Boat-Related Carbon Monoxide (CO) Poisonings

Updated: January 2006

At the request of the U.S. Coast Guard, an interagency team (comprised of representatives of the National Park Service, the US Department of Interior, and the National Institute for Occupational Safety and Health) investigating boat-related CO poisonings compiled a listing of CO poisonings occurring across the United States. The last update of the listing compiled by the interagency team was dated October 2004.

This update was prepared by the Double Angel Foundation CO Awareness Committee (www.doubleangel.org), a non-profit organization dedicated to providing ongoing awareness of the dangers of CO poisoning on boats. The newly identified poisonings added to the October 2004 listing are presented at the beginning of each section in blue font**.** Throughout the listing, information new to the update (such as updated numbers, or information added to text about poisonings that were in previous listings) are also in blue font.

This should not be viewed as a complete list of boat-related CO poisonings that have occurred, but rather as a listing of poisonings we have been able to identify through a number of sources.

Each listing includes the name of the body of water (if known), a brief summary of the circumstances of the poisoning, the source of the information, and the source of CO exposure (if made clear by the record reviewed). Individual entries are listed in alphabetical order by state in which the incident occurred, organized in sections listed below.

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Key: ■ Denotes a single CO fatality

▸ Denotes a single non-fatal CO poisoning

I. CO Poisonings Outside the Cabin of Houseboats

23 CO-Related Fatalities in this Category *53 Non-Fatal CO Poisonings in this Category*

Arizona - Lake Havasu

A past general manager of 3 Buoys Houseboat Vacations reported the following information: The company was based in Canada, but had 11marinas in the US. One of the marinas was on Lake Havasu, where they had 75 boats that were time share/rentals (several owners, but also rented to non-owners). Their boats were 54' long, 14'wide, with generators that exhausted under the rear deck at water level. In 1985, two employees died from CO exposure while sitting on the rear swim platform when the generator operated. The following year, two customers of the same company were poisoned in the same circumstance - sitting on the rear deck platform. (Source: Personal communication, Past Manager of the Houseboat Rental Company) **Rear-directed generator exhaust terminus**

Arizona/Utah - Lake Powell – *for more information about the Lake Powell poisonings, please see other publications listed on the website.*

Since 1994, there have been 10 fatal outdoor poisonings on or near houseboats on Lake Powell. All of the fatalities occurred on privately owned boats, and at least 9 of the 10 deaths were associated with boat that had a stern deck that extends several feet beyond the transom, and a lower swim platform. Eight of the 10 deaths occurred on boats with a rear-directed generator exhaust terminus. Eight of the 10 deaths were witnessed, and these 8 people were known to have entered the airspace beneath the stern deck at some point prior to losing consciousness. The witnessed deaths all occurred within seconds or minutes of exposure. Five of the deaths were associated with exposure to generator exhaust. Two of the deaths were attributed to both generator and propulsion engine exhaust. Two deaths were associated with propulsion engine exhaust only. The source of CO in the tenth death is not specified. (Source: Review of NPS EMS Records, Glen Canyon National Recreation Area)

(36) Since 1990, there have been 36 non-fatal poisonings occurring outside the cabin area of houseboats on Lake Powell. Twenty-nine of these poisonings were associated with exposure to generator exhaust only; 3 were associated with propulsion engine exhaust only; 1 was associated with exhaust from both types of engines; and the remaining 3 were associated with the operation of an engine that was not clearly described in the record. Twenty-one of these poisonings resulted in loss of consciousness, and 15 of these people lost consciousness while in the water (thus were near-drownings). (Source: Review of NPS EMS Records, Glen Canyon National Recreation Area)

Florida - Silver Glen Springs

In August 1995, a 43-year-old man wearing snorkel gear went into the airspace beneath the extended rear deck of a 1994 Stardust houseboat to check the engine outdrive. The boat's 12.5 kW Kohler generator was activated just before he entered the airspace. The generator exhaust terminus was directed into the airspace. The boat propulsion engines were not operating. Approximately 5 minutes after he entered the airspace, he was observed floating unresponsively face down in the shallow water. He was retrieved from the water and bystanders administered CPR. He was then transported to shore, and Emergency Medical Service was called. He was resuscitated in the hospital emergency department, and but died 17 hours after his exposure. His COHb (carboxyhemoglobin – CO in the blood) measured in the hospital 2 hours after exposure, and after more than an hour on oxygen therapy, was 29.7%. A forensic toxicologist estimated that the man's COHb was greater than 70% when he collapsed. Inspection and testing of the houseboat revealed that operation of the generator caused rapid accumulation of CO in the above-water airspace beneath the deck (the airspace he entered) such that the concentration would reach 4,000 to 10,000 parts per million (ppm) within 2 to 5 minutes after the generator was activated. The cause of death determined by autopsy was cerebral anoxia, due to acute carbon monoxide poisoning with submersion. (Source, Lab Director, Miami-Dade County Medical Examiner Department) **Rear-directed generator exhaust terminus**

Georgia - Chattahoochee River

In May 2000, a 57-year-old man was repeatedly diving in 6 – 8 feet of water to release the boat anchor from where it was jammed. Each time he emerged, he was near the side-directed generator exhaust terminus of a 1999 Sumerset houseboat. The generator was operating at the time. When he did not resurface, witnesses dove into the water trying to find him. They were not successful. Although no autopsy was conducted, blood was drawn and stored. This stored blood was analyzed for COHb content over sixteen months later; the result was 22%. (Source: Georgia Department of Natural

Resources, Game and Fish Division Law Enforcement Section investigative report) **Side-directed generator exhaust terminus**

Kansas – Perry Lake

In July 2004, a 34-year old woman drowned and two others lost consciousness as a result of CO poisoning. A group of women were swimming behind a group of tethered (rafted) houseboats on which one or more generators were operating. There was little wind when the incident occurred. Two of the women were unconscious, either both floating in the water or one in the water and one on the swim platform of one of the boats. One of the women was not breathing, but was revived, and the second was unconscious and unresponsive. A number of minutes later, someone noted that the third woman was missing. Her body was recovered approximately 30 minutes later. On autopsy, her COHb was 45%. (Source: TV and newspaper coverage of the incident; personal communication with the medical examiner and sheriff's department) **Generator exhaust**

Missouri - Lake of the Ozarks

In June 1998, a 4-year-old girl was swimming behind the stern deck of a 1989 50' Gibson houseboat with a group of other children. She wearing a personal flotation device, and was under the direct supervision of adult swimmers. She swam to the swim platform, held on to the ladder while her mother applied sunscreen to her face, and then swam away. Within moments she was observed floating face up on the water, unconscious and rigid. She was quickly brought into the boat where her mother, a registered nurse, checked her for respirations and pulse. She appeared pale and stiff at that time, was unresponsive with poor respiratory effort. After 2 to 3 minutes of aggressive stimulation, the child began responding with grunts but was described as disoriented and sleepy. Paramedics were called and arrived 10 to 15 minutes later. They administered oxygen and transported the child to the nearest hospital emergency department within 30-45 minutes. Her COHb level at the hospital after approximately 1 hour of oxygen therapy was 22.2%. Upon examining the houseboat during their next visit to the lake, the child's parents discovered that the exhaust terminus for the onboard generator that was operating at the time of this poisoning was located at the edge of the swim platform, in the center of the rungs of the ladder that the child was holding onto when the sun screen was applied. (Multiple sources including the parents and a peer-reviewed publication) **Rear-directed generator exhaust terminus**

In the summer of 1999, a man died on this lake as he swam behind a houseboat. An autopsy revealed that death came not from drowning, but by asphyxiation from CO. We currently have no further information on this death. (Source: Kansas City Star, 12/14/00, Lee Hill Kavanaugh) **Unspecified direction of generator exhaust terminus**

Missouri - Table Rock Lake

In the July 1999, 2 girls swimming behind a houseboat succumbed to generator exhaust, but were rescued. (Source: Kansas City Star, 12/14/00, Lee Hill Kavanaugh). Records related to this incident revealed that the children were aged 8 and 11, and were found unconscious floating behind the Gibson 54' houseboat. One of the girls was not breathing when she was found. The girls had been wearing personal flotation devices swimming behind the boat as the boat owner worked on the front of the boat. The generator (no manufacturer specified) was operating at the time, and the exhaust of the generator "comes out of the boat right under the swim platform where they were swimming." (Source: Missouri Department of Public Safety, Missouri State Water Patrol Accident Investigation Report) **Rear-directed generator exhaust terminus**

Nevada - Lake Mead

In July 1997, a 52-year-old man working to clear a rope from around the propeller on a rented houseboat lost consciousness as a result of exposure to CO in generator exhaust. (Source: Review of NPS EMS records, Lake Mead National Recreation Area) **Unspecified direction of generator exhaust terminus**

In October 1997, an 8-year-old child floating in a small rubber raft on the starboard side of a houseboat was poisoned by CO in houseboat generator exhaust. He was exposed for about 5 minutes when he became dizzy, and fell down when he tried to walk. He was transported to a local hospital for treatment. (Source: Review of NPS EMS records, Lake Mead National Recreation Area) **Unspecified direction of generator exhaust terminus**

In June 1999, a 7-year-old child was playing near a houseboat generator for about 10 minutes when she fell into the water and lost consciousness as a result of CO exposure. (Source: Review of NPS EMS records, Lake Mead National Recreation Area) **Unspecified direction of generator exhaust terminus**

In June 2003, a 57-year-old man lost consciousness due to significant exposure to CO. He was making a second attempt

to remove an entangled rope from the prop of his beached vessel when he was overcome. On the previous evening, he'd spent two hours under the swim platform attempting to remove the rope, but had to discontinue his efforts when he became weak and nauseous. The next morning, he put on a life jacket, entered the water, and resumed his efforts. Thirty minutes later a friend same him float from underneath the swim platform. He was conscious and alert, but slow to answer some questions. He was transported to a medical facility where he was treated for CO poisoning after physicians determined that his COHb was very high (the record states "doctors there determined that he had nearly 20 times the maximum permissible amount of carbon monoxide in his blood" but it is unclear what that refers to). He was admitted to the hospital in serious but stable condition. Further investigation revealed that the 22-horsepower generator on the boat had been operating the entire time. (Source: NPS records) **Unspecific direction of generator exhaust terminus**

North Carolina/Virginia - Kerr Lake

In 1995, a man in his 40's entered the airspace beneath the extended stern deck of a 60' houseboat (manufacturer unknown) to conduct repairs. The home dock of this houseboat was Steel Creek Marina. The on-board generator with a rear-direct exhaust terminus was operating when he entered the airspace. He quickly died of CO poisoning. The local Coast Guard Auxiliary was contacted, and a full investigation was conducted. The reporter of the incident did not know who conducted the investigation (i.e., Coast Guard, law enforcement, State Wildlife, etc.) but did remember that the man's death was directly attributed to the design of the boat. (Source: Report by a private individual whose boat was also docked at Steel Creek Marina) **Rear-directed generator exhaust terminus**

