yet another aspect, a building structure includes a first set of walls extending vertically and horizontally enclosing an area of land such that the area of land is in an internal region of the building structure, a second set of walls that divide the internal region of the building structure in any of a horizontal and vertical direction into rooms displaced any of a horizontally and vertically from one another, a supply unit adjacent to a particular wall of the first set of walls to facilitate delivery of breathable air from a source of compressed air to an emergency support system of the building structure, a fill station of the internal region of the building structure to provide the breathable air to a breathable air apparatus at multiple locations of the building structure, a secure chamber of the fill station as a safety shield that confines a possible rupture of an over-pressurized breathable air apparatus within the secure chamber, and a distribution structure that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure.

[0044] In another aspect, a safety system of a building structure includes a supply unit of the building structure to facilitate delivery of breathable air from a source of compressed air to an air distribution system of the building structure, a valve to

prevent leakage of the breathable air from the air distribution system potentially leading to loss of a system pressure, a fill panel interior to the building structure having a RIC/UAC fitting pressure rated for a fill outlet of the fill panel to fill a breathable air apparatus to expedite a breathable air extraction process from the air distribution system and to provide the breathable air to the breathable air apparatus at multiple locations of the building structure, and a distribution structure that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure.

[0045] In a further aspect, a method of safety of a structure includes ensuring that a prescribed pressure of an emergency support system maintains within a threshold range of the prescribed pressure by including a valve of the emergency support system to prevent leakage of breathable air from the emergency support system and expediting an air extraction process from the emergency support system by including a RIC/UAC fitting to a fill panel to fill a breathable air apparatus.

[0046] In yet another aspect, a building structure includes a first set of walls extending vertically and horizontally enclosing an area of land such that the area of land is in an internal region of the building structure, a second set of walls that divide the internal region of the building structure in any of a horizontal and vertical direction into areas displaced any of a horizontally and vertically from one another, a supply unit adjacent to a particular wall of the first set of walls to facilitate delivery of breathable air from a source of compressed air to an emergency support system of the building structure, a fill panel of the internal region of the building structure having a RIC/UAC fitting to expedite a breathable air extraction process from the emergency support system and to provide the breathable air to the breathable air apparatus at multiple locations of the building structure, and a distribution structure that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure.

[0047] In another aspect, a safety system of a mine structure includes a supply unit of the mine structure to facilitate delivery of breathable air from a source of compressed air to an air distribution system of the mine structure, a valve to prevent leakage of the breathable air from the air distribution system potentially leading to loss of system

pressure, a fill site interior to the mine structure to provide the breathable air to a breathable air apparatus at multiple locations of the mine structure, and a distribution structure that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the mine structure.

[0048] In yet another aspect, a method of safety of a mine structure includes ensuring that a prescribed pressure of an emergency support system maintains within a threshold range of the prescribed pressure by including a valve of the emergency support system to prevent leakage of breathable air from the emergency support system, safeguarding a filling process of a breathable air apparatus by enclosing the breathable air apparatus in a secure chamber of a fill site of the emergency support system of the mine structure to provide a safe placement to supply the breathable air to the breathable air apparatus, and providing a spare storage of breathable air through an air storage tank of a storage sub-system to store breathable air that is replenishable with a source of compressed air.

[0049] In a further aspect, a safety system of a structure includes a supply unit of a building structure to facilitate delivery of breathable air from a source of compressed air to an air distribution system of the building structure, a distribution structure that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure, and an air storage sub-system to provide an additional supply of air to the building structure in addition to the source of compressed air.

[0050] Methods, systems, and apparatuses disclosed herein may be implemented in any means for achieving various aspects, and may be executed in a form of a machine-readable medium embodying a set of instructions that, when executed by a machine, cause the machine to perform any of an operations disclosed herein. Other features will be apparent from an accompanying drawing and from the detailed description that follows.

BRIEF DESCRIPTION OF THE DRAWINGS

[0051] Example embodiments are illustrated by way of example and not limitation in the figures of the accompanying drawings, in which like references indicate similar elements and in which:

[0052] **Figure 1** is a block diagram of an air distribution system in a structure, according to one embodiment.

[0053] **Figure 2** is block diagram of an air distribution system in a structure having fill sites located vertically from one another, according to one embodiment.

[0054] **Figure 3** is a block diagram of an air distribution system in a structure having fill sites located horizontally from one another, according to one embodiment.

[0055] **Figure 4A** is a front view of the supply unit of the air distribution system, according to one embodiment.

[0056] **Figure 4B** is a rear view of the supply unit of the air distribution system, according to one embodiment.

[0057] **Figure 5** is an illustration of a supply unit enclosure encompassing the supply unit, according to one embodiment.

[0058] **Figure 6A** is an illustration of a fill station interior to the structure, according to one embodiment.

[0059] **Figure 6B** is an illustration of a fill panel interior to the structure, according to one embodiment.

[0060] **Figure 7A** is a diagrammatic view of a pipe of the distribution structure embedded in a fire rated material, according to one embodiment.

[0061] **Figure 7B** is a cross sectional view of the distribution structure embedded in the fire rated material, according to one embodiment.

[0062] **Figure 8** is a network view of an air monitoring system with a wireless module communicating with building administration and an emergency agency through a network, according to one embodiment.

[0063] **Figure 9** is a front view of a control panel of an air storage sub-system, according to one embodiment.

[0064] **Figure 10** is an illustration of the air storage sub-system, according to one embodiment.

[0065] **Figure 11** is a block diagram of an air distribution system having the air storage sub-system, according to one embodiment.

[0066] **Figure 12** is a process flow of a safety of a building structure having an air storage sub-system, according to one embodiment.

[0067] **Figure 13** is a process flow that describes further the operations of **Figure 12**, according to one embodiment.

[0068] **Figure 14** is a process flow that describes further the operations of **Figure 13**, according to one embodiment.

[0069] **Figure 15** is a process flow that describes further the operations of **Figure 14**, according to one embodiment.

[0070] **Figure 16** is a process flow that describes further the operations of **Figure 15**, according to one embodiment.

[0071] **Figure 17** is a process flow of a safety of a building structure having a fill station, according to one embodiment.

[0072] **Figure 18** is a process flow of a safety of a building structure having a fill site, according to one embodiment.

[0073] **Figure 19** is a process flow of a safety of a mine structure, according to one embodiment.

[0074] Other features of the present embodiments will be apparent from the accompanying drawings and from the detailed description that follows.

DETAILED DESCRIPTION

[0075] A Breathable air safety system and method having an air storage sub-system is disclosed. In the following description, for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the various embodiments. It will be evident, however to one skilled in the art that the various embodiments may be practiced without these specific details.

[0076] The terms “air distribution system” and “emergency support system” are used interchangeably throughout the document.

[0077] In one embodiment, a safety system of a building structure includes a supply unit (e.g., the supply unit 100 of **Figures 1-3**) of a building structure to facilitate delivery of breathable air from a source of compressed air to an air distribution system (e.g., the air distribution system 150, 250, 350 of **Figures 1-3**) of the building structure, a valve (e.g., the valve of the series of valves 408 of **Figure 4**) to prevent a leakage of the breathable air from the air distribution system 150 potentially leading to loss of a system pressure, a fill station (e.g., the fill station 102A of **Figure 6A**) interior to the building structure to provide the breathable air to a breathable air apparatus at multiple locations of the building structure, a secure chamber (e.g., the holders 612 of **Figure 6A**) of the fill station 102A as a safety shield that confines a possible rupture of an over-pressurized breathable air apparatus within the secure chamber 612, a distribution structure (e.g., the distribution structure 104 of **Figures 1-3**) that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure, and an air storage sub-system (e.g., the air storage sub-system 950 of **Figure 10**) to provide an additional supply of air to the building structure in addition to the source of compressed air.

[0078] In another embodiment, a method of safety of a building structure includes ensuring that a prescribed pressure of an emergency support system (e.g., the air distribution system 150, 250, 350 of **Figures 1-3**) maintains within a threshold range of the prescribed pressure by including a valve of the emergency support system to prevent leakage of breathable air from the emergency support system 150, safeguarding a filling process of a breathable air apparatus by enclosing the breathable air apparatus in a secure chamber (e.g., the holders 612 of **Figure 6A**) of a fill site (e.g., the fill site 102 of **Figures 1-3**) of the emergency support system of the building

structure to provide a safe placement to supply the breathable air to the breathable air apparatus, and providing a spare storage of breathable air through an air storage tank of an air storage sub-system to store the breathable air that is replenishable with a source of compressed air.

[0079] In yet another embodiment, a building structure (e.g., a horizontal building structure such as a shopping mall, a vertical building structure such as a high rise building, a mid rise building, and/or a low rise building, a mine, a subway, and/or a tunnel, etc.) includes a first set of walls extending vertically and horizontally enclosing an area of land such that the area of land is in an internal region of the building structure, a second set of walls that divide the internal region of the building structure in any of a horizontal and vertical direction into rooms displaced any of horizontally and vertically from one another, a supply unit (e.g., the supply unit 100 of **Figures 1-3**) adjacent to a particular wall of the first set of walls to facilitate delivery of breathable air from a source of compressed air to an emergency support system (e.g., the air distribution system 150, 250, 350 of **Figures 1-3**) of the building structure, a fill station (e.g., the fill station 102A of **Figure 6A**) of the internal region of the building structure to provide the breathable air to a breathable air apparatus at multiple locations of the building structure, a secure chamber (e.g., the holders 612 of **Figure 6A**) of the fill station 102A as a safety shield that confine a possible rupture of an over-pressurized breathable air apparatus within the secure chamber 612, a distribution structure (e.g., the distribution structure 104 of **Figures 1-3**) that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure, and an air storage sub-system (e.g., the air storage sub-system 950 of **Figure 10**) to provide an additional supply of air to the building structure in addition to the source of compressed air.