Tennessee - Center Hill Lake

In May 1997, a father dove under the stern deck of his houseboat to repair a mechanical problem. According to the Tennessee Wildlife Resources Agency, he entered an airspace beneath the stern deck into which the exhaust of the operating onboard generator was directed. Because the father did not surface, his son dove under the boat to find him. Both men died of CO poisoning while in that cavity. (Sources: Arizona Republic, November 29, 2000; and Tennessee Wildlife Resources Agency investigative records) **Rear-directed generator exhaust terminus**

Tennessee - Tims Ford Lake

In July 1999, a 7-year-old boy wearing a type III personal floatation device was playing and swimming on and near the swim deck of a 1979 46' Stardust houseboat when he was overcome by exhaust from the on-board generator. He fell into the lake and was found floating on his back unresponsive and in convulsions. He was rescued by others on the boat. (Source: Tennessee Wildlife Resources Agency Boating Accident Report) **Rear-directed generator exhaust terminus**

A 61-year-old woman wearing a ski belt while cleaning algae from the back of a 1990 Gibson 42' houseboat died from CO exposure in June 2000. She had been in the water approximately 20 minutes when her husband went outside and saw her floating 30 feet from the boat on her back and unresponsive. He worked for approximately 30 minutes to pull her from the water onto the swim platform. At this point, he began to feel lightheaded. He got back into the boat and deactivated the generator. Because a storm was approaching, and he was afraid that his wife would be blown away, he tied his wife's body to the swim platform until rescuers arrived. His wife died of CO poisoning, and he was admitted to a hospital intensive care unit for CO poisoning treatment. The wife's blood CO concentration was 62%. (Sources: Arizona Republic, November 29, 2000; also AP, December 25, 2000; and Tennessee Wildlife Resources Agency Boating Accident Report) **Rear-directed generator exhaust terminus**

Tennessee - Norris Lake

In July 1999, a 45-year-old man went into the water to repair the slide on his 77' 1995 Stardust houseboat. Approximately 5 minutes after he swam under the stern deck of the houseboat, two minors on board went to get help because they did not see the man resurface. His body was recovered from the lake about 3 hours later. Although no autopsy was performed, blood was drawn and analyzed for carboxyhemoglobin (COHb – CO in blood) content, which was 37%. (Source: Tennessee Wildlife Resources Agency Boating Accident Report) **Rear-directed generator exhaust terminus**

Tennessee - Unspecified water body

In 1998, a child found floating near the rear of a houseboat that had its generator operating was found to have died because of carbon monoxide exposure. (Source: Tennessee Wildlife Resources Agency Investigative Report) **Unspecified direction of generator exhaust terminus**

Tennessee - Dale Hollow Lake

In June 1997, a family rented a houseboat from Hendrick Creek Resort on Dale Hollow Lake. Several children were playing on the slide and around the back of the boat all day while the generator operated to power the air conditioning inside the boat. One of the children (aged 9) reported to her mother three times that day that she felt sick, but her symptoms were attributed to the hot weather and sun. Her mother had also been feeling ill when she sat in a tube tied to the back deck of the houseboat, and attributed her symptoms to the exhaust, but not necessarily to CO. In the afternoon, the child swam on the side of the boat where the generator exhausted because that area was shaded from the sun. The exhaust exited the boat very near the area where she swam. Her 7-year-old brother was on the stern deck playing. He was talking to her and she told him that she felt sick. He told her to get out of the water. She was reaching for the ladder, and did not make it. She sank into water that was 8-11 feet deep. The boy reported to his mother that the girl had gone down and didn't come back up. The child's body was found by emergency response personnel. Although an autopsy was performed, no

carboxyhemoglobin analysis was done. (Sources: Personal communication from the child's family; and Tennessee Wildlife Resources Agency Boating Accident Report) **Unspecified direction of generator exhaust terminus**

Texas - Lake Travis

A 19-year-old employee of a houseboat rental company was piloting a 66' houseboat (no manufacturer specified) when a buoy cable became entangled in the engine propeller. After deactivating the generator (the exhaust of which was directed to the rear of the boat into the airspace beneath the swim deck) and waiting a few minutes to assess the situation, he decided to go under the aft swim deck of the boat to free the cable. He was aware of the carbon monoxide (CO) danger and made efforts to avoid breathing while under the swim deck. Unable to hold his breath long enough, he was forced to take two breaths while working to free the cable. A coworker arrived on the scene minutes later to find the employee unconscious. The employee was airlifted to the nearest hospital. Doctors later reported that his blood carbon monoxide level was in the lethal range, although no specific details were available from the reporter of this incident. (Source: Written communication from the rental company manager, Austin TX) **Rear-directed generator exhaust terminus**

Upon reading the press coverage of the poisonings at Lake Powell, the manager of a fleet of 9 large rental houseboats phone to say "We've been waiting for this day for years." Between 1995 and 2000, he had personal involvement with four documentable cases of aft swim-deck CO poisonings (including the one above) and indirect knowledge of numerous others. None were fatalities, but two required hyperbaric oxygen treatment. All of these poisonings involved generator exhaust routed under the swim deck at the back of the boat. (Source: Written communication from the rental company manager, Austin TX) **Rear-directed generator exhaust terminus**

II. CO Poisonings Outside the Cabin of Cabin Cruisers and Ski Boats

***31** CO-Related Fatalities in this Category* ***81** Non-Fatal CO Poisonings in this Category*

New information (post October 2004 update)

California – Folsom Lake

In May 2004, the operator of a Master Craft 19' 1997 ski boat with an inboard engine was idling the vessel with three children swimming in the water directly behind it. One of the children (who was 8 years old) became ill and then lost consciousness. Upon awakening, he became nauseous. The child was transported to a boat dock, where medical personnel provided treatment and transport to a nearby hospital, where the child was diagnosed with CO poisoning. (Source: USCG BARD) **Propulsion engine exhaust**

Colorado – Bonney Reservoir

In September 2004, a 3-year-old child was playing on the swim platform of a Master Craft 19' 1995 ski boat with a 350 horsepower inboard propulsion engine while the propulsion engine operated. A few minutes later, the child was observed unconscious. The child was taken to shore and emergency personnel were contacted. Park officers began treating the victim with oxygen, transported to a nearby hospital, and treated for carbon monoxide poisoning. (Source: USCG BARD) **Propulsion engine exhaust**

Michigan – Lake Huron

In August 2005, a 35-year-old woman and a male companion disappeared from a Wellcraft 27' cabin cruiser boat. The couple was last heard from on August 11, when a cousin spoke with one of them by cell phone at about 1:30 pm, and they reported being near Rogers City, MI. They expected to be in Mackinac in about 2 hours. They never arrived. The boat was found adrift the next day at about 11 am, unoccupied with its motor running. The woman's body was found on August 24th. News reports posted on November 6, 2005 cited CO as contributory to her death, based on analysis of splenic blood that contained 13% COHb. Her companion's body had not been found as of the date of the news report. This incident was obviously unwitnessed, but circumstances around the incident (both occupants missing from the boat, engine still operating when the boat was found, etc.) indicate that the occupants were either at the back of the boat and fell into the water, or that they were swimming behind the boat with the engine operating), and thus were outside the cabin of the boat when the woman was poisoned. (Source: Several news clippings posted on the internet)

Minnesota – Lake Minnetonka

In July 2000, a 15-year-old girl survived CO poisoning while she was lying on the rear padded sunning deck of a ski boat. Boat occupants were waiting for a fireworks display, with the engine operating to power the on-board music system. Other occupants thought the girl was sleeping until they tried unsuccessfully to awaken her. She has stopped breathing. Her COHb measured upon transport to the local hospital was 30%. (Source: TV news coverage; Emergency Nurses Association contact in the treating hospital) **Propulsion engine exhaust**

Texas – Gulf of Mexico

In July 2005, a 21-year-old woman drowned as a result of CO poisoning. The woman was boating with her husband and a group of friends in a 21-foot ski boat. She and her husband were floating in the water, hanging onto the ski platform in the aft portion of the stationary boat. The boat operator started the engine and began moving at about 5 miles per hour when the woman slipped from the platform and sank. Her husband was unable to locate her; investigators conducted an "exhaustive, extensive search" but were again unsuccessful. Several hours later, her body rose to the water's surface and was discovered. Her COHb upon autopsy was 67%. (Source: Galveston Daily News, Galveston County Medical Examiner's autopsy report) **Propulsion engine exhaust**

Washington – Lake Tapps

In August 2005, a 22-year-old woman drowned as a result of CO poisoning. The woman was holding onto the swim step of a 1987 Master Craft ski boat. The vessel was in gear and moving at idle speed through the water. Witnesses said that her eyes looked funny just before she let go of the step, and sank beneath the water's surface. Her COHb upon autopsy was 39%. (Source: Various news articles; Pierce County Fire Department; Pierce County Sheriff Department; Pierce County Medical Examiner's Report) **Propulsion engine exhaust**

Alaska – Kasilof River

In July, 2004, a 55-year-old man and his 13-year-old son were fishing on a commercial drift boat about 40 miles off the mouth of Kasilof River. Their fishing net became entangled on the propulsion engine outdrive. There was a hatch in the deck to allow access to the area, because this is not an uncommon event. With the engine in neutral and idling, the victim laid down on the deck, placed his upper body into the hold, and began working on the tangled line. His son was standing close by waiting for instructions when he noticed his dad's hat floating away. His son called to alert his dad to this, but his dad never answered. When his son saw that his dad was no longer working on the net, he called his name several times to no avail. His son was unable to rouse him, and characterized his breathing as "weird". The son radioed for assistance, while waiting for the responding vessel to arrive pulled his dad from the hold and opened another distress call. When the responders to the first radio transmission arrived 10 minutes after the call, the victim was still unconscious. They deactivated the engines, used their boat to keep the victim's boat from drifting, and relayed the victim's vital signs to the Coast Guard. "It became very apparent that (the victim) succumbed to CO poisoning. The hatch hadn't vented enough of the engine exhaust when it was opened." Another boat arrived, and all responders tried uncuccessfully to wake the victim. In an hour, a rescue vessel arrived - and the victim concurrently began to awaken but was "way, way out of it." He didn't remember anything, and didn't realize what was happening. 1 1/2 hours the initial loss of consciousness, responders began to transport him to the hospital. After arriving at the hospitall, the victim was placed on oxygen, and was diagnosed and treated for CO poisoning. He was released from the hospital 8 hours after losing consciousness. (Source: Kenai peninsula online web posting.) **Propulsion engine exhaust**

Alabama - Dog River

In September 1997, a 10-year-old passenger riding on the swim platform of a 19' 1989 Correct Craft ski boat was fatally poisoned within two minutes of exposure to engine exhaust while the boat was operating at idle speed. The boat was powered by a 1995/1996 240-horsepower inboard engine. Four juveniles were riding on or holding onto the swim platform in an activity that was described to investigators as "common practice" by the owner of the boat. When the boat was at idle speed, the four passengers climbed out onto the swim platform. They were positioned in various places on the platform: sitting on the platform; holding onto the platform with arms extended and being towed behind the boat; chest up on the swim platform with legs dangling behind the boat, etc. About two minutes after they got on the platform and the boat began to move at idle speed, the victim let go of or fell from the platform, separated from the boat, drifted astern of the boat for approximately 50 feet, and sank beneath the surface in 18' of water. None of the passengers were wearing a personal floatation device. His body was recovered six hours later. His COHb on autopsy was 50%. Cause of death listed on the death certificate was carbon monoxide toxicity and drowning. (Source: Alabama Marine Police Marine Accident Investigation Report, Alabama Department of Forensic Sciences Report of Autopsy) **Propulsion engine exhaust**

Alabama – Magnolia River

In August 1996, three girls (ages 6, 8, and unknown), were sitting on the swim platform of a Master Craft 1985 ski boat with a slotted teakwood swim platform. They were dragging their feet in the water as the boat moved at idle speed through a no-wake zone heading home. As the girls hopped back on the boat, the operator noticed that one was missing. He looked back and saw a foot sticking up in the turbulence 100 feet back. The operator reversed the boat, dove in, and found his 8-year-old daughter unconscious, eyes wide, mouth agape, head down, feet up, fully unconscious 5 feet underwater. After 20 minutes of successful resuscitation, she transported to the hospital. The hospital tested for COHb, revealing that she had CO poisoning. She was admitted to the hospital overnight. (Source: Statement from the parent of the victim) **Propulsion engine exhaust**

Arizona - Bartlett Lake

In May 1998, an 11-year-old boy and 3 children of similar age were being slowly pulled through the water while holding onto the wooden ski platform attached to the rear transom of the boat. The boat was a 1992 20' Master Craft Ski-ProStar 205, with a fully exposed propeller, centered at the rear underside of the water craft. At one point, the victim was the only person being pulled through the water, with the three mates sitting immediately nearby on the platform, and two adults located in the front of the boat. When the victim's swim trunks started to slip off, he uttered an exclamation, and released one hand to grab his clothing. Water gushed up into his face. He then turned around as if to say something. His eyes rolled back, and he released the platform with his other hand as well. He then disappeared underwater. He was not wearing a personal floatation device. Divers recovered his body the following day. His COHb was 48% with cause of death determined to be "drowning, due to carbon monoxide incapacitation due to inhalation of exhaust." The certificate of death listed drowning (but not CO poisoning) as the cause of death. Investigators' reports did not indicate malfunction of the boat or motor, nor did any witness describe the odor of fumes or exhaust. No other passenger on the boat described becoming

ill. (Source: Arizona Health Department; Maricopa county Sheriff's Department investigative records; Arizona Game and Fish Boating Accident Report) **Propulsion engine exhaust**

In May 2004, an 18-year-old student died as a result of "teak surfing". Twenty students were participating in an unofficial activity that included boating. The victim was holding onto the swim platform of an unspecified manufacture motorboat with piped exhaust when he let go and sank. Witnesses stated that the victim did not attempt to swim. Other passengers were not able to find him in the 15-foot deep water. When the body was recovered the next morning, there was no apparent trauma. His COHb was 57%. (Source: Arizona Republic newspaper, local television coverage, Arizona Vital Records; Medical examiner's report) **Propulsion engine exhaust**

Arizona - Lake Havasu

In February 1997, 3 children aged 4, 12, and 13 were overcome by propulsion engine exhaust while riding in a 24' 1991 Master Craft boat with an inboard engine. The vessel entered a no-wake zone and was operating at a wakeless speed. The boat operator removed the engine cover because there was a hole in the water-cooled exhaust manifold. The boat traveled in this configuration from the buoy line to the dock, an estimated distance of approximately 100 yards. Exhaust from the engine overpowered the three passengers, making them nauseous. They were given oxygen on scene and released to an adult. (Source: Arizona Game and Fish Boating Accident Report) **Propulsion engine exhaust**

In May 2001, a 22-year-old occupant of a 28' 1996 Nordic pleasure craft powered by a inboard stern drive propulsion engine was swimming at the back of the boat with the motor operating. The boat was located 200 yards SE of Spectator Point. The victim was overcome by carbon monoxide, lost consciousness, and drowned. (Source: Coast Guard database; Arizona Game and Fish Boating Accident Report) **Propulsion engine exhaust**

In July 2001, a 12-year-old girl seated on the stern of a 21' 1980 Bahmer Sport Cruiser open motor boat moving slowly through the water was overcome by engine exhaust and fell into the water. The victim was transported to the hospital to be treated for CO poisoning. Her COHb after 40 minutes of oxygen therapy was 20.6%. (Source: Coast Guard database; Arizona Game and Fish Boating accident report) **Propulsion engine exhaust**

.In March 2002, a 9-year-old girl was poisoned while on an evening pleasure boat ride in the Bridgewater Channel under the London Bridge-year. They were on a 1991 Ultra XT, 21-foot open-bow low-profile ski-type boat powered by a 454 cubic-inch Chevrolet inboard engine and a Berkeley jet pump drive system. Two swim steps extend from the transom, one each side of the jet drive at water level. Under each swim step is a 3.5" exhaust outlet. The engine cover is an upholstered "tanning deck." The boat was moving forward at idle speed while the girl sitting on the transom at the rear of the tanning deck with her feet on the port-side swim platform. After approximately 10-15 minutes, she became dizzy and called out to her dad. Almost immediately, she lost consciousness, slipped from the deck, and disappeared behind the boat. She was wearing a life jacket. When her father got to the back of the boat, her left arm was extended with her hand grasping the leading plank of the swim step, which resulted in her face being held up out of the water by the rear of the step. Her body was limp and trailing behind the boat. She was completely non-responsive and when she was pulled into the boat, her father noticed her eyes were rolled back and faint gurgling noises were coming from her mouth. She was placed upright in the rear seat and her father unsuccessfully to get a response. She then vomited, still unconscious,. Her father moved the boat to a nearby dock where bystanders had noticed the situation and called 9-1-1. Paramedics arrived in a few minutes and immediately administered oxygen by face mask. In about 3 minutes, she regained consciousness and responded well to the paramedic's inquiries. She was transported by ambulance to the local emergency room, where she spent about six hours on O2. Except for headaches while in the emergency room, she apparently made a 100% recovery from the incident. Nurses in the emergency room told her father that the girl's COHB level was 27%, however, it is unknown how long the girl had been on oxygen therapy before the blood sample was drawn. (Source: the victim's father) **Propulsion engine exhaust**

In May 2002, a 20-year-old man drowned and his companion lost consciousness after wading in the water not far from a boat with propulsion engines operating. He and another adult were in the Bridgewater Channel. The engine was operating so that the battery would remain charged while the radio operated. Both adults complained of dizziness, thinking they were dehydrated. One walked to the shore to get some water from the cooler. She lost consciousness, and was escorted to a nearby boat where she was given food and water. While on the boat, she asked someone to find the person she was with. A bystander discovered the second person in the water. Although the cause of death was listed as drowning, his COHb was greater than 40%. (Source: Today's News Herald, Lake Havasu City, and personal communication with public health officials) **Propulsion engine exhaust**

In September 2002, an 18-year-old woman lost consciousness while on the back of an unspecified type of pleasure craft while spending the day in the London Bridge channel of Lake Havasu. By-standers stated that she went into convulsions before she lost consciousness. She was transported to the nearby hospital by EMS responders, where her COHb was

measured to be 28.5 after nearly 30 minutes of oxygen therapy. (Source: Lake Havasu Regional Medical Center) **Propulsion engine exhaust**

In May 2003, a 31-year-old man drowned in the Bridgewater Channel secondary to CO poisoning. His COHb was reportedly 47%. (Source: Arizona Department of Health Services report, Mohave County Health Director, and Today's News-Herald reports)

During Memorial weekend May 2003, a 21 year old female lost consciousness and slipped into the water while standing behind an idling boat in the Bridgewater Channel. She was pulled from the water and EMS was notified. A field drawn COHb was found to be 47% at the hospital. After approximately 72 minutes of 100% oxygen via a nonrebreather mask her CoHb was 18.6%. She was transported to a hyberbaric chamber for treatment. Her 22 year female companion was checked for CO exposure and was found to have an expired CO level of 19%. She was treated with 100% in the ER and later released. (Source: Local hospital emergency department)

During Labor Day weekend, August 2003, a 23 year old female was standing in waist deep water behind 2 idling boats when she lost consciousness. She was pulled from the water by a bystander and EMS was notified. A field drawn COHb was found to be 42.7% at the hospital. After 50 minutes of 100% oxygen via a nonrebreather mask her repeat CoHb was 21.5%. She was admitted to the hospital and maintained on a nonrebreather mask then, discharged the next day. (Source: Local hospital emergency department)

Arizona – Lake Pleasant

In October 2003, a man was transported to the hospital and treated for CO poisoning after losing consciousness while fueling his 41' Formula watercraft (Vessel #1). He was standing on the swim platform of a second vessel (Vessel #2) while fueling his watercraft, and suddenly loss consciousness, falling onto the platform. Vessel #1 was unoccupied, and at anchor with the propulsion engine deactivated. Vessel #2 was at a 45 degree angle to Vessel #1, with the transom adjacent to side of Vessel #1. The propulsion engine of Vessel #2 was idling, and a generator was operating running the built-in fueling system. (Source: Arizona Game and Fish Department) **Propulsion engine and generator exhaust**

In March 2003, a 21-year-old female lost consciousness for an extended period while on the ski deck behind a ski boat. When she regained consciousness, she was lethargic, complaining of dizziness, and nausea. During transport to a nearby hospital, she vomited several times. Although emergency responders assessed her condition as related to alcohol consumption, hospital blood tests revealed a low level of alcohol. Another blood sample was then drawn (nearly 3 hours after her last CO exposure), and found to contain 18.6% COHb. She was treated for CO poisoning. The hospital record notes that a male friend of the patient died on the same boat six months prior to this incident, but attempts to locate the patient, and thus the boat, have so far been unsuccessful. (Source: County sheriff, local hospital) **Propulsion engine exhaust**

Arizona - Unspecified water body near Phoenix

In 1997, on a lake near Phoenix, a 13-year-old girl was found dead in the stern seat of a ski boat that had been operating around the lake for a couple of hours. She moved to a seat in the back of the boat while the family was headed back to the dock, and about 15-20 minutes later she was discovered to be dead. Examination of her blood postmortem revealed high CO levels. The sheriff's office recorded that they examined the boat and motor, but did not identify any problems. (Source: Arizona Department of Health Services) **Propulsion engine exhaust**

Arizona/Utah - Lake Powell for more information about the Lake Powell poisonings, please see other publications listed on the website.