[0080] In a further embodiment, a safety system of a tunnel structure includes a supply unit (e.g., the supply unit 100 of **Figures 1-3**) of a tunnel structure to facilitate delivery of breathable air from a source of compressed air to an air distribution system (e.g., the air distribution system 150, 250, 350 of **Figures 1-3**) of the tunnel structure, a valve (e.g., the check valve of a series of valves 408 of **Figure 4**) to prevent leakage of the breathable air from the air distribution system 150 potentially leading to loss of system pressure, a fill site (e.g., the fill site 102 of **Figure 1**) interior to the tunnel

structure to provide the breathable air to a breathable air apparatus at multiple locations of the tunnel structure, and a distribution structure (e.g., the distribution structure 104 of **Figures 1-3**) that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the tunnel structure.

[0081] In yet a further embodiment, a safety system of a building structure includes a supply unit (e.g., the supply unit 100 of **Figures 1-3**) of a building structure to facilitate delivery of breathable air from a source of compressed air to an air distribution system (e.g., the air distribution system 150, 250, 350 of **Figures 1-3**) of the building structure, a valve (e.g., the valve of a series of valves 408 of **Figure 4**) to prevent leakage of the breathable air from the air distribution system 150 potentially leading to loss of a system pressure, a fill station (e.g., the fill station 102A of **Figure 6A**) interior to the building structure to provide the breathable air to a breathable air apparatus at multiple locations of the building structure, a secure chamber (e.g., the holders 612 of **Figure 6A**) of the fill station 102A as a safety shield that confines a possible rupture of an over-pressurized breathable air apparatus within the secure chamber 612, and a distribution structure (e.g., the distribution structure 104 of **Figures 1-3**) that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure.

[0082] In a next embodiment, a method of safety of a building structure includes ensuring that a prescribed pressure of an emergency support system (e.g., the air distribution system 150, 250, 350 of **Figures 1-3**) maintains within a threshold range of the prescribed pressure by including a valve of the emergency support system to prevent leakage of breathable air from the emergency support system (e.g., the air distribution system 150, 250, 350 of **Figures 1-3**), safeguarding a filling process of a breathable air apparatus by enclosing the breathable air apparatus in a secure chamber (e.g., the holders 612 of **Figure 6A**) of a fill site (e.g., the fill site 102 of **Figures 1-3**) of the emergency support system 150 of the building structure to provide a safe placement to supply the breathable air to the breathable air apparatus, and maintaining the prescribed pressure of the emergency support system 150 such that a system pressure is compatible with the breathable air apparatus through a distribution structure that is rated for use with compressed air that couples the supply unit and the

fill site 102 to transfer breathable air of the source of compressed air to the fill site 102.

[0083] In another embodiment, a building structure (e.g., a horizontal building structure such as a shopping mall, a vertical building structure such as a high rise building, a mid rise building, and/or a low rise building, a mine, a subway, and/or a tunnel, etc.) includes a first set of walls extending vertically and horizontally enclosing an area of land such that the area of land is in the internal region of the building structure, a second set of walls that divide the internal region of the building structure in any of a horizontal and vertical direction into rooms displaced any of a horizontally and vertically from one another, a supply unit (e.g., the supply unit 100 of **Figures 1-3**) adjacent to a particular wall of the first set of walls to facilitate delivery of breathable air from a source of compressed air to an emergency support system (e.g., the air distribution system 150, 250, 350 of **Figures 1-3**) of the building structure, a fill station (e.g., the fill station 102A of **Figure 6A**) of the internal region of the building structure to provide the breathable air to a breathable air apparatus at multiple locations of the building structure, a secure chamber (e.g., the holders 612 of **Figure 6A**) of the fill station 102A as a safety shield that confines a possible rupture of an over-pressurized breathable air apparatus within the secure chamber 612, and a distribution structure (e.g., the distribution structure 104 of **Figures 1-3**) that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure.

[0084] In yet another embodiment, a safety system of a building structure includes a supply unit (e.g., the supply unit 100 of **Figures 1-3**) of a building structure to facilitate delivery of breathable air from a source of compressed air to an air distribution system (e.g., the air distribution system 150, 250, 350 of **Figures 1-3**) of the building structure, a valve to prevent leakage of the breathable air from the air distribution system potentially leading to loss of system pressure, a fill panel (e.g., the fill panel 102B of **Figure 6**) interior to the building structure having a RIC/UAC fitting pressure rated for a fill outlet of the fill panel to fill a breathable air apparatus to expedite a breathable air extraction process from the air distribution system and to provide the breathable air to the breathable air apparatus at multiple locations of the building structure, and a distribution structure (e.g., the distribution structure 104 of

Figures 1-3) that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure.

[0085] In a further embodiment, a method of safety of a structure includes ensuring that a prescribed pressure of the emergency support system 150 maintains within a threshold range of the prescribed pressure by including a valve of the emergency support system to prevent leakage of breathable air from the emergency support system, and expediting an air extraction process from the emergency support system by including a RIC/UAC fitting to a fill panel to fill a breathable air apparatus.

[0086] In yet a further embodiment, a building structure includes a first set of walls extending vertically and horizontally enclosing an area of land such that the area of land is in the internal region of the building structure, a second set of walls that divide the internal region of the building structure in any of a horizontal and vertical direction into areas displaced any of a horizontally and vertically from one another, a supply unit (e.g., the supply unit 100 of **Figures 1-3)** adjacent to a particular wall of the first set of walls to facilitate delivery of breathable air from a source of compressed air to an emergency support system (e.g., the air distribution system 150, 250, 350 of **Figures 1-3)** of the building structure, a fill panel of the internal region of the building structure having a RIC/UAC fitting to expedite a breathable air extraction process from the emergency support system and to provide the breathable air to the breathable air apparatus at multiple locations of the building structure, and a distribution structure (e.g., the distribution structure 104 of **Figures 1-3)** that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure.

[0087] In a subsequent embodiment, a safety system of a mine structure includes a supply unit (e.g., the supply unit 100 of **Figures 1-3)** of a mine structure to facilitate delivery of breathable air from a source of compressed air to an air distribution structure (e.g., the distribution structure 104 of **Figures 1-3)** of the mine structure, a valve (e.g., the check valve of a series of valves 408 of **Figure 4)** to prevent a leakage of the breathable air from the air distribution structure 150 potentially leading to loss of a system pressure, a fill site (e.g., the fill site 102 of **Figures 1-3)** interior to the mine structure to provide the breathable air to a breathable air apparatus at multiple

locations of the mine structure, and a distribution structure (e.g., the distribution structure 104 of **Figures 1-3**) that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the mine structure.

[0088] In yet another embodiment, a method of safety of a mine structure includes ensuring that a prescribed pressure of the emergency support system 150 maintains within a threshold range of the prescribed pressure by including a valve of the emergency support system to prevent leakage of breathable air from the emergency support system 150, safeguarding a filling process of a breathable air apparatus by enclosing the breathable air apparatus in a secure chamber (e.g., the holders 612 of **Figure 6A**) of a fill site (e.g., the fill site 102 of **Figures 1-3**) of the emergency support system 150 of the mine structure to provide a safe placement to supply the breathable air to the breathable air apparatus, and providing a spare storage of breathable air through an air storage tank (e.g., the air storage tanks 1008 of **Figure 10**) of a storage sub-system (e.g., the air storage sub-system 950 of **Figure 10**) to store breathable air that is replenishable with a source of compressed air.

[0089] **Figure 1** is a block diagram of an air distribution system 150 in a structure, according to one embodiment. The air distribution system 150 may include any number of supply units 100, any number of fill sites 102 that are coupled to the rest of the air distribution system 150 through a distribution structure 104. The air distribution system 150 may also include an air monitoring system 110 having a CO/Moisture sensor 106 and a low pressure sensor 108.

[0090] The supply unit 100 may be placed at a number of locations exterior to the structure (e.g., a horizontal building structure such as a shopping mall, a vertical building structure such as a high rise building, a mid rise building, and/or a low rise building, a mine, a subway, and/or a tunnel structure, etc.) to allow ease of access by a source of compressed air and/or to expedite supplying the air distribution system 150 with breathable air. The supply units 100 may also be placed at locations that are substantially free of traffic to decrease potential obstruction present in an emergency situation (e.g., a building fire, a chemical attack, terror attack, subway accident, mine collapse, and/or a biological agent attack, etc.).

[0091] The fill sites 102 may also be placed at a number of locations of the structure (e.g., a horizontal building structure such as a shopping mall, a vertical building

structure such as a high rise building, a mid rise building, and/or a low rise building, a mine, a subway, and/or a tunnel, etc.) to provide the breathable air to a breathable air apparatus at multiple locations (e.g., at multiple access points) of the structure. In one embodiment, the fill sites 102 may include wireless capabilities (e.g., a wireless module 114) for communication with remote entities (e.g., the supply unit 100, building administration, and/or an authority agency, etc.).

[0092] The distribution structure 104 may have any number of fill sites 102 (e.g., the fill panel 102B and/or the fill station 102A) on each floor and/or different floors.

Each fill site 102 may be sequentially coupled to one another and to the supply units 100 through the distribution structure 104. The distribution structure 104 may include any number of pipes to expand an air carrying capacity of the air distribution system 150 such that breathable air is replenished with a source of compressed air at a higher rate..