Since 1990, 3 people have died from CO poisoning on Lake Powell while being seated in an open boat or occupying the rear platform of the boat. The circumstances of these poisonings are listed below:

In July 1995, a 16-year-old girl died while riding in a slowly moving 20.5' Bahmer boat powered by a 454 cubic inch Chevrolet inboard propulsion engine with jet drive. She was sitting in the driver's side transom seat very close to the exhaust ports. The boat was traveling at about 10 miles per hour while towing a personal water craft. The trip from the campsite to the boat dock took about 45 minutes. When the boat reached the wakeless buoys, other passengers noticed that the girl was limp, with her chest arched in the air and her hair trailing behind in the water. She was transported to a nearby hospital emergency department, and then on to a second hospital in Phoenix. She was pronounced dead a day after she was exposed.

In June 2001, an 18-year-old passenger of a 1993 21' Master Craft ProStar 205 ski boat drowned in Lake Powell as a result of CO poisoning. There were 10 passengers on the boat at the time. At the time of the death, three of the 10 passengers were being pulled behind the boat in an activity referred to as "teak surfing". This activity was described by this and other families as very common and "what wake boarders do when they are not on their board". The operator of the boat reported having been teak surfing on this boat at least 15 times, and his father reported that the activity had been done by others on this boat at least a hundred times. None of the people teak surfing were wearing a personal floatation device (PFD). Shortly after beginning teak surfing (estimated less than 2 minutes), one of the teenagers was unable to maintain her hold on the platform. She was reported as having "jerky arm movements" and difficulty in communicating. She was pulled into the boat by the passengers, where she recovered. Another teen took her position on the platform, and they began teak surfing again. Approximately 1-2 minutes later, one of the three teens began to experience unspecified symptoms. Two of the three teens then pulled themselves up onto the swim platform while the boat continued to move forward. The third surfer, still positioned for teak surfing, lost consciousness and released his hold on the platform. He sank beneath the surface. His body was retrieved from the water three days later. His COHb on autopsy was 57%. Subsequent measured CO concentrations on the platform ranging between 10,000 and 27,000 parts per million (ppm) under similar circumstances were in agreement with exposure estimates calculated to be between 10,000 and 16,000 ppm based on his COHb concentration and estimated time of exposure.

In August 2002, two 9-year-old girls were poisoned outside of a moored 2001 26" Sea Ray 260DA Cabin Cruiser. One girl died and one survived. They were observed playing in shallow water (about 2.5" deep) near the starboard stern of the boat very near the exhaust terminus of the operating generator. One girl was called into the boat by her parents, and when she climbed out of the water onto the swim platform, she stumbled and fell onto the floor. She was thought to be suffering from dehydration. The other girl was discovered to be missing about 15 - 30 minutes later. She was found lying on the bottom of the lake. Attempts to resuscitate her were unsuccessful. The survivor's COHb was 15.1% after over 70 minutes of oxygen therapy. The girl that died had a COHb of 39% after more than 40 minutes of resuscitative efforts including CPR and intubation.

(22) Since 1990, 22 people survived CO poisoning outdoors on pleasure craft (boats other than houseboats) on Lake Powell. Eleven of the 22 lost consciousness. Twenty-one of these survivors were poisoned by propulsion engine exhaust, and one was poisoned by generator exhaust. Ten of the 22 people were riding at the stern of the boat (on the transom, on the padded sunning deck, on the engine cover, or in the rear seats) of a moving boat. Four of the 22 people were outside in a boat being towed by another boat. The remaining 8 of 22 people poisoned outside of the cabin area of pleasure craft were in the water when they were poisoned, or were dangling from or sitting on a water-level swim platform. The circumstances of these 8 poisonings are described below:

Two survivors were poisoned during the teak surfing event described above.

One was the survivor poisoned by generator exhaust in the incident involving a fatality described above.

One poisoning occurred while the person was "holding onto a swim deck and handle while being towed." This person lost consciousness within 5 minutes of beginning this activity, was recovered from the water and revived. His carboxyhemoglobin (COHb) measurement was 32% after 37 minutes of oxygen therapy.

Circumstances of another incident were described as follows: "swimming behind a boat for 10-15 minutes." This person lost consciousness and recovered.

"Behind a boat with motors running for 2 hours." This person lost consciousness when he climbed onto the swim step of the boat as the motors continued to operate. He recovered, and had a COHb of 18% after 50 minutes of oxygen therapy.

Exposed to exhaust for 20 minutes while in the water behind the boat. This person experienced loss of hearing, blurred vision, and near loss of consciousness. Her COHb was 5.3% after 220 minutes of oxygen therapy.

Playing for several minutes with a shower hose that was fed hot water by the operating engine while sitting on the swim platform; her arms clenched, she started crying, her eyes rolled to the top of her head and she appeared to stop breathing. She was given rescue breathing and was transported to the hospital.

(Source: Review of NPS EMS Records, Glen Canyon National Recreation Area)

California - Colorado River

In July 2000, a 15-year-old girl died as a result of exposure to CO while holding onto the slotted teakwood swim platform of a moving Master Craft ski boat. She was "teak surfing" on the platform with two others who became

symptomatic and got into the boat. She stayed on the platform, and her hands became caught in the slots between the boards. She lowered her head, and ultimately slipped from the platform. Her body was recovered 16 hours later. Her COHb was 64.1%. (Source: parent of the girl and autopsy records) **Propulsion engine exhaust**

In October 2001, an 11-year-old boy wearing a personal floatation device lost consciousness while being towed behind a 1989 20' Cole pleasure craft with a jet drive engine. Two children had been wakeboarding earlier. After finishing, they began heading back to their camp, the boys both holding onto the transom swim step, with the boat traveling at idle speed. The victim's head was within 36 inches of the engine's starboard side exhaust pipe when he was overcome. He was retrieved from the water, placed in the boat, and traNsported to the launch ramp where he was treated by first responders. His COHb was 12% after over 100 minutes of oxygen therapy. (Source: Imperial County Sheriff's Office Boating Safety and Enforcement accident report) **Propulsion engine exhaust**

In August 2001, a 17-year-old girl was being dragged directly behind a 22' 1998 Ultra Stealth ski boat powered by an inboard jet-propulsion engine. She was being towed on the Colorado River. The operator motored upriver at approximately 5-10 mph and the victim was holding onto the port side transom handle which put her body right behind the engine's port side exhaust terminus. Her upper torso was on the swim platform. There were four people on the back of the boat; the victim was in the middle. They were pulled for approximately 100 yards before they began to fall off the transom platform into the water, one at a time. The other three transom-riders emerged from the water, but the victim did not. None of the three surviving transom-riding passengers reported symptoms related to CO exposure (thus, no disorientation, HA, nausea, or dizziness). The victim's body was recovered the following day. Her COHb level was 41%. (Source: Personal communication, County sheriff's department of two of the three counties involved in recovering her body and investigating the incident) **Propulsion engine exhaust**

California - Discovery Bay

In June 2000, a 6-year-old girl who was either standing on or holding onto the swim platform at the rear of a 1992 Malibu 19.5' ski boat with an inboard engine for about 20 – 25 minutes when she lost consciousness and fell into the water. The boat was traveling at idle speed (about 5 miles per hour) during the time that she was on the platform. She was described by a witness as "getting sick as she was riding on the platform". She lowered her head into the water, released the platform, and sank. Her body was found in 12 feet of water. Her COHb concentration was 61%. (Source: A series of articles from area newspapers) **Propulsion engine exhaust**

In August 2002, an 8-year-old boy was poisoned while riding on the slotted teakwood swim platform of a 2000 Master Craft Model 205 ski boat. He lost consciousness after the boat traveled a short distance. Boat occupants raced him back to the shore. He was still unconscious on arrival. He had no pulse, no respiration, and did not respond to stimulus. When EMS responders provided oxygen therapy, he responded by crying. He was air lifted to a nearby hospital with a hyperbaric medicine department., and then transported again to Children's Hospital. (Source: Contra Costa Law Enforcement and Water Patrol) **Propulsion engine exhaust**

California - Folsom Lake

In May, 2003, an 11-year-old boy died as a result of CO poisoning while teak surfing behind a Calabria ski boat. As the group he was with made their way back to shore, the boy climbed into the water and grabbed the right-hand side of the swim deck, as he had done many times before. Two other children were also teak surfing, one on either side of the victim, and one of the children's parents watched them from the back of the slowly moving boat. After approximately five minutes, the victim slipped beneath the water. Four adults immediately dived in to look for the boy, but were unsuccessful. His body was recovered the following day. (Source: The Sacramento Bee newspaper) **Propulsion engine exhaust**

California – Lake Berryessa

In July 2004, a 23-year-old female lost consciousness as a result of CO poisoning while sitting on the swim platform of a 2004 Malibu Wakesetter ski boat. The boat was moored during a busy holiday weekend near the Pope Creek Bridge, with the propulsion engine idling to charge the boat's battery. She was transported to a local hospital where she was treated for CO poisoning. (Source: Napa Valley Register newspaper, Napa County Sheriff's Department) **Propulsion engine exhaust**

California – Pacific Ocean, Coyote Point Recreation Area

In January 2004, a 28-year-old man was found floating face down behind a speedboat after having been witnessed to be working on the boat at the marina shortly before he was found in the water. He was thought to have been in the boat, lost

consciousness, falling into the water. Autopsy revealed that his COHb was nearly 100%, and 92% on second analysis. (Source: News clipping located by US Coast Guard, autopsy records) **Propulsion engine exhaust**

California – Pacific Ocean, Ballena Bay, San Francisco Waterfront

In April 2004, three people sitting in an open 1940 44' Stevens powerboat survived CO poisoning. The boat was returning to Ballena Bay after leaving the Opening Day on the Bay parade along the San Francisco waterfront. The victims had enjoyed the parade from the open cockpit. There are no engine exhaust leaks within the vessel and the exhaust was diverted underwater at the stern. Apparently, the wonderful weather enjoyed on parade day with little or no wind had resulted in the exhaust fumes trailing the boat and filling the cockpit. Trouble only became apparent when it was realized that one of the boat occupants thought to be napping was actually unconscious. Two men and a woman were sent to the hospital, two via ambulance, and the third under his own power. The men spent the night in an Oakland hospital, and the female was able to return home after a few hours. As a result of these poisonings, a CO alarm was to be installed in the open cockpit.

California - Shasta Lake

In September 2001, a 62-year-old man was swimming near his 1976 22' Sea Ray cabin cruiser boat with an inboard/outboard engine. He was talking with his wife who was on the boat. The boat was not moving, but the propulsion engine was operating at the time, being used to charge the boat batteries. The man went to the swim platform at the rear of the boat to rest While resting for approximately 1-3 minutes, he started splashing water at his wife. His eyes then became fixed, and he lost consciousness. His wife tried to pull him from the water, but couldn't. His body drifted from the boat to a nearby island. Initial forensic toxicological testing upon autopsy indicated that his COHb concentration was 89.3%. The test was repeated, this time indicating a COHb concentration of 80.8%. (Source: Family member, Shasta County Coroner records, and Shasta County Sheriff investigative records) **Propulsion engine exhaust**

In February 2002, 2 men (ages 51 and 52) were poisoned (one fatally) while occupying a moving 1981 19' Marlin pleasure craft. The men were fishing with downriggers, trolling at a very slow speed. The 200 horse power propulsion engine was new, operating well with no mechanical problems. Engine exhaust exited in the water. There was no wind during the incident. The man that survived remembered seeing the second passenger at the stern of the boat leaning over adjusting a downrigger, but then the survivor lost track of events. When he again became aware of his surroundings, the survivor realized that the other passenger's head was resting on the gunnel area at the back of the boat. The second passenger was unresponsive at this time. The survivor administered CPR, called 911, and motored the boat to shore where EMS responders treated the second passenger, but were unable to resuscitate him. Initial investigators assumed that the man died of a heart attack. On autopsy, his COHb was found to be 68%, and his cause of death was CO intoxication. (Source: Shasta County Sheriff and Coroner records) **Propulsion engine exhaust**

California - Unspecified water body

In 1997, the operator of an open motorboat was cruising at approximately 5 miles per hour with his two children sitting on the swim step. The children were overcome by exhaust. Both were taken to the hospital for treatment – one needed oxygen therapy. (Source: US Coast Guard Database) **Propulsion engine exhaust**

California - Unspecified water body

In 2003, a child sitting on the swim step of a 2001 Sanger boat was overcome by CO, but survived. The boat was moving slowly through the water while she sat with her feet in the water to cool off. (Source: Interview with the child's mother) **Propulsion engine exhaust**

Connecticut - Candlewood Lake

In August 2001, a 15-year-old boy who was being pulled behind a ski boat while holding onto both the metal handle attached to the transom and the slotted teak wood swim platform. According to the investigator reporting the incident, the boy began to have problems with his bathing suit after being towed for an estimated 10-15 minutes. He released the platform, floated briefly, lost consciousness and sank (he was not wearing a personal floatation device). His body was recovered several hours later. His COHb measured during the autopsy was 56%. (Source: Law enforcement officer investigating the incident) **Propulsion engine exhaust**

Florida – Longboat Key

In October 1999, four people survived CO poisoning outside the cabin area of a cabin cruiser boat. A family of five was boating from their home to a nearby restaurant, with all passengers seated outside the cabin area. They traveled in a no-wake zone for 10-15 minutes, after which one adult passenger collapsed. Within a few minutes, the two children (ages 8 and 10) on board said they were ill. When another adult passenger became ill, they decided to return to dock. The air

conditioner was on in the cabin. The cabin door was open, and the forward hatches were closed. All the canvas was down, and the vent window on the forward windshield was open. The only canvas that was up was a bimini. When they got back to the dock, the children were in convulsions and the younger one was throwing up. When one of the symptomatic adults ran to call for assistance, she collapsed. All had suffered CO poisoning. (Source: The boat owner and operator.)

Florida - St. John's River

In May 2000, an 8-year-old boy died from CO poisoning while he was on or near the swim platform of a 1997 pleasure motorboat. The boat was anchored in the river, and the onboard generator was operating, with exhaust discharging to the rear of the boat in close proximity to the platform where the boy was positioned. The boy disappeared from the platform. His body was later found in the water. The autopsy revealed that the boy's carbon monoxide blood concentration was 34.8%. (Source: Law firm representing the family of the boy.) **Rear-directed generator exhaust terminus**

Georgia - Lake Hartwell

In July 1998, a 21-year-old man was wakeboarding behind a 1980 19' Correct Craft Ski Nautique ski boat with a 200 horse power propulsion engine. When he finished, he grabbed onto the teakwood swim platform and rode along behind the slowly moving boat. Passengers asked him to get up into the boat, but he refused. He then disappeared from the platform and drowned. His COHb was listed as 37 to 41%, and his cause of death was listed as asphyxia due to drowning. (Source: Friends of the victim, coroner records, and State of Georgia Boating Accident report) **Propulsion engine exhaust**

Georgia - Lake Thurmond

In June 2002, a sister and brother (aged 2 and 4 respectively) were poisoned while sitting on the swim platform of a stationary Mastercraft ski boat while the inboard stern drive propulsion engine operated at idle. The children sat on the swim platform only as long as it took for a parent to don a ski vest. The girl lay in a prone position so that she could kick the water. In less than one minute, she became unconscious and unresponsive. Her father, a physician, observed that she had a pulse, but was not breathing. Rescue breathing was performed for approximately 15 to 20 assisted ventilations. She then resumed breathing on her own. Thirty-five minutes after the incident, she was treated with oxygen and transported to a local hospital. Her COHb was 14.3% nearly 3 hours after exposure. Back-calculations suggested that her COHb at the time she lost consciousness was 50 to 75%. Her brother was removed from the swim platform during the initial resuscitation of his sister, and was monitored by friends while his sister was transported. During this time, he complained of a severe headache, vomited, and fell asleep. He was then also transported to the hospital for evaluation. His COHb was 10.1% approximately 4 hours after his exposure. Back-calculations suggested that his COHb was 18 to 21% at the end of his exposure. (Source: Centers for Disease Control Morbidity and Mortality Weekly Report, September 20, 2002, 51:37;829-830**)** **Propulsion engine exhaust**

Idaho - Lake Pend Orielle

In June 2002, a 61-year-old man was poisoned as he fished from the back of a slowly moving 2000 Bayliner Sierra Sun Cruiser 2855 cutty cabin boat. He was standing on the back open deck of the boat as it moved slowly through the water, when he lost consciousness as a result of CO poisoning. His COHb was 22% when measured at the hospital. (Source: Augusta Chronicle newspaper article 10/6/2002; interview of victim; Boating Accident Report) **Propulsion engine exhaust**

Louisiana - Belle River

On Labor Day, 2000, a 25-year-old man was being pulled behind a 1999 Mastercraft Prostar 205 ski boat, riding the platform in an activity described as "teak surfing". The boat was traveling at approximately 5 miles per hour, having traversed a distance of 1 to 1.4 miles. The person reporting this death stated that the man was "there one minute, and gone the next". The man's body was recovered the next day. (Source: Personal communication from a friend of the victim; Coast Guard database) **Propulsion engine exhaust**

Michigan - Clark Lake

In July 2001, 3 children aged 11, 13, and 13 were poisoned while "body surfing" behind a slowly moving (5 mph) Master Craft 19' 1997 ski boat powered by an inboard engine. Within 5 minutes of the 11-year-old deciding to join in on the activity, adults noticed that she had let go and was floating face down in the water. She sank in 8 feet of water. When she was pulled from the bottom of the lake into the boat (3 – 6 minutes later), she was not breathing, but had a pulse. Her mother, a registered nurse, started rescue breathing with the child spontaneously breathing again after approximately 5 minutes. After treatment with oxygen for approximately 45 minutes, her COHb was 35.2 %. The other two children also experienced symptoms of CO poisoning. One of the two had a COHb concentration of 14.7% after 2 ½ to 3 hours of

oxygen therapy. (Source: Investigative records of the Brooklyn/Columbia Police Department, State of Michigan Water Accident Report, parent of one of the children) **Propulsion engine exhaust**

Minnesota – Mississippi River near Brainerd

In May 2000, a 4-year-old boy survived CO poisoning while occupying the rear platform of an unspecified ski boat. "The kids used to hang behind this platform while dad towed them with the ski boat. But one day when he called for his son to get out of the water, there was no response." The boy was unconscious, had stopped breathing, and had no discernable pulse. Emergency responders transported him to a local hospital where he was treated for CO poisoning in a hyperbaric chamber. His COHb prior to hospital treatment was 29.6%. (Source: Fox News in Denver and Minnesota) **Propulsion engine exhaust**

Nevada - Lake Mead

In August 1997, a 7-year-old child lying on a personal water craft with her face next to the exhaust port was poisoned as the craft moved across the water. She lost consciousness and was unable to respond to EMS personnel. She recovered after treatment with oxygen, and was transported to a local hospital. (Source: Review of NPS EMS records) **Propulsion engine exhaust**

In June 1996, a 66-year-old man was poisoned as he worked on the inboard engine of an unspecified type of pleasure craft. While working, he began to feel dizzy, but did not lose consciousness. He was diagnosed as having CO poisoning by the responding flight for life nurse, but refused treatment or transport. (Source: Review of NPS EMS records) **Propulsion engine exhaust**

New York - Otisco Lake

A 16-year-old girl bathing off the stern of a recreation open bow motor boat (1981 Crestliner 17' pleasure craft) died from CO poisoning. The boat was in the center of a freshwater lake. The boat engine was operating because the girl's swimming partner had asked other boat occupants to activate it to warm the water where they were swimming behind the boat. After swimming for approximately 10 minutes her partner felt tired and cold and got back into the boat. As he looked back at the girl still in the water, he noticed that she put her head in the water, and then disappeared. He thought she was taking an underwater dive, but became alarmed when she didn't resurface. Her body was found five days later, 50-feet deep in the water. The autopsy revealed a carbon monoxide blood concentration of 62%. Testing of the boat conducted after the death revealed that CO was present in concentrations of 100 ppm in the air several inches above the water level at the stern when the engine idled for 8 minutes. The largest accumulation of CO was at the stern just above water surface as well as at the transom. (Source: Peer-reviewed publication – Jumbelic MI [1997]. Open air carbon monoxide poisoning; personal communication with Dr. Jumbelic.] **Propulsion engine exhaust**

North Carolina - Unspecified water body

In 1990, a person being pulled behind a 1976 Correct Craft boat powered by a 220 HP inboard gasoline-powered propulsion engine survived CO poisoning that occurred as a result of proximity to the exhaust of the boat. (Source: US Coast Guard data) **Propulsion engine exhaust**

Ohio - Lake Sylvan

In August 2000, an 11-year-old girl was riding on the swim platform of a 21' inboard Malibu ski boat with two friends who were near her age. The boat was moving slowly (operating under 10 miles per hour) while the children lay on their stomachs on platform with their legs dangling in the water. The weather was calm and clear. The girl began to lose consciousness, falling from the boat, grabbing the ankle of the child next to her as she went. The third child on the platform dove into the water to try and save the other two, as did another boat passenger. The 11-year-old girl disappeared from view and drowned. Her COHb was 50%. (Source: Ohio Division of Water Craft records; Coast Guard database) **Propulsion engine exhaust**

Oklahoma - Keystone Lake

In 1984, 2 children were being pulled behind a Correct Craft ski boat in an activity described as in records "body surfing" behind the boat, very near the propulsion engine. One of the children became nauseous. The second girl (a 12-year-old) put her head down for a minute, and then lifted it up. Her eyes then rolled back, and she let go of the boat. She sank immediately without struggle, and drowned. Because the second girl had become ill and nauseous, investigators began to suspect that the cause of both girls' symptoms could be CO poisoning. The fatal victim's COHb was 64%.