[0093] The air monitoring system 110 may contain multiple sensors such as the CO/Moisture sensor 106 and the pressure sensor 108 to track and record quality of the breathable air (e.g., like impurity levels and contaminants concentration, etc.) in the air distribution system 150. Since emergency personnel (e.g., a fire fighter, a SWAT team, a law enforcer, and/or a medical worker, etc.) depend on the breathable air distributed via the air distribution system 150, it is essential that quality of the breathable air be constantly maintained. The air monitoring system 110 may also include other sensors that detect other hazardous substances (e.g., benzene, acetamide, acrylic acid, asbestos, mercury, phosphorous, propylene oxide, etc.) that contaminates the breathable air.

[0094] In one embodiment, the distribution structure 104 that is compatible to use with compressed air may facilitate dissemination of the breathable air of the source of compressed air to multiple locations of the structure. A fire rated material (e.g., the fire rated material 702 of **Figure 7A**) may encase the distribution structure 104 such that the distribution structure 104 has the ability to withstand elevated temperatures for a prescribed period of time. The pipes of the distribution structure 104 may include a sleeve exterior to the fire rated material 702 to protect the fire rated material 702 from damage. Both ends of the sleeve may be fitted with a fire rated material 702 approved by an authority agency (e.g., certified according to the approved standards). In addition, the distribution structure 104 may include a robust solid casing to prevent

physical damage to the distribution structure 104 potentially compromising safety and reliability of the air distribution system 150.

[0095] The distribution structure 104 may include support structures at specific intervals (e.g., less than five feet) to provide adequate structural support for each pipe of the distribution structure 104. The pipes and the fittings of the distribution structure 104 may be of stainless steel, and thermoplastic material, etc. compatible to use with compressed air.

[0096] In another embodiment, the air distribution system 150 may include an air monitoring system 110 to automatically track and record impurity levels and/or contaminant concentration in the breathable air of the air distribution system 150. The air monitoring system 110 may have an automatic shut down feature to discontinue air distribution to the fill sites 102 in a case that any of an impurity level and contaminant concentration exceeds a safety threshold. For example, a pressure monitoring system (e.g., the pressure sensor 108 of **Figure 1**) may automatically track and record the system pressure of the air distribution system 150. Further, a pressure switch may be electrically coupled to an alarm system (e.g., the fire alarm system) such that the alarm system is set off when the system pressure of the air distribution system 150 exceeds the safety threshold.

[0097] **Figure 2** is block diagram of an air distribution system in a structure having fill sites located vertically from one another, according to one embodiment. In the air distribution system 250, the distribution structure 104 may individually couple each fill site 102 (e.g., the fill panel 102B and/or the fill station 102A) to the supply unit 100. Individual coupling may be advantageous in case one pipe of the distribution structure 104 becomes inoperable and/or unserviceable, the other pipes can still deliver air to the fill sites 102 (e.g., the fill panel 102B and/or the fill station 102A).

[0098] In the air distribution system 250, the distribution structure 104 may sequentially couple each fill site 102 (e.g., the fill panel 102B and/or the fill station 102A) displaced predominantly vertically from the supply unit 100. Each air distribution system 250 may be used in conjunction with one another depending on a particular architectural style of the structure in a manner that provides efficient access to the breathable air of the air distribution system 250 reliably.

[0099] **Figure 3** is a block diagram of an air distribution system 350 in a structure (e.g., mines, building, tunnel, etc.) having fill sites (e.g., the fill panel and/or fill

stations, etc.) located horizontally from one another, according to one embodiment. The air distribution system 350 may include any number of supply units 100, any number of fill sites 102 (e.g., a fill panel and/or a fill station, etc.) that are coupled to the rest of the air distribution system 150 through a distribution structure 104. The air distribution system 150 may also include an air monitoring system 110 having a CO/Moisture sensor 106 and a pressure sensor 108. In the air distribution system 350, the distribution structure 104 may sequentially couple each fill site 102 (e.g., a fill panel and/or a fill station, etc.) displaced predominantly horizontally from the supply unit 100. Each air distribution system 350 may be used in conjunction with one another depending on the particular architectural style of the structure in a manner that provides efficient access to the breathable air of the air distribution system 350 reliably.

[00100] Figure 4A is a front view of the supply unit 100 of the air distribution system 150, according to one embodiment. The supply unit 100 may provide accessibility of a source of compressed air to supply breathable air to the air distribution system (e.g., the air distribution system 150, 250, and/or 350 of Figures 1-3). The supply unit 100 may include a fill pressure indicator 400, a fill control knob 402, a system pressure indicator 404, and a connector 406.

[00101] The supply unit 100 may include an adjustable pressure regulator of the supply unit 100 that is used to adjust a fill pressure of the source of compressed air to ensure that the fill pressure does not exceed the safety threshold of the design pressure of the air distribution system 150. Further, the supply unit 100 may also include a pressure gauge (e.g., the fill pressure indicator 400, the system pressure indicator 404, etc.) of the supply unit enclosure 500 to indicate any of the system pressure (e.g., through the system pressure indicator 404 of Figure 4) of the air distribution system 150 and the fill pressure (e.g., through the fill pressure indicator 400 of Figure 4) of the source of compressed air.

[00102] The fill pressure indicator 400 may indicate pressure level at which breathable air is being delivered by the source of compressed air to the air distribution system 150. The fill control knob 402 may be used to control the fill pressure such that the fill pressure does not exceed a safety threshold of a design pressure of the air distribution system 150. The system pressure indicator 404 may indicate current pressure level of the breathable air in the air distribution system 150.

[00103] The connector 406 may be a CGA connector, a RIC/UAC connector (e.g., the RIC/UAC connector 620 of **Figure 6B**) etc. which is compatible with an air outlet of the source of compressed air of various emergency agencies (e.g., fire station, law enforcement agency, medical provider, and/or SWAT team, etc.). The connector 406 (e.g., CGA connector, RIC/UAC connector 620, etc.) of the supply unit 100 may facilitate a connection with the source of compressed air through ensuring compatibility of the supply unit 100 with the source of compressed air. In one embodiment, the supply unit 100 of a building structure may facilitate delivery of breathable air from a source of compressed air to the air distribution system 150 of the building structure.

[00104] **Figure 4B** is a rear view of the supply unit 100 of the air distribution system 150, according to one embodiment. The supply unit 100 also may include a series of valves 408 (e.g., a valve, an isolation valve, and/or a safety relief valve, etc.) to ensure that system pressure is maintained within a safety threshold of the design pressure of the air distribution system 150.

[00105] The supply unit 100 of a structure (e.g., building structure, tunnel structure, mine structure, etc.) may facilitate delivery of breathable air from a source of compressed air to the air distribution system 150 of the structure. The supply unit 100 may include the series of valves 408 (e.g., the valve, and/or the safety relief valve, etc.) to prevent a leakage of the breathable air from the air distribution system 150 potentially leading to loss of system pressure. For example, the supply unit 100 may include a valve of the series of valves 408 to automatically discontinue transfer of breathable air from the source of compressed air to the air distribution system 150. The safety relief valve of the supply unit 100 and/or the fill site 102 may release breathable air when a system pressure of the air distribution system 150 exceeds a threshold value of the design pressure to ensure reliability of the air distribution system 150 through maintaining the system pressure such that the system pressure is within a pressure rating of each component of the air distribution system 150.

[00106] **Figure 5** is an illustration of a supply unit enclosure 500 encompassing the supply unit 100, according to one embodiment. The supply unit enclosure 500 may include a locking mechanism 502 to secure the supply unit 100 from unauthorized access. Further, the supply unit enclosure 500 may also contain a fire rated material

702 such that the supply unit 100 withstands elevated temperatures for a prescribed period of time.

[00107] The supply unit enclosure 500 encompassing the supply unit 100 may have any of a weather resistant feature, ultraviolet and/or infrared solar radiation resistant feature to prevent corrosion and/or physical damage. The locking mechanism 502 may secure the supply unit 100 from intrusions that potentially compromise safety and reliability of the air distribution system 150.

[00108] In addition, the supply unit enclosure 500 may include a robust metallic material to protect the supply unit 100 from any of an intrusion and damage due to various hazards. For example, the robust metallic material may be substantially 18 gauge carbon steel. The supply unit enclosure 500 may be provided with a visible marking to provide luminescence in a reduced light environment. The locking mechanism 502 may also include a tamper switch which automatically triggers an alarm and electrically communicates a signal to any of administrative personnel of the structure and an emergency supervising station when an intrusion of any of the supply unit 100 and the secure chamber 612 occurs.

[00109] **Figure 6A** is an illustration of the fill station 102A interior to the structure, according to one embodiment. The fill station 102A may be a type of the fill site 102 of **Figure 1**. The fill station 102A may include a system pressure indicator 600, a fill pressure regulator 602, a fill pressure indicator 604, another fill pressure indicator 606, and fill control knob 608. The fill station 102A may also include a RIC/UAC connector 610 and multiple breathable air apparatus holders 612 used to supply air from the air distribution system 150. The fill station 102A may be a rupture containment chamber such that over-pressurized compressed air cylinders are shielded and contained to prevent injuries.

[00110] The system pressure indicator 600 may indicate current pressure level of breathable air in the air distribution system 150. The fill pressure regulator 602 may enable adjusting of a fill pressure of a source of compressed air to ensure that the fill pressure does not exceed design pressure of the air distribution system 150. The fill pressure indicator 604 and another fill pressure indicator 606 may indicate pressure level at which breathable air is being delivered by the source of compressed air to the air distribution system 150. The fill control knob 608 may be used to control the fill

pressure such that the fill pressure does not exceed a safety threshold for which the air distribution system 150 is designed for.