(Source: Death certificate, deposition of county medical examiner, medical records, and legal filing) **Propulsion engine exhaust**

Oregon – Lost Creek Lake

In April 2004, a family of 5 (3 children, the father who was operating the boat, and the 34-year-old mother) riding in an open pleasurecraft powered by an inboard/outboard engine exhibited symptoms of CO poisoning while the boat was underway. Foul weather had caused the operator to put the canopy up on the boat. The mother was sitting outside the canopy near the engine while the boat was underway, and lost consciousness. The boat operator called for emergency assistance. The operator, who was sitting under the canopy was not as ill. Only the mother was tested for COHb concentration and treated for CO poisoning. She was placed on 100% oxygen for 6 hours. According to the mother, it took several days for the children to recover from their exposure. (Source: Jackson County Sheriff Department Investigative report, personal communication from the investigative officer) **Propulsion engine exhaust**

Oregon - Unspecified water body

In 1996, two children (aged 7 and 10) were poisoned while at the back of an open motorboat. Victim 1 was instructing Victim 2. After trying unsuccessfully to kneeboard, Victim 2 got back in the boat complaining of feeling sick and dizzy. Victim 1 remained at the back helping another person get ready to ski. Victim 1 then fell into the water, face down, and began drifting away from the boat. When Victim 1 was recovered, she was blue and her hands and arms were crumpled. She was foaming at the mouth and nose, and having seizures. Victim 2 jumped into the water to get the kneeboard that Victim 1 had left behind. When Victim 1 jumped into the water, she had a seizure and passed out. Both were wearing PFDs. (Source: Coast guard database) **Propulsion engine exhaust**

Tennessee - Ocoee Lake

In June 1995, 3 girls were being towed at idle speed behind a 19' Malibu ski boat powered by a 1993 Mercruiser 5.7 liter engine. They were holding onto the swim board attached to the boat transom. One of the girls (a 16-year-old) was wearing a n adult-sized extra-large Type III personal flotation device (PFD) with the top of three buckles unfastened. She commented to the others that she did not feel well. Just after making that statement, she lost consciousness, let go of the deck, slipped out of the PFD, drifted about two feet, and sank. Her body was recovered in 95' feet of water two days later. Her COHb concentration was 62%. (Source: Tennessee Boating Accident Investigation Record) **Propulsion engine exhaust**

Tennessee - Old Hickory Lake

In 1997, a boat operator paused to pull in the ski rope when a skier had finished skiing. The children in the boat were hot, so they were allowed to jump in the water while they paused there. The propulsion engine was not deactivated because the stop was going to be so brief. One of the children sat on the swim platform for "less than 2 minutes" prior to getting back in the boat. She called out for her mother, looked up, and then lost consciousness. She then went into a seizure, stopped breathing, and turned blue. She was wearing a life jacket, so her mother was able to pull her from the water and get her into the boat, initiating resuscitation efforts. Her family transported her to the hospital. (Source: WSMV television interview, Nashville TN) **Propulsion engine exhaust**

Texas - Lake Travis

In June 2001, a 28-year-old woman was in the water with her arms propped on the swim platform while the boat's engine was operating. Within minutes, friends noticed that the woman was missing. Her body was recovered approximately five hours later. Her COHb was 53%. (Source: Abstract prepared by Brad Hall and others, Travis County Office of the Medical Examiner) **Propulsion engine exhaust**

Utah - Bear Lake

In July 1996, a 10-year-old passenger on a 17' Master Craft boat with an inboard/outboard engine was poisoned while sitting on the swim platform while the engine was running. She was resting on the platform that was three to four inches above the exhaust ports. When other passengers noticed that she was getting sick, they helped her into the boat. She then lost consciousness. She was transported to a nearby hospital, where she was treated for CO poisoning. (Source: US Coast Guard Database; Utah Division of Parks and Recreation Incident/Accident Report) **Propulsion engine exhaust**

In August 1995, a 19-year-old passenger of a 19' 1994 Malibu Echelon open motorboat with an inboard gasoline engine was found lying in the open boat conscious, but very weak with numb legs. The boat was out of gear drifting with the engine operating. He was on the back of the boat when he lost consciousness. When emergency responders found him,

he could not stand long enough to exit the boat. He was transported by ambulance to a nearby hospital, where he was treated for dehydration and released. He experienced a "second seizure" later in the evening. He was then taken to a

second hospital, where he was diagnosed with and treated for CO poisoning. The record states that he nearly died. (Source: Utah Division of Parks and Recreation Incident/Accident Report) **Propulsion engine exhaust**

Utah - Great Salt Lake

- In October 1995, the 23-year-old operator of a brine shrimp barge experienced "motor problems". No information is provided about the specific type of motor. He was exposed to CO for approximately 10 minutes when he began to experience a headache. He experienced nausea and lost consciousness three times. Responders treated him with oxygen, and transported him to a nearby hospital for further treatment. (Source: Utah Division of Parks and Recreation Incident/Accident Report) **Unspecified engine exhaust**

Utah - Hyrum Lake

- In July 1998, 2 children aged 7 and 9 were poisoned while swimming near a 1996 24' SeaRay boat. The boat's propulsion engine was idling while the children swam. One of the children collapsed while trying to climb up the boat ladder and fell back into the water. The second child became ill while in the water. They both had to be helped back into the boat where they were laid on the floor of the boat. They were transported to a nearby hospital emergency room for treatment. (Source: Utah Division of Parks and Recreation Incident/Accident Report) **Propulsion engine exhaust**

Utah - Unspecified water body

- In 1996, a 10-year-old passenger sat on the swim platform of a pleasure craft while the inboard propulsion engine was operating and was poisoned. (Source: US Coast Guard Database) **Propulsion engine exhaust**

- In 1997, a 25-year-old water skier was poisoned as she was preparing to ski. (Source: US Coast Guard Database) **Propulsion engine exhaust**

Washington – Lake Tapps

- In August 2003, a 21-year-old girl slipped from the swim platform on a ski boat, and drowned. According to the parents, she and others had been swimming from the boat which was stationed about 50 feet from the dock.. She and others were offered a ride (pulled by the ski boat). The boat slowly headed back, traveling about half the distance to the dock, when she "sleepily" let go, and went under without a struggle. The cause of death was drowning due to carbon monoxide poisoning. Her COHb was 52%. (Source: Pierce County Medical Examiner, news articles, correspondence with parents) **Propulsion engine exhaust**

Washington - Unspecified water body

- In 1995, an occupant of an open motorboat powered by an outboard engine was poisoned while in the water. The victim tried to untangle a ski rope from the engine propeller while the engine was operating. The person climbed back into the vessel, but said he was dizzy. He then dove back into the water, became unresponsive, and floated towards the front of the vessel where he sank. His body had not been recovered when the report was submitted. (Source: US Coast Guard Database) **Propulsion engine exhaust**

Washington – Lake Washington

- In July 2004, a 4-year-old lost consciousness as a result of CO poisoning on the swim step of her family's ski boat. The victim and friends were jumping off the boat into the lake about 200 yards from the dock. The victim, who was wearing a personal floatation device, was sitting on the swim step at the back of the boat, near the exhaust as the boat idled. A companion saw the victim slumped over and alerted her father, who began resuscitation and yelled for someone to call 911. Responding EMS personnel arrived within 4 minutes, treated the victim, and transported her to a local hospital. She was then transferred to a hyperbaric medicine department in another hospital for further treatment. The parents had boated for 15 years, and were surprised that someone could succumb to CO poisoning while outside on a boat. (Source: King County Journal newspaper) **Propulsion engine exhaust**

III. CO Poisonings within the Cabin of Houseboats

3 CO-Related Fatalities in this Category ***178 Non-fatal CO Poisonings in this Category***

New information (post October 2004 update)

Tennessee – Dale Hollow Lake

In August 2004, 15 people (9 adults and 6 children) survived CO poisoning while sleeping in the living quarters of a Lakeview 72' 2002 houseboat. The boat occupants felt sick and sleepy throughout the night. Some were hard to awaken in the morning when Emergency Medical Service personnel were summoned. The vessel was moored with the port stern to the wind, with no windows or doors open as the generator operated through the night. The vessel was inspected by Coast Guard officials who found a gap in the bulkhead that should have been sealed, and also a generator exhaust pipe that was not large enough. Reportedly (unconfirmed) 2 of the boat occupants were hospitalized for 4-6 weeks, and one may have brain damage as a result of this CO poisoning incident. (Source: USCG BARD, Tennessee Wildlife Resources Agency Boating Accident Report) **Generator exhaust**

Arizona/Utah - Lake Powell – for more information about the Lake Powell poisonings, please see other publications listed on the website.