[00111] The RIC/UAC connector 610 may facilitate direct coupling to an emergency equipment to supply breathable air through a hose (e.g., connecting the RIC/UAC connector 610 and the emergency equipment). In essence, precious time may be saved because emergency personnel may not need to spend time to remove the emergency equipment from their rescue attire before they can be supplied with breathable air. Further, the RIC/UAC connector 610 may also directly couple to a face-piece of a respirator to supply breathable air.

[00112] The multiple-breathable air apparatus holders 612 can hold multiple compressed air cylinders to be filled simultaneously. In addition, the multiple breathable air apparatus holders 612 can be rotated in order that additional compressed air cylinders may be loaded while the multiple compressed air cylinders are filled inside the fill station 102A.

[00113] In one embodiment, the fill station 102A interior to a structure (e.g., building structure, tunnel structure, mine structure, etc.) may provide breathable air to a breathable air apparatus at multiple locations of the structure. A secure chamber (e.g., the holders 612 of **Figure 6A**) of the fill station 102A may be a safety shield that confines a possible rupture of an over-pressurized breathable air apparatus within the secure chamber 612. The fill station 102A may include a valve to prevent leakage of air (e.g., potentially leading to pressure loss of the air distribution system) from the air distribution system 150 through ensuring that the system pressure is maintained within a threshold range of design pressure to reliably fill the breathable air apparatus. An isolation valve may be included to isolate a breathable fill station from a remaining portion of the air distribution system 150.

[00114] The isolation valve may be automatically actuated through an air pressure sensor (e.g., the low pressure sensor 108 of **Figure 1**) of the air distribution system 150. The fill station 102A may include a pressure regulator to adjust a fill pressure to fill the breathable air apparatus and/or to ensure that the fill pressure does not exceed the pressure rating of the breathable air apparatus potentially resulting in a rupture of the breathable air apparatus. The fill station 102A may include a pressure gauge (e.g., the system pressure indicator 600, the fill pressure indicator 604, and another fill pressure indicator 606) to indicate any of a fill pressure (e.g., the fill pressure

indicator 604, 606) of the fill station 102A and a system pressure (e.g., the system pressure indicator 600) of the air distribution system 150.

[00115] In one embodiment, the air fill station 102A may have a physical capacity to enclose the breathable air apparatus and include the RIC/UAC connector 610 to facilitate a filling of the breathable air apparatus. The fill station 102A may also include a securing mechanism of the secure chamber 612 having a locking function which is automatically actuated through a coupling mechanism (e.g., with a flow switch) that indicates a status of air flow to the breathable air apparatus fillable in the fill station 102A.

[00116] **Figure 6B** is an illustration of a fill panel 102B interior to the structure, according to one embodiment. The fill panel 102B may include a fill pressure indicator 614 (e.g., pressure gauge), a fill control knob 616 (e.g., pressure regulator), a system pressure indicator 618, a number of RIC/UAC connectors 620 and fill hoses 622. The fill panel 102B may also include a fill panel enclosure 624 with a locking mechanism to secure the fill panel 102B from intrusions that potentially compromise safety and reliability of the air distribution system 150. The system pressure indicator 618 may indicate current pressure level of breathable air in the air distribution system 150. The fill control knob 616 may be used to adjust fill pressure such that the fill pressure does not exceed a safety threshold for which the air distribution system 150 is designed for.

[00117] The RIC/UAC fitting 620 may facilitate direct coupling to emergency equipment to supply breathable air through a hose (e.g., connecting the RIC/UAC fitting 620 and the emergency equipment). Further, the RIC/UAC fitting 620 connected with the fill hoses 622 may also directly couple to a face-piece of a respirator to supply breathable air to emergency personnel (e.g., a fire fighter, a SWAT team, a law enforcer, and/or a medical worker, etc.) and/or stranded survivors in need of breathing assistance. Each fill hose 622 may be designed for different pressure rating and may be couple-able to any of a self-contained breathable air apparatus and respiratory mask through the compatible RIC/UAC connector 620. The fill panel enclosure 624 may be provided with a visible marking to provide luminescence in a reduced light environment.

[00118] In one embodiment, the fill panel 102B interior to a structure (e.g., tunnel structure, mine structure, building structure, etc.) may have a RIC/UAC fitting 620 to

fill a breathable air apparatus to expedite a breathable air extraction process from the air distribution system 150 and/or to provide the breathable air to the breathable air apparatus at multiple locations of the structure. The fill panel 102B may include a safety relief valve set to have an open pressure (e.g., of at most approximately 10% more than a design pressure) of the air distribution system 150 to ensure reliability of the air distribution system 150 through maintaining the system pressure such that the system pressure is within a threshold range of a pressure rating of each component of the air distribution system 150. For example, the fill panel enclosure 624 may be made from 18 gauge carbon steel to minimize physical damage due to various naturally occurring and man-imposed hazards through protecting the fill panel from any of an intrusion and damage. The fill panel 102B may include an isolation valve to isolate a damaged fill panel 102B from a remaining operable portion of the air distribution system 150.

[00119] Figure 7A is a diagrammatic view of a pipe of the distribution structure 104 in a fire rated material 702, according to one embodiment. The distribution structure 104 having pipes may be enclosed in the fire rated material 702. The fire rated material 702 may prevent the distribution structure 104 from damage (e.g., due to fire) such that the air distribution system 150 may be operational for a longer time period in an emergency situation (e.g., building fire, chemical attack, terror attack, subway accident, mine collapse, and/or a biological agent attack, etc.).

[00120] Figure 7B is a cross sectional view 700 of the distribution structure 104 embedded in a fire rated material 702, according to one embodiment. Section 700 is a cross section of the distribution structure 104 embedded in the fire rated material 702.

[00121] Figure 8 is a network view of an air monitoring system 806 with a wireless module 808 communicating with a building administration 802 and an authority agency 804 through a network 810, according to one embodiment. The air monitoring system 806 may include various sensors (e.g., the CO/Moisture sensor 106 of Figure 1, the pressure sensor 108 of Figure 1, and/or hazardous substance sensor, etc.) and/or status indicators regarding system readiness information (e.g., system pressure, in use, not in use, operational status, fill site usage status, fill site operational status, etc.).

[00122] The air monitoring system 806 may communicate sensor readings to a building administration 802 (e.g., building management, security, and/or custodial

services, etc.) such that proper maintenance measures may be taken. The air monitoring system 806 may also send alert signals (e.g., as a reminder) for regular system inspection and maintenance to the building administration 802 through the network 810. The air monitoring system 806 may also communicate sensor readings to an authority agency 804 (e.g., a police station, a fire station, and/or a hospital, etc.). The wireless module 808 may be a device which communicates with other devices to enable the air monitoring system 806 monitor the air distribution system 150.

[00123] **Figure 9** is a front view of a control panel 900 of an air storage sub-system 950, according to one embodiment. The control panel 900 includes a fill pressure gauge 902, a storage pressure gauge 904, a booster pressure gauge 906, a system pressure gauge 908 and a storage bypass knob 910. The fill pressure gauge 902 may indicate pressure level at which breathable air is being delivered by the source of compressed air to the air distribution system (e.g., an air distribution system 150, 250, and/or 350 of **Figures 1-3**). The storage pressure gauge 904 may display pressure level of air storage tanks in the air storage sub-system 950.

[00124] The booster pressure gauge may display pressure level of a booster tank (e.g., the booster tank 1006 of **Figure 10**). The system pressure gauge 908 may indicate current pressure level of the breathable air in the air distribution system 150 recorded by the pressure monitoring system. Air stored in the air storage sub-system 950 may be directly supplied to the air distribution system 150 through utilizing the storage bypass knob 910.

[00125] **Figure 10** is an illustration of the air storage sub-system 950, according to one embodiment. Particularly, **Figure 10** illustrates the control panel 900, tubes 1000, a driver air source 1002, a pressure booster 1004, a booster tank 1006, and air storage tanks 1008, according to one embodiment. The control panel 900 may provide status information associated with storage pressure, booster pressure, pressure of the compressed air source, and the system pressure of the air storage sub-system 950. The tubes 1000 having a looped configuration may couple each air storage tank 1008 to one another. The looped configuration of the tubes 1000 may increase in robustness of the tubes 1000 and thus may prevent damage of the tubes 1000 due to stress. In one example embodiment, the control panel 900 is mounted on the tubes 1000 coupled to the air storage tank 1008 and the booster tank 1006.

[00126] The driving air source 1002 may be used to pneumatically drive the pressure booster 1004 to maintain a higher pressure in the air distribution system 150 such that a breathable air apparatus is reliably filled. For example, a supply of breathable air in the air storage tanks 1008 may be conserved through utilizing a driving air source 1002 to drive the pressure booster 1004.

[00127] In addition, the driving air source 1002 may enable the breathable air to be optimally supplied to the structure (e.g., mine, tunnel, building, etc.) through allowing the breathable air to be isolated from driving the pressure booster 1004. The booster tank 1006 may store air at a higher pressure than the air stored in the air storage tanks 1008 to ensure that the air distribution system is constantly supplied with breathable air sufficiently pressurized to fill a breathable air apparatus.

[00128] In one embodiment, the air storage sub-system 950 may include air storage tanks 1008 to provide storage of air that is dispersible to multiple locations of the structure (e.g., building structure, tunnel structure, mine structure, etc.). The air storage tanks 1008 of the air storage sub-system 950 may be coupled to each other through tubes 1000 (e.g., having a looped configuration) to increase robustness of the tubes 1000 to prevent breakage due to stress. In addition, a booster tank 1006 of the air storage sub-system 950 may be coupled to the air storage tanks 1008 to store compressed air of a higher pressure than the compressed air that is stored in the air storage tank 1008. A driving air source 1002 of the air storage sub-system 950 may be coupled to the pressure booster 1004 to pneumatically drive a piston of the pressure booster 1004 to maintain a higher pressure of the air distribution system 150 such that a breathable air apparatus is reliably filled.

[00129] Further, the driving air source 1002 may enable the breathable air to be optimally supplied to the structure (e.g., through allowing the breathable air to be isolated from driving the pressure booster 1004). The air storage sub-system 950 may also include an air monitoring system (e.g., that includes the CO/Moisture sensor 106 of **Figures 1-3**) to automatically track and record any of impurities levels and contaminants concentration in the breathable air of the air distribution system 150. The air monitoring system 110 may include an automatic shut down feature to discontinue air dissemination to the fill station 102A when any of impurity level and contaminant concentration exceeds a safety threshold. The air storage sub-system 950 may also include a pressure monitoring system (e.g., a pressure sensor 108 of **Figure**

1) to continuously track and record the system pressure of the air distribution system 150.

[00130] A pressure switch may be electrically coupled to an alarm system such that the alarm system is set off when the system pressure of the air distribution system 150 exceeds a safety threshold. The pressure switch may electrically transmit a warning signal to an emergency supervising station when the system pressure of the air distribution system 150 is below the prescribed level.

[00131] The air storage sub-system 950 may include an indicator unit to provide status information of the air distribution system 150 associated with storage pressure, booster pressure, pressure of the compressed air source, and/or the system pressure, etc. Further, the air storage sub-system 950 may also include a selector valve accessible by an emergency personnel to isolate the source of compressed air from the air storage sub-system 950 such that the breathable air of the source of compressed air is directly deliverable to the fill site 102 through the distribution structure 104. The air storage sub-system 950 may be housed in a fire rated enclosure that is certified to be rupture containable to withstand elevated temperatures for a prescribed period of time. In some embodiment, the air storage sub-system 950 may provide an additional supply of air to the building structure in addition to the source of compressed air.

[00132] Figure 11 is a block diagram of the air distribution system 150 having the air storage sub-system 950, according to one embodiment. The air distribution system 150 may include a number of supply units 100, a number of fill sites 102 that are coupled to the rest of the air distribution system 150 through a distribution structure 104, according to one embodiment. The air distribution system 150 may also include an air monitoring system 110 having a CO/Moisture sensor 106 and a pressure sensor 108, and the air storage sub-system 950. Air storage tanks 1008 and/or a booster tank 1006 of the air storage subsystem 950 of Figure 10 may be supplied with breathable air through a source of compressed air that is coupled to the air distribution system 150 through the supply unit 100 and supplied independently of the supply unit 100. The air storage sub-system 950 may provide a spare source of breathable air to the air distribution system 150 in addition to an external source of compressed air.

[00133] In one embodiment, the distribution structure 104 that is compatible with use with compressed air may facilitate dissemination of the breathable air of the source of compressed air to multiple locations of the building structure.

[00134] **Figure 12** is a process flow of a safety of a building structure having an air storage sub-system (e.g., the air storage sub-system 950 of **Figure 10**), according to one embodiment. In operation 1202, it may be ensured that a prescribed pressure of an emergency support system (e.g., the air distribution system 150, 250, 350 of **Figures 1-3**) maintains within a threshold range of the prescribed pressure by including a valve (e.g., the valve of a series of valves 408 of **Figure 4B**) of the emergency support system 150 to prevent leakage of breathable air from the emergency support system 150. In operation 1204, a filling process of a breathable air apparatus may be safeguarded by enclosing the breathable air apparatus in a secure chamber (e.g., the holders 612 of **Figure 6A**) of a fill site (e.g., the fill site 102 of **Figures 1-3**) of the emergency support system 150 of the building structure to provide a safe placement to supply the breathable air to the breathable air apparatus.

[00135] In operation 1206, a spare storage of breathable air may be provided through an air storage tank (e.g., the air storage tanks 1008 of **Figure 10**) of a storage sub-system (e.g., the air storage sub-system 950 of **Figure 10**) to store the breathable air that is replenishable with a source of compressed air. In operation 1208, corrosion and/or physical damage due to weather may be prevented by incorporating a supply unit enclosure (e.g., the supply unit enclosure 500 of **Figure 5**) that is weather resistant. In operation 1210, intrusion of the supply unit (e.g., a supply unit 100 of **Figures 1-3**) potentially compromising the safety and reliability of the breathing emergency support system 150 may be prevented by incorporating a locking mechanism (e.g., the locking mechanism 502 of **Figure 5**) of the supply unit enclosure 500.

[00136] In operation 1212, physical damage of various external hazards may be minimized to protect the supply unit 100 and the fill site 102 from any of an intrusion and damage through utilizing a robust metallic material to the supply unit enclosure 500. In operation 1214, leakage of air from the emergency support system 150 leading to a potential pressure loss of the emergency support system 150 may be prevented through utilizing a valve 408 of any of the supply unit 100 and the fill site 102.

[00137] **Figure 13** is a process flow that describes further the operations of **Figure 12**, according to one embodiment. In operation 1302, transfer of breathable air from the source of compressed air to the emergency support system 150 may be

discontinued through utilizing a valve 408 of the emergency support system 150. In operation 1304, breathable air from the emergency support system 150 may be released automatically when the system pressure of the emergency support system 150 exceeds the prescribed pressure through triggering a safety relief valve 408 of any of the supply unit 100 and the fill site 102.

[00138] In operation 1306, compatibility of the emergency support system 150 and the source of compressed air of an authority agency may be ensured through any of a CGA connector (e.g., the connector 406 of **Figure 4A**) and a RIC/UAC connector (e.g., the RIC/UAC connector 610 and 620 of **Figures 6A and 6B**) of the supply unit 100. In operation 1308, a fill pressure may be adjusted to ensure that the fill pressure of the source of compressed air does not exceed the prescribed pressure of the emergency support system 150 through a pressure regulator of the supply unit 100.

[00139] In operation 1310, the system pressure of the emergency support system 150 and/or the fill pressure of the source of compressed air may be monitored through the pressure gauge of the supply unit enclosure 500. In operation 1312, accessibility of the supply unit enclosure 500 through providing luminescence in reduced light environments may be improved by incorporating a visible marking. In operation 1314, a fill site 102 may be isolated from a remaining portion of the emergency support system 150 using an isolation valve of the fill site 102 such that the remaining portion of the emergency support system 150 is utilizable in an emergency situation.

[00140] **Figure 14** is a process flow that describes further the operations of **Figure 13**, according to one embodiment. In operation 1402, the isolation valve (e.g., a valve of a series of valves 408 of **Figure 4**) may be automatically actuated based on an air pressure sensor of the emergency support system 150. In operation 1404, a fill pressure of the fill site 102 may be adjusted to ensure that the fill pressure does not exceed the pressure rating of the breathable air apparatus through a pressure regulator of the fill site 102.

[00141] In operation 1406, the fill pressure of the fill site 102 and/or the system pressure of the emergency support system 150 may be monitored by incorporating a pressure gauge to the fill site 102. In operation 1408, the distribution structure 104 may be enabled to withstand elevated temperatures for a period of time using a fire rated material (e.g., the fire rated material 702 of **Figure 7A**) to encase the distribution structure 104.

[00142] In operation 1410, the fire rated material 702 may be prevented from damage by incorporating a sleeve at least three times an outer diameter of each pipe of the distribution structure 104 exterior to the fire rated material 702. In operation 1412, physical damage to the distribution structure 104 potentially compromising the safety and integrity of the emergency support system 150 may be prevented by utilizing a robust solid casing of the distribution structure 104. In operation 1414, the robust solid casing may be protected from any damage using another sleeve at least three times an outer diameter of a pipe of the distribution structure 104 exterior to the robust solid casing.

[00143] **Figure 15** is a process flow that describes further the operations of **Figure 14**, according to one embodiment. In operation 1502, impurities and/or contaminants in the breathable air of the breathing emergency support system 150 may be automatically tracked and recorded through an air monitoring system 110. In operation 1504, air dissemination to the fill sites 102 may be suspended automatically in a case that an impurity level and/or contaminant concentration exceeds a safety threshold. In operation 1506, the system pressure of the emergency support system 150 may be tracked and recorded through a pressure monitoring system.

[00144] In operation 1508, the pressure monitoring system and the fire alarm system of the building structure may be electrically coupled such that the fire alarm system is automatically triggered through a pressure switch when the system pressure of the emergency support system 150 is outside a safety range. In operation 1510, a warning signal may be electrically transmitted to an emergency supervising station through the pressure switch when the system pressure of the emergency support system 150 is below the prescribed level.

[00145] In operation 1512, an alarm may be automatically triggered and a signal may be coupled electrically to any of relevant administrative personnel of the building structure and the emergency supervising station when an intrusion of the supply unit 100 occurs through a tamper switch of the locking mechanism 502 of the supply unit enclosure 500. In operation 1514, pressure of the breathable air stored in the air tank may be increased through a pressure booster (e.g., the pressure booster 1004 of **Figure 10**) to increase a pressure of the breathable air compared to the pressure of the breathable air in air storage tanks (e.g., the air storage tanks 1008 of **Figure 10**) to

ensure that the emergency support system 150 constantly has a supply of breathable air that has enough pressure to fill the breathable air apparatus.