(80) Since 1990, 80 people have been overcome by CO poisoning while occupying the living quarters of houseboats on Lake Powell. All of these poisonings were associated with exposure to generator exhaust, and all people survived. (Source: Review of NPS EMS Records, Glen Canyon National Recreation Area) **Generator exhaust**

California - The Delta, Stockton

In June 1999, 11 people (9 boat passengers, a medical technician, and a deputy) survived CO poisoning on a houseboat anchored in Dredge Cut. The source of CO was a propane-powered generator. The emergency medical technician and a fellow deputy became poisoned as they worked to diagnose the problem and evacuate boat occupants. No other details were available from the newspaper article covering the incident. (Source: San Francisco Examiner, Saturday Jun 19, 1999) **Unspecified generator exhaust terminus location**

California - Pacific Ocean, San Rafael

In November 2002, 2 people (ages 54 and 71) died while watching a video aboard a moored 41' Deutschland houseboat. The boat was in a covered-birth area of the San Rafael marina, and there were high winds due to a storm. The generator was operating to provide electrical power. Apparently, the high winds caused the generator exhaust to come back aboard the boat. Firefighters summoned to the scent found the CO concentrations to be seven times the lethal amount. (Source: Nevada State Boating Law Administrator, news clippings from *Northern California* newspaper Nov. 22 – Dec 5, 2002 and from an unidentified newspaper) **Unspecified generator exhaust terminus location**

Georgia – Lake Lanier

In May 2004, 8 people spending the night on a houseboat on Lake Lanier were treated for carbon monoxide poisoning. The Forsythe County Fire Department stated that the occupants were sleeping on one of several houseboats tied up near an island on Two Mile Creek. Carbon monoxide detectors on the houseboat did not alarm (cause unknown). However, CO alarms from nearby houseboats went off awakening the passengers of the boat and surrounding boats. Most of the 8 people were reportedly sleeping in the cabin but decided to come up on deck to get some fresh air, with several losing consciousness on deck. The generator was reportedly running until 4 a.m. when the boaters went to bed. The location of the generator exhaust terminus is unknown. All were treated on site with oxygen and 3 were admitted to a hospital (two in critical condition) for hyperbaric treatment. Reported COHbs were 10%, 30%, and 40% for the 3 hospitalized patients. (Source: News clipping forwarded by US Coast Guard; further detail provided by the National Center for Environmental Health and the US Army Corps of Engineers) **Generator exhaust**

Illinois – Lake Michigan

In September 2002, a person died of CO poisoning (COHb of 51%) while attempting to repair the inboard engine of a disabled 1981 Marianette cabin cruiser. The engine and muffler had failed, allowing lake water to fill the bilge compartment and subsequently the boat sank. (Source: US Coast Guard database) **Propulsion engine exhaust**

Kentucky - Dale Hollow Lake

In April 2000, 11 people were poisoned inside the houseboat they were occupying. One person lost consciousness, and 9 children experienced vomiting and extreme headaches. They ran the generator during the nights while they slept. They were told at the hospital that this was the second time this year that his had happened at this lake. (Source: Lake-Times News, May 1, 2000; personal communication – e-mails from victims) **Unspecified generator exhaust terminus location**

Kentucky - Lake Cumberland

In June 2000, 15 people, ages ranging from 16 to 47, were overcome by CO on two rented houseboats. One of the houseboats was a 3-month-old 77-foot Stardust. The other boat was manufactured by Horizon. The boats were tied together and anchored in a cove. Both boats had gasoline-fueled generators; the generator on the Stardust boat was marina installed with side-directed exhaust terminus. The exhaust of one of the generators seeped into the adjacent boat through an open bathroom window. CO was circulated through the full interior of the boat by the central air-conditioning system. Boat occupants who awoke at about 5 a.m. had headaches and were nauseous. Realizing they had a problem, the group radioed the marina and ambulances met the boats at the shore. The Kentucky Water Patrol Officer that responded to the emergency witnessed that two occupants were unconscious when he arrived, and others were drifting in and out of consciousness. All 15 people were treated at the emergency department of a nearby hospital; three were admitted as hospital inpatients for further treatment. There were six carbon monoxide detectors on this boat, but none

were properly connected when the boat was inspected after the poisoning incident. Boat occupants initially denied disconnecting the detectors, but later took responsibility for that act and ignoring warnings. (Source: News articles from an unspecified newspaper, further details from a Stardust Cruisers, Inc. representative) **Side-directed generator exhaust terminus**

Kentucky - Laurel Lake

In June 1996, 17 people (six adults and 11 children) were roused in the early morning only when a passenger heard her 20-month-old son vomiting. As the mother tried to get to her son, she could hardly move. Gradually, she arose, wakened the remaining passengers who reported feeling drowsy, sick, and wracked by headaches. All passengers were diagnosed as having CO poisoning, with CO blood levels ranging from 3 to 17 percent. One passenger was hospitalized, and the others were treated with oxygen and released. The victims were on a rented 72-foot houseboat that had a gasoline-powered generator that was operating at the time of the poisonings, and had been operating through out the night. There were no CO detectors on the boat. (Source: Lexington Herald-Leader, Stephen Trimble. Found in an internet search, no date listed on the article.) **Unspecified generator exhaust terminus location**

Minnesota - Namakan Lake, Voyageurs National Park

In June 2002, 5 people were poisoned while sleeping overnight in the cabin of a houseboat. When National Park Service Rangers reached the boat, they found five people vomiting, semi-conscious, and demonstrating signs and symptoms of CO poisoning. The passengers were treated with oxygen, and transported to waiting ambulances. A propane furnace and portable generator had been operating overnight while the occupants slept. The boat's CO detector was not functioning, and boat windows were closed . The wiring to the CO detector was routed to a battery source behind the kitchen drawer. Wiring became disconnected due to repeated opening and closing of the drawer. As a result of this incident, the company that manufactures the houseboat immediately conducted an inspection of all houseboat CO detectors. (Source: National Park Service press release) **Generator and propane stove exhaust**

Missouri - Table Rock Lake

In July 2000, 8 people were poisoned on a houseboat rented from Tri-Lakes Houseboat Rentals. Records related to this incident indicated that the County Fire Department measured "high levels of CO on the stern deck of the boat and in the engine compartment while the generator was running." They also checked inside the passenger area of the boat, and found "levels were higher than normal when the back door of the boat was open." The wiring to the CO detector on board the houseboat had been cut at some point, and the CO detector was not functioning at the time of this incident. The CO detectors were not routinely checked on the boats. It is not clear from this report where the poisoned occupants were when the onset of symptoms occurred. It is assumed that some of the victims were on the stern deck because the report refers to measurements in that area. However, the number of people poisoned indicates that the exposure may have occurred inside the boat. (Source: Missouri Department of Public Safety, Missouri State Water Patrol Accident Investigation Report) **Unspecified generator exhaust terminus**

Nevada - Lake Mead

In November 1996, a 35-year-old man working on a houseboat "in a confined space for 7 hours" and exposed to "noxious fumes" experienced headache, nausea, vomiting, dizziness, light-headedness, and difficulty walking was assessed as having CO poisoning and transported by air to a local hospital. (Source: Review of NPS EMS records) **Unspecified generator exhaust terminus**

In October 1997, a 51-year-old woman was asleep in the rear cabin of a houseboat when the CO alarm sounded, awaking her and others on the boat. The woman lapsed into unconsciousness and also suffered from nausea. She was transferred to a hospital for treatment. Records indicated that two houseboats were tied together, and that both boats were operating their generator. (Source: Review of NPS EMS records) **Unspecified generator exhaust terminus location**

In July 2000, 4 occupants of a houseboat were poisoned while sleeping in the rear cabin. The on-board generator was operating at the time of the poisoning. An inspection of the boat indicated that plumbing holes in the floor of the adjacent bathroom allowed CO to enter the sleeping area. In addition, it was also noted that the exhaust for the generator was close to the cabin's rear area. Inspectors suggested that the exhaust be moved closer to the rear of the boat. (Source: Review of NPS EMS records) **Side-directed generator exhaust terminus**

Tennessee - J. Percy Priest Lake

In November 2001, 2 people (ages 31 and 37) survived CO poisoning while sleeping in the cabin of a 1973 43' Nauta-Line houseboat. At the time of the incident, four boats were rafted together with generators operating all night. The boat on which people were poisoned was in the middle. The two victims did not appear in the morning, and were found in the boat. They were transported to a nearby hospital, where their COHb concentrations were measured to be 18.6 and 24.3%. Investigation of the incident indicated that there was a leak in the generator exhaust system due to a broken gasket. (Source: Tennessee Boating Accident report) **Unspecified generator exhaust terminus location**

IV. CO Poisonings within the Cabin or Canopy of Cabin Cruisers or Other Boats

33 CO-Related Fatalities in this Category ***112 Non-Fatal CO Poisonings in this Category***

New information (post October 2004 update)

California – Shasta Lake

In January 2005, a 58-year-old man died from CO poisoning inside a Bayliner 25' 1986 cabin cruiser boat. He was found unresponsive lying on the floor of the boat that was moored at a slip at the Bridge Bay Marina. The boat was covered in canvas for the winter, with covers that were open a few inches only at the back end of the boat. The boat's propulsion engine was operating. He was lying partially under the driver's seat, with legs in the step down to the sleeping quarters. There was a strong smell of exhaust, especially in the sleeping area. The body was found by marina staff when the victim's wife called to check on his whereabouts. According to the Medical Examiner, his measured COHb of 27% is below what is usually considered fatal for an adult. There was thought to be an element of asphyxia (oxygen deprivation) involved in his death as well, as the engine kept running while the victim was inside the canvas covers, likely causing the oxygen to be replaced by carbon dioxide as well as CO. (Source: News clipping on the internet; Coroner report) **Propulsion engine exhaust**

Florida – Lake George Inlet

In June 2005, a 36-year-old man and his 35-year-old wife died of CO poisoning while inside a Chaparral 23' cabin cruiser. The couple's boat was moored near a second boat; both boats' generators were operating to power the air conditioners. When the victims' generator ran out of gas at about 10:00 am, the second couple opened the door and found the occupants' bodies. When emergency workers entered the cabin, they found high concentrations of CO. Autopsy results revealed that the husband's COHb was 75.2%; the wife's COHb was 77.2%. (Source: The News-Press; Coroner's report; press release from Florida Fish and Wildlife) **Generator exhaust**

Maine – Atlantic Ocean

In June 2005, a 74-year-old man survived CO poisoning inside a sailboat. The Rockland Police Department was dispatched to the harbor because a 27' sailboat was found adrift. The boat was spotted just past the breakwater, off Owl's Head Shore. As the police approached the boat, a pair of legs were noticed protruding from the bulkhead. Upon investigation, they found an elderly male disoriented, unable to sit or stand. He had evidently been overcome by CO from engine exhaust in the cabin. He was pulled out onto the deck and EMS and USCG were summoned. The victim was transported to a nearby hospital. (Source: Internet news search; Rockland Police Department)

New Mexico – Elephant Butte Lake

In July 2004, a man (aged 33) and a boy (3) survived CO poisoning inside the cabin of a Larson cabin cruiser . Exhaust leaked into the boat cabin where they were found unconscious. The victims were revived and transported to hospital for treatment. (Source: USCG BARD; NM State Parks Division)

Wisconsin – Mississippi River

In June 2000, two men (aged 19 and 22) died from and one survived CO poisoning while sleeping inside a 31' cabin cruiser. The three victims were sleeping inside a moored boat. A leaky generator was thought to be the cause of the poisonings. (Source: Minnesota Daily Newspaper) **Generator exhaust**

Alabama – Mississippi Sound South of Bayou La Batre

In June 2003, a man and woman were found dead in the cabin of a drifting ommercial shrimp boat. The captainless boat was discovered by a passing commercial fisherman who boarded the boat and found the bodies. Carbon monoxide poisoning was the cause of death. It was speculated that the two died from exhaust from the engine that is often located directly below the wheel house. (Source: Mobile Register newspaper, confirmation of the cause of death from the Alabama Department of Forensic Sciences)

Arizona/Utah - Lake Powell – for more information about the Lake Powell poisonings, please see other publications listed on the website.