[00146] **Figure 16** is a process flow that describes further the operations of **Figure 15**, according to one embodiment. In operation 1602, a supply of breathable air in the air storage tank 1008 may be conserved through utilizing a driving air source (e.g., the driving air source 1002 of **Figure 10**) to drive the pressure booster 1004.

[00147] **Figure 17** is a process flow of a safety of a building structure having a fill station (e.g., the fill station 102A of **Figure 6A**), according to one embodiment. In operation 1702, it may be ensured that a prescribed pressure of an emergency support system (e.g., the air distribution system 150, 250, 350 of **Figures 1-3**) maintains within a threshold range of the prescribed pressure by including a valve (e.g., the valve of a series of valves 408 of **Figure 4**) of the emergency support system 150 to prevent leakage of breathable air from the emergency support system 150. In operation 1704, a filling process of a breathable air apparatus may be safeguarded by enclosing the breathable air apparatus in a secure chamber (e.g., the holders 612 of **Figure 6A**) of a fill site (e.g., the fill site 102 of **Figures 1-3** of the emergency support system 150 of the building structure to provide a safe placement to supply the breathable air to the breathable air apparatus.

[00148] In operation 1706, the prescribed pressure of the emergency support system (e.g., the air distribution system 150, 250, 350 of **Figures 1-3**) may be maintained such that a system pressure is compatible with the breathable air apparatus through a distribution structure (e.g., the distribution structure 104 of **Figures 1-3**) that is rated for use with compressed air that couples the supply unit 100 and the fill site 102 to transfer breathable air of the source of compressed air to the fill site 102.

[00149] **Figure 18** is a process flow of a safety of a building structure having a fill site (e.g., the fill site 102 of **Figures 1-3**) according to one embodiment. In operation 1802, it may be ensured that a prescribed pressure of an emergency support system (e.g., the air distribution system 150, 250, 350 of **Figures 1-3**) maintains within a threshold range of the prescribed pressure by including a valve (e.g., a valve of a series of valves 408 of **Figure 4**) of the emergency support system 150 to prevent leakage of breathable air from the emergency support system 150. In operation 1804, an air extraction process may be expedited from the emergency support system 150

by including a RIC/UAC fitting (e.g., the RIC/UAC fitting 620 of **Figure 6B**) to a fill panel 102B to fill a breathable air apparatus.

[00150] **Figure 19** is a process flow of a safety of a mine structure, according to one embodiment. In operation 1902, it may be ensured that a prescribed pressure of an emergency support system (e.g., the air distribution system 150, 250 and 350 of **Figures 1-3**) maintains within a threshold range of the prescribed pressure by including a valve (e.g., a check valve of a series of valves 408 of **Figure 4**) of the emergency support system 150 to prevent leakage of breathable air from the emergency support system 150.

[00151] In operation 1904, a filling process of a breathable air apparatus may be safeguarded by enclosing the breathable air apparatus in a secure chamber (e.g., the holders 612 of **Figure 6A**) of a fill site 102 of the emergency support system 150 of the mine structure to provide a safe placement to supply the breathable air to the breathable air apparatus. In operation 1906, a spare storage of breathable air may be provided through an air storage tank 1008 of storage sub-system 950 to store the breathable air that is replenishable with a source of compressed air.

[00152] Although the present embodiments have been described with reference to specific example embodiments, it will be evident that various modifications and changes may be made to these embodiments without departing from the broader spirit and scope of the various embodiments. For example, the various devices, modules, analyzers, generators, etc. described herein may be enabled and operated using hardware circuitry (e.g., CMOS based logic circuitry), firmware, software and/or any combination of hardware, firmware, and/or software (e.g., embodied in a machine readable medium). For example, the various electrical structure and methods may be embodied using transistors, logic gates, and electrical circuits (e.g., Application Specific Integrated Circuitry (ASIC)).

[00153] In addition, it will be appreciated that the various operations, processes, and methods disclosed herein may be embodied in a machine-readable medium and/or a machine accessible medium compatible with a data processing system (e.g., a computer system), and may be performed in any order. Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense.

[00154] The above disclosed invention may be made in different manufacturing environments and/or may be used in different industrial applications. For example,

the different components such as pressure gauges, air storage tanks, hose pipe, breathable air apparatus, CGA connector, RIC/UAC connector, respiratory mask, valves which constitute a breathable air safety system may be manufactured in one or more manufacturing environments and/or may be assembled at a location to build the breathable air safety system having an air storage sub-system. As far the usage, the breathable air safety system may be used, for example, in multiple types of structures to facilitate efficient delivery of breathable air in case of an emergency situation.

Such structures include, but are not limited to, buildings, mines, tunnels, etc.

Whereas many alterations and modifications of the embodiments will no doubt become apparent to a person of ordinary skill in the art after having read the foregoing description, it is to be understood that the particular embodiments shown and described by way of illustration are in no way intended to be considered limiting. By way of example, although efficiently providing breathable air in case of emergency situation through the breathable air safety system is one particularly useful application, it is to be appreciated that the scope of the present teachings is not limited to providing breathable air to the emergency personnel, but rather can include storing the breathable air in an air storage sub-system, maintaining a prescribed pressure in the emergency support system, tracking impurities and contaminants in the breathable air, safeguarding a filling process before dispersing the breathable air at multiple locations of the structure.

[00155] Those skilled in the art may understand that the breathable air safety system may be used in conjunction with one or more systems, that may depend upon particular architectural style of the structure in a manner that provides efficient access to the breathable air of the air distribution system reliably and is not limited to the vertical and horizontal position of the structure as mentioned in above embodiments. Thus, references to the details of the described embodiments are not intended to limit their scope.

CLAIMS

What is claimed is:

1. A safety system of a building structure, comprising:

a supply unit (100) of a building structure to facilitate delivery of breathable air from a source of compressed air to an air distribution system (150, 250, 350) of the building structure;

a valve (408) to prevent leakage of the breathable air from the air distribution system (150, 250, 350) potentially leading to loss of system pressure;

a fill station (102A) interior to the building structure to provide the breathable air to a breathable air apparatus at multiple locations of the building structure;

a secure chamber (612) of the fill station (102A) as a safety shield that confines a possible

rupture of an over-pressurized breathable air apparatus within the secure chamber;

a distribution structure (104) that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure; and

an air storage sub-system (950) to provide an additional supply of air to the building structure in addition to the source of compressed air.

2. The safety system of claim 1, further comprising an air storage tank (1008) of the air storage sub-system (950) to provide storage of air that is dispersible to the multiple locations of the building structure.

3. The safety system of claim 2, further comprising a plurality of air storage tanks (1008) of the air storage sub-system (950) that are coupled to each other through tubes (1000) having a looped configuration to increase robustness of the tubes (1000) through preventing breakage due to stress.

4. The safety system of claim 2, further comprising a booster tank (1006) of the air storage sub-system (950) coupled to the air storage tank (1008) to store compressed air of a higher pressure than the compressed air that is stored in the air storage tank (1008).

5. The safety system of claim 1, further comprising a driving air source (1002) of the air storage sub-system (950) to pneumatically drive a piston of a pressure booster (1004) to maintain a higher pressure of the air distribution system (150, 250, 350) such that a breathable air apparatus is reliably filled.
6. The safety system of claim 5, wherein the driving air source (1002) enables the breathable air to be optimally supplied to the building structure through allowing the breathable air to be isolated from driving the pressure booster (1004).
7. The safety system of claim 1, further comprising an air monitoring system (110) to automatically track and record any of impurities and contaminants in the breathable air of the air distribution system (150, 250, 350).
8. The safety system of claim 7, wherein the air monitoring system (110) includes an automatic shut down feature to suspend air dissemination to the building structure in a case that any of impurity levels and contaminant levels exceed a safety threshold.
9. The safety system of claim 1, further comprising a pressure monitoring system to continuously track and record the system pressure of the air distribution system (150, 250, 350).
10. The safety system of claim 9 further comprising a pressure switch that is electrically coupled to an alarm system such that the alarm system is set off when the system pressure of the air distribution system (150, 250, 350) is outside a safety range.
11. The safety system of claim 10, wherein the pressure switch electrically transmits a warning signal to an emergency supervising station when the system pressure of the air distribution system (150, 250, 350) is outside the safety range.
12. The safety system of claim 1, further comprising at least one indicator unit (614, 618) of the air storage sub-system (950) to provide status information of the air

distribution system (150, 250, 350) including storage pressure, booster pressure, pressure of the compressed air source, and the system pressure.

13. The safety system of claim 1, further comprising a supply unit enclosure (500) encompassing the supply unit (100) having any of a weather resistant feature, ultraviolet and infrared solar radiation resistant feature to prevent corrosion and physical damage.

14. The safety system of claim 13, further comprising a locking mechanism (502) of the supply unit enclosure (500) to secure the supply unit (100) from intrusions that potentially compromise safety and reliability of the air distribution system (150, 250, 350).

15. The safety system of claim 13, further comprising a robust metallic material of the supply unit enclosure (500) to minimize a physical damage due to various hazards to protect the supply unit (100) from any of an intrusion and damage.

16. The safety system of claim 15, wherein the robust metallic material is at least substantially 18 gauge carbon steel.

17. The safety system of claim 1, further comprising a valve (408) of the supply unit (100) to automatically suspend transfer of breathable air from the source of compressed air to the air distribution system (150, 250, 350) when useful.

18. The safety system of claim 1, further comprising any of a safety relief valve (408) of the supply unit (100) and the fill station (102A) to release the breathable air when a system pressure of the air distribution system (150, 250, 350) exceeds a threshold value beyond the design pressure to ensure reliability of the air distribution system (150, 250, 350) through maintaining the system pressure such that it is within a pressure rating of each component of the air distribution system (150, 250, 350).

19. The safety system of claim 1, further comprising any of a CGA connector (406) and RIC/UAC connector (406) of the supply unit (100) to facilitate a connection with

the source of compressed air through ensuring compatibility with the source of compressed air.

20. The system of claim 1, further comprising an adjustable pressure regulator (602) of the supply unit (100) that is used to adjust a fill pressure of the source of compressed air to ensure that the fill pressure does not exceed design pressure of the air distribution system (150, 250, 350).

21. The safety system of claim 13, further comprising at least one pressure gauge (400, 404) of the supply unit enclosure (500) to indicate any of the system pressure of the air distribution system and the fill pressure of the source of compressed air.

22. The safety system of claim 13, further comprising a visible marking of the supply unit enclosure (500) and the fill station enclosure (624) to provide luminescence in a reduced light environment.

23. The safety system of claim 1, further comprising another valve (408) of the fill station (102A) to prevent leakage of air from the air distribution system (150, 250, 350) potentially leading to a pressure loss of the air distribution system (150, 250, 350) through ensuring that the system pressure is maintained within a threshold range of the design pressure to reliably fill the breathable air apparatus.

24. The safety system of claim 1, further comprising an isolation valve (408) of the fill station (102A) to isolate the fill station (102A) from a remaining portion of the air distribution system (150, 250, 350).

25. The safety system of claim 24, wherein the isolation valve (408) is automatically actuated based on an air pressure sensor (108) of the air distribution system (150, 250, 350).

26. The safety system of claim 1, further comprising at least one pressure regulator (402) of each of the fill station (102A) to adjust a fill pressure to fill the breathable air apparatus and to ensure that the fill pressure does not exceed the pressure rating of the

breathable air apparatus potentially resulting in a rupture of the breathable air apparatus.

27. The safety system of claim 1, further comprising at least one pressure gauge (400, 404) of the fill station (102A) to indicate any of a fill pressure of the fill station (102A) and a system pressure of the air distribution system (150, 250, 350).

28. The safety system of claim 1, further comprising at least one of a fire rated material (702) and a fire rated assembly to enclose the distribution structure (104) such that the distribution structure (104) has the ability to withstand elevated temperatures for a prescribed period of time.

29. The safety system of claim 28, further comprising a sleeve that is at least three times an outer diameter of each of a plurality of pipes of the distribution structure (104) exterior to the fire rated material (702) to further protect the fire rated material (702) from any damage.

30. The safety system of claim 29, wherein both ends of the sleeve are fitted with the fire rated material (702) that is approved by an authority agency (604).

31. The safety system of claim 1, further comprising a robust solid casing of the distribution structure (104) to prevent physical damage to the distribution structure (104) potentially compromising the safety and integrity of the air distribution system (150, 250, 350).

32. The safety system of claim 1, further comprising another sleeve at least three times an outer diameter of a pipe of the distribution structure (104) exterior to the robust solid casing to further protect the robust solid casing from any damage.

33. The safety system of claim 32, wherein both ends of another sleeve is fitted with the fire rated material (702) that is approved by the authority agency (604).

34. The safety system of claim 1, further comprising a plurality of support structures

of each pipe of the distribution structure (104) at intervals no larger than five feet to provide adequate structural support for each pipe.

35. The safety system of claim 1, wherein the distribution structure (104) comprises any of a stainless steel and a thermoplastic material that is compatible for use with compressed air.

36. The safety system of claim 1, further comprising an air monitoring system (110) to automatically track and record any of impurities and contaminants in the breathable air of the air distribution system (150, 250, 350).

37. The safety system of claim 36, wherein the air monitoring system (110) includes an automatic shut down feature to suspend air distribution to the fill stations (102A) in a case that any of an impurity level and contaminant concentration exceeds a safety threshold.

38. The safety system of claim 36, further comprising a pressure monitoring system (108) to automatically track and record the system pressure of the air distribution system (150, 250, 350).

39. The safety system of claim 38, further comprising a pressure switch that is electrically coupled to a fire alarm system of the building structure such that the fire alarm system is set off when the system pressure of the air distribution system (150, 250, 350) is outside a safety range.

40. The safety system of claim 39, wherein the pressure switch electrically transmits a warning signal to an emergency supervising station when the system pressure of the air distribution system (150, 250, 350) is outside the safety range.

41. The safety system of claim 1, wherein the fill station (102A) has a physical capacity to enclose at least one breathable air apparatus and includes a RIC/UAC connector (406, 610) that expedites a filling process of the breathable air apparatus.

42. The safety system of claim 14, further comprising a tamper switch of the locking mechanism (502) of the supply unit enclosure (500) such that an alarm is automatically triggered and a signal is electrically coupled to any of relevant administrative personnel of the building structure and the emergency supervising station when an intrusion of the supply unit (100) occurs.

43. The safety system of claim 1, wherein the secure chamber (612) is certified to be rupture containable according to approved standards.

44. The safety system of claim 1, further comprising a selector valve (408) that is accessible by emergency personnel to selectively utilize the source of compressed air to deliver breathable air to the air fill station (102A).

45. The safety system of claim 1, wherein the air storage sub-system (950) is housed in a fire rated enclosure (624) that is certified to be rupture containable to withstand elevated temperatures for a prescribed amount of time.

46. The safety system of claim 1, further comprising a securing mechanism of the secure chamber (612) of the fill station (102A) having a locking function is automatically actuated via a coupling mechanism with a flow switch that indicates a status of air flow to the breathable air apparatus that is fillable in the fill station (102A).

47. A method of safety of a building structure, comprising:

ensuring that a prescribed pressure of an emergency support system (150, 250, 350) maintains within a threshold range of the prescribed pressure by including a valve (408) of the emergency support system (150, 250, 350) to prevent leakage of breathable air from the emergency support system(150, 250, 350);

safeguarding a filling process of a breathable air apparatus by enclosing the breathable air apparatus in a secure chamber (612) of a fill site (102) of the emergency support system (150, 250, 350) of the building structure to provide a safe placement to supply the breathable air to the breathable air apparatus; and

providing a spare storage of breathable air through an air storage tank (1008) of an air storage sub-system (950) to store the breathable air that is replenishable with a source of compressed air.

48. The method of claim 47, further comprising preventing corrosion and physical damage due to weather by incorporating a supply unit enclosure (500) that is weather resistant.

49. The method of claim 48, further comprising preventing intrusion of the supply unit (100) potentially compromising the safety and reliability of the breathing emergency support system by incorporating a locking mechanism (502) of the supply unit enclosure (500).

50. The method of claim 47, further comprising minimizing physical damage of various external hazards to protect the supply unit (100) and the fill site (102) from any of an intrusion and damage through utilizing a robust metallic material to the supply unit enclosure (500).

51. The method of claim 47, further comprising preventing leakage of air from the emergency support system (150, 250, 350) leading to a potential pressure loss of the emergency support system through utilizing a valve (408) of any of the supply unit (100) and the fill site (102).

52. The method of claim 47, further comprising discontinuing transfer of breathable air from the source of compressed air to the emergency support system (150, 250, 350) through utilizing a valve (408) of the emergency support system.

53. The method of claim 47, further comprising automatically releasing breathable air from the emergency support system (150, 250, 350) when the system pressure of the emergency support system exceeds the prescribed pressure through triggering a safety relief valve (408) of any of the supply unit (100) and the fill site (102).

54. The method of claim 47, further comprising ensuring compatibility of the emergency support system (150, 250, 350) and the source of compressed air of an authority agency (804) through any of a CGA connector (406) and a RIC/UAC connector (406) of the supply unit (100).
55. The method of claim 47, further comprising adjusting a fill pressure to ensure that the fill pressure of the source of compressed air does not exceed the prescribed pressure of the emergency support system (150, 250, 350) through a pressure regulator (402) of the supply unit (100).
56. The method of claim 47, further comprising monitoring any of the system pressure of the emergency support system (150, 250, 350) and the fill pressure of the source of compressed air through a pressure gauge (400, 404) of the supply unit enclosure (500).
57. The method of claim 47, further comprising improving accessibility of the supply unit enclosure (500) through providing luminescence in reduced light environments by incorporating a visible marking.
58. The method of claim 47, further comprising isolating a fill site (102) from a remaining portion of the emergency support system (150, 250, 350) using an isolation valve of the fill site (102) such that the remaining portion of the emergency support system (150, 250, 350) is utilizable in an emergency situation.
59. The method of claim 58, further comprising automatically actuating the isolation valve based on an air pressure sensor (108) of the emergency support system.
60. The method of claim 47 further comprising adjusting a fill pressure of the fill site (102) to ensure that the fill pressure does not exceed the pressure rating of the breathable air apparatus through a pressure regulator (602) of the fill site (102).
61. The method of claim 60, further comprising monitoring any of the fill pressure of

the fill site (102) and the system pressure of the emergency support system (150, 250, 350) by incorporating a pressure gauge (600, 604, 606) to the fill site (102).

62. The method of claim 47, further comprising enabling the distribution structure (104) to withstand elevated temperatures for a period of time using a fire rated material (702) to encase the distribution structure (104).

63. The method of claim 47, further comprising preventing the fire rated material (702) from damage by incorporating a sleeve at least three times an outer diameter of each pipe of the distribution structure (104) exterior to the fire rated material (702).

64. The method of claim 63, further comprising preventing physical damage to the distribution structure (104) potentially compromising safety and integrity of the emergency support system (150, 250, 350) by utilizing a robust solid casing of the distribution structure (104).

65. The method of claim 64, further comprising protecting the robust solid casing from any damage using another sleeve at least three times an outer diameter of a pipe of the distribution structure (104) exterior to the robust solid casing.

66. The method of claim 47, further comprising automatically tracking and recording any impurities and contaminants in the breathable air of the breathing emergency support system through an air monitoring system (110).

67. The method of claim 47, further comprising automatically suspending air dissemination to the fill sites (102) in a case that any of an impurity levels and contaminant concentration exceeds a safety threshold.

68. The method of claim 47, further comprising tracking and recording the system pressure of the emergency support system (150, 250, 350) through a pressure monitoring system (108).

69. The method of claim 68, further comprising electrically coupling the pressure

monitoring system (108) and a fire alarm system of the building structure such that the fire alarm system is automatically triggered through a pressure switch when the system pressure of the emergency support system (150, 250, 350) is outside a safety range.

70. The method of claim 69, further comprising electrically transmitting a warning signal to an emergency supervising station when the system pressure of the emergency support system (150, 250, 350) is below a prescribed level through the pressure switch.

71. The method of claim 47, further comprising automatically triggering an alarm and electrically coupling a signal to any of relevant administrative personnel of the building structure and an emergency supervising station when an intrusion of the supply unit (100) occurs through a tamper switch of the locking mechanism (502) of the supply unit enclosure (500).

72. The method of claim 47, further comprising increasing pressure of the breathable air stored in the air tank (1006) through a pressure booster (1004) to increase a pressure of the breathable air compared to the pressure of the breathable air in a plurality of air storage tanks (1008) to ensure that the emergency support system (150, 250, 350) constantly has a supply of breathable air that has enough pressure to fill the breathable air apparatus.

73. The method of claim 72, further comprising conserving a supply of breathable air in the air storage tank (1008) through utilizing a driving air source (1002) to drive the pressure booster (1004).

74. The method of claim 47, wherein the prescribed pressure of the emergency support system (150, 250, 350) is designated based on a municipality code that specifies a pressure rating of the breathable air apparatus that is used in an authority agency (604) of a particular geographical location.

75. A building structure, comprising:

a first set of walls extending vertically and horizontally enclosing an area of land such that the area of land is in an internal region of the building structure;

a second set of walls that divide the internal region of the building structure in any of a horizontal and vertical direction into rooms displaced any of horizontally and vertically from one another;

a supply unit (100) adjacent to a particular wall of the first set of walls to facilitate delivery of breathable air from a source of compressed air to an emergency support system of the building structure;

a fill station (102A) of the internal region of the building structure to provide the breathable air to a breathable air apparatus at multiple locations of the building structure;

a secure chamber (612) of the fill station (102A) as a safety shield that confine a possible rupture of an over-pressurized breathable air apparatus within the secure chamber;

a distribution structure (104) that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure; and

an air storage sub-system (950) to provide an additional supply of air to the building structure in addition to the source of compressed air.

76. The building structure of claim 75, further comprising an air monitoring system (110) to automatically track and record any impurities and contaminants in the breathable air of an air distribution system (150, 250, 350).

77. The building structure of claim 76, further comprising air pressure monitor (108) that is electrically coupled to an alarm such that the alarm is set off when the system pressure of the air distribution system (150, 250, 350) is outside a prescribed threshold range.

78. The building structure of claim 75, further comprising a physical enclosure (624) of the fill station (102A) exterior to the secure chamber (612) of the fill station (102A) that provides additional protection to the fill station (102A) from any of an elevated temperature or physical impact.

79. A safety system of a tunnel structure, comprising:

a supply unit (100) of a tunnel structure to facilitate delivery of breathable air from a source of compressed air to an air distribution system (150, 250, 350) of the tunnel structure;

a valve (408) to prevent leakage of the breathable air from the air distribution system (150, 250, 350) potentially leading to loss of system pressure;

a fill site (102) interior to the tunnel structure to provide the breathable air to a breathable air apparatus at multiple locations of the tunnel structure; and

a distribution structure (104) that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the tunnel structure.

80. A safety system of a building structure, comprising:

a supply unit (100) of a building structure to facilitate delivery of breathable air from a source of compressed air to an air distribution system (150, 250, 350) of the building structure;

a valve (408) to prevent leakage of the breathable air from the air distribution system (150, 250, 350) potentially leading to loss of a system pressure;

a fill station (102A) interior to the building structure to provide the breathable air to a breathable air apparatus at multiple locations of the building structure;

a secure chamber (612) of the fill station (102A) as a safety shield that confines a possible rupture of an over-pressurized breathable air apparatus within the secure chamber (612); and

a distribution structure (104) that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure.

81. A method of safety of a building structure, comprising:

ensuring that a prescribed pressure of an emergency support system (150, 250, 350) maintains within a threshold range of the prescribed pressure by including a valve (408) of the emergency support system (150, 250, 350) to prevent leakage of breathable air from the emergency support system (150, 250, 350);

safeguarding a filling process of a breathable air apparatus by enclosing the breathable air apparatus in a secure chamber (612) of a fill site (102) of the emergency support system (150, 250, 350) of the building structure to provide a safe placement to supply the breathable air to the breathable air apparatus; and

maintaining the prescribed pressure of the emergency support system (150, 250, 350) such that a system pressure is compatible with the breathable air apparatus through a distribution structure (104) that is rated for use with compressed air that couples the supply unit (100) and the fill site (102) to transfer breathable air of the source of compressed air to the fill site (102).

82. A building structure, comprising:

a first set of walls extending vertically and horizontally enclosing an area of land such that the area of land is in an internal region of the building structure;

a second set of walls that divide the internal region of the building structure in any of a horizontal and vertical direction into rooms displaced any of horizontally and vertically from one another;

a supply unit (100) adjacent to a particular wall of the first set of walls to facilitate delivery of breathable air from a source of compressed air to an emergency support system of the building structure;

a fill station (102A) of the internal region of the building structure to provide the breathable air to a breathable air apparatus at multiple locations of the building structure;

a secure chamber (612) of the fill station (102A) as a safety shield that confines a possible rupture of an over-pressurized breathable air apparatus within the secure chamber; and

a distribution structure (104) that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure.

83. A safety system of a building structure, comprising:

a supply unit (100) of a building structure to facilitate delivery of breathable air from a source of compressed air to an air distribution system (150, 250, 350) of the building structure;

a valve (408) to prevent leakage of the breathable air from the air distribution system (150, 250, 350) potentially leading to loss of system pressure;

a fill panel (102B) interior to the building structure having a RIC/UAC fitting (620) pressure rated for a fill outlet of the fill panel (102B) to fill a breathable air apparatus to expedite a breathable air extraction process from the air distribution system (150, 250, 350) and to provide the breathable air to the breathable air apparatus at multiple locations of the building structure; and

a distribution structure (104) that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure.

84. A method of safety of a structure, comprising:

ensuring that a prescribed pressure of an emergency support system (150, 250, 350) maintains within a threshold range of the prescribed pressure by including a valve (408) of the emergency support system (150, 250, 350) to prevent leakage of breathable air from the emergency support system (150, 250, 350); and

expediting an air extraction process from the emergency support system (150, 250, 350) by including a RIC/UAC fitting (620) to a fill panel (102B) to fill a breathable air apparatus.

85. A building structure, comprising:

a first set of walls extending vertically and horizontally enclosing an area of land such that the area of land is in the internal region of the building structure;

a second set of walls that divide the internal region of the building structure in any of a horizontal and vertical direction into areas displaced any of a horizontally and vertically from one another;

a supply unit (100) adjacent to a particular wall of the first set of walls to facilitate delivery of breathable air from a source of compressed air to an emergency support system (150, 250, 350) of the building structure;

a fill panel (102B) of the internal region of the building structure having a RIC/UAC fitting (620) to expedite a breathable air extraction process from the emergency support system and to provide the breathable air to the breathable air apparatus at multiple locations of the building structure; and

a distribution structure (104) that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure.

86. A safety system of a mine structure, comprising:

a supply unit (100) of a mine structure to facilitate delivery of breathable air from a source of compressed air to an air distribution system (150, 250, 350) of the mine structure;

a valve (408) to prevent leakage of the breathable air from the air distribution system (150, 250, 350) potentially leading to loss of system pressure;

a fill site (102) interior to the mine structure to provide the breathable air to a breathable air apparatus at multiple locations of the mine structure; and

a distribution structure (104) that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the mine structure.

87. A method of safety of a mine structure, comprising:

ensuring that a prescribed pressure of an emergency support system maintains within a threshold range of the prescribed pressure by including a valve (408) of the emergency support system (150, 250, 350) to prevent leakage of breathable air from the emergency support system (150, 250, 350);

safeguarding a filling process of a breathable air apparatus by enclosing the breathable air apparatus in a secure chamber (612) of a fill site (102) of the emergency support system of the mine structure to provide a safe placement to supply the breathable air to the breathable air apparatus; and

providing a spare storage of breathable air through an air storage tank (1008) of a storage sub-system (950) to store breathable air that is replenishable with a source of compressed air.

88. A safety system of a structure, comprising:

a supply unit (100) of a building structure to facilitate delivery of breathable air from a source of compressed air to an air distribution system (150, 250, 350) of the building structure;

a distribution structure (104) that is compatible with use with compressed air that facilitates dissemination of the breathable air of the source of compressed air to multiple locations of the building structure; and

an air storage sub-system (950) to provide an additional supply of air to the building structure in addition to the source of compressed air.