Since 1990, 1 person has died of CO poisoning while riding inside an enclosed area of a pleasurecraft (not a houseboat) on Lake Powell. On May 5th, 1995 two occupants of a disabled vessel called for assistance. They joined the two occupants ``of the assisting vessel, the boat described above, while the disabled vessel was in tow. The tow was initiated at approximately 7:20 p.m. with one person at the helm, and the three other passengers seated in the boat's canopied cabin. Within an estimated five minutes, all passengers were overcome by carbon monoxide from the engine exhaust. The vessel continued to run until all the fuel in the 60-gallon tank was consumed. The boat was found on May 6th at 9:22 a. m. in a resting position on shore. The person at the helm had no pulse and was cold to the touch. His COHb on autopsy was 55%. The other passengers, who had begun to regain consciousness at approximately 9:00, were disoriented. They were transported to the hospital for treatment. (Source: Review of NSP EMS Records, Glen Canyon National Recreation Area)

(19) Since 1990, 19 people have been poisoned while in the cabin or within a canopy of a pleasurecraft (other than houseboat) on Lake Powell. Six of the 19 people were poisoned by generator exhaust while inside a cabin cruiser boat during a single incident. The remaining 13 people were poisoned by propulsion engine exhaust. Eight of the 19 people lost consciousness as a result of their exposure. (Source: Review of NSP EMS Records, Glen Canyon National Recreation Area)

California - Unspecified water body

In 1998, 4 people were poisoned while occupying the cabin of a cabin cruiser boat powered by an inboard engine. Three people were above deck and four were below deck. There appeared to have been a ventilation system failure that caused CO to enter the cabin area, sickening all four people below deck. The two most seriously affected were a 7-year-old female and a 4-year-old male. All received medical attention and recovered. (Source: US Coast Guard Database)

Florida - Intracostal Waterway, Duval County

In June 1995, a 54-year-old man went to check out his boat that was docked at its bulkhead. He activated the boat's air conditioner, and left up the canvas and plastic covering that enclosed the top deck. A few hours later, he was found dead. The boat's engines, generator, and air conditioning system were still operating and the boat's CO alarm was sounding. Exhaust from the boat's engines and generator coming in through the rear entry flap of the boat's deck covering had killed him. Testing of the CO alarm indicated that the alarm was miscalibrated and did not go off until almost an hour after it was supposed to. By the time the alarm sounded, the man could no longer help himself. One result of lawsuits related to this case was the discovery that testing conducted by the manufacturer of the CO alarm showed repeated malfunctions of the alarms. Changes in the manufacturing process had allowed contamination of sensitive components of the alarm. According to the manufacturer, the alarm sensor mimics the body's carboxyhemoglobin level over a period of time. There had been a longstanding problem with other gases and fumes contaminating the sensor during the manufacturing process. This would cause the sensor to "drift", which in turn results in miscalibration of the sensor, and faulty alarming. The following information is included in the court's decision:

"The United States Coast Guard and a well-known boating industry organization, the American Boat and Yacht Council (ABYC) went to great lengths to try and educate the boating industry to the potential for carbon monoxide poisoning. For several years prior to the manufacture of this boat, the ABYC developed a recommended standard that went into effect shortly after the decedent's boat was manufactured. However, this recommended standard was widely circulated within the boating industry well prior to the construction of decedent's boat. Further, the boat manufacturer did absolutely no scientific testing to determine if and how carbon monoxide would enter into its boats after they had been constructed. Other problems were that the CO alarm was installed in an area of the boat cabin contrary to instructions in the alarm manual, and was wired directly to the boat batteries which caused the batteries to fail. Further, there were no instructions or warnings given to the decedent about operating conditions in which he would be exposed to hazardous levels of CO. (Source: Pajcic and Pajcic "Profiles and Precedents" biannual report of settlements for the last six months of 1997; and Florida Jury Verdict Reporter, a publication of Florida Legal Periodicals, Inc., Volume XVIII, No. 10, Oct 1997)

Unspecified generator exhaust terminus location, and propulsion engine exhaust

Florida - Intracostal Waterway near Jacksonville

In 1991, a woman died while occupying the cabin of a moving 42' Sea Ray Express cabin cruiser piloted by her husband. She was seated at the table, and her sister was seated near the door. The sea was very rough. When the husband went to the cabin at one point, his wife was ill. They assumed it was sea-sickness due to the rough ride. He returned to the helm. After many miles of returning to the calmer waters of the intracoastal waterway, the sister asked him to return to the cabin. He found his wife on the floor beneath the table, dead. The resulting investigation determined that she died of CO

poisoning. (Source: personal communication with the husband, United States District Court Middle District of Florida Jacksonville Division records) **Propulsion engine exhaust**

Florida – Ocean near Clearwater

In June 2004, three passengers were overcome by CO while traveling in the air conditioned cabin of a 40-foot Wellcraft cabin cruiser. The boat, with nine passengers aboard, left Island Estates at about 7:00 a.m. for a fishing trip. When the boat returned shortly after noon, one member of the group went into the cabin to wake three people who had decided to take a nap. The sleeping boaters could not be awakened. Rescue crews determined that the passengers had suffered CO poisoning. They were transported to the local hospital, and then on to a hospital where they could be treated in a hyperbaric oxygen chamber. One of the three remained hospitalized for several days. (Source: Tampa Tribune newspaper) (NOTE: This case was attributed to diesel engine exhaust in the news article. Clarification about the fuel type for the engine was provided by the US Coast Guard.) **Propulsion engine exhaust**

Florida - Unspecified water body

In 1998, 4 people (ages 6, 9, 10, and 38) survived poisoning aboard a cabin cruiser pleasure craft with an inboard stern drive propulsion engine. The database states that exhaust fumes drifted into the cabin. (Source: US Coast Guard Database)

Maryland - Broad Creek

In 2000, 3 children survived poisoning aboard a cabin cruiser pleasure craft that was rafted with several others. All of the boats were operating their generators for electrical power. There were 3 juveniles asleep in the cabin of one of the vessels with the windows and doors closed. CO had collected in the cabin. When the juveniles were awakened, they were sluggish, unresponsive, and nauseous. (Source: US Coast Guard Database) **Generator exhaust**

Maryland - Main Bay Area

In 2000, the operator of a cabin cruiser pleasure craft with an inboard propulsion engine was poisoned. The operator stated that he had the canopy of his vessel closed. There was no wind, and it believed that the exhaust from the engine collected inside. When the operator began to feel ill, he called for help suspecting CO poisoning. (Source: US Coast Guard Database)

Maryland - Unspecified water body

In 1991, a person aboard a cabin cruiser pleasure craft was poisoned as a result of a loose equipment hose that allowed CO to escape into the cabin of the boat. (Source: US Coast Guard Database)

In 1995, a 13-year-old boy was poisoned while resting in the cabin of a cabin cruiser pleasure craft. He was taken to the hospital after the boat was docked. (Source: US Coast Guard Database)

In 1995, 6 people (aged 8, 8, 14, 15, 35, and 46) occupying a cabin cruiser pleasure craft were overcome by CO and taken to the hospital after the boat was docked. (Source: US Coast Guard Database)

In May 2001, 2 people (the operator and a passenger) were poisoned aboard a cabin cruiser pleasure craft with an inboard propulsion engine. The cockpit was enclosed by side and back curtains, and a back door was open. A "station wagon effect" caused exhaust to be drawn into the vessel. The passenger went into the cabin and was overcome by CO that had apparently accumulated in the lower areas. Both were treated for CO poisoning and released. (Source: US Coast Guard Database)

Minnesota - Mississippi River

In June 2000, two of three people aboard a cabin cruiser pleasure craft died as a result of CO poisoning. The boat was anchored and the boat's generator was operating. The report cites a leak in the muffler, a leak in the sealed cabin to the engine compartment, and a CO detector that was disabled. (Source: US Coast Guard Database) **Generator exhaust**

Minnesota - Unspecified water body

In August 2001, 6 occupants of a 1994 Mainship inboard stern drive cabin cruiser pleasure craft survived poisoning that occurred while they were sleeping. A gasoline-powered generator located in the engine compartment was operating during the night so that the air conditioner could be operated. Some passengers were in and out of consciousness

and vomiting, with symptoms continuing as they exited the cabin. (Source: US Coast Guard Database) **Generator exhaust**

Missouri - Lake of the Ozarks

In June 1999, 4 people (ages 32, 39, 40, and 42) died as a result of CO exposure inside a 40' Silverton Cabin Cruiser that was tied to a dock. A Water Patrol officer found the boat docked at a restaurant, where it had been docked for two days. Lights inside the houseboat were operating and the generator was running. A 40-year-old man and two friends were found dead inside the boat. The man's wife was observed to be breathing when emergency responders arrived, but died shortly thereafter. The cause of death was carbon monoxide poisoning resulting from a rusted generator exhaust pipe that allowed CO to leak into the cabin of the boat. The local fire department measured 272 parts per million of CO inside the cabin door of the cruiser after the victims had been removed from the boat cabin. (Source: Several, including news clips forwarded by Scott Thomsen, AP; News coverage from the Jefferson City News Tribute, Wednesday June 2, 1999; Missouri Department of Public Safety, Missouri State Water Patrol Incident Report Number F99-3410) **Unspecified generator exhaust terminus location**

In September 1998, 6 people were overcome by CO while riding in the cabin of a 1986 36' Carver Cabin Cruiser powered by an inboard/outboard propulsion engine. The boat was traveling at approximately 20 miles per hour with the door to the cabin open when one member of the party informed the pilot that someone was ill. Approximately 30 seconds later, people in the cabin began to lose consciousness. The six passengers overcome by CO exposure were transported by ambulance to a nearby hospital for treatment. (Source: Missouri Department of Public Safety, Missouri State Water Patrol Incident Report Number H98-3710) **Propulsion engine exhaust**

Nevada - Lake Mead

In May 1993, 2 people (ages 35 and 50) were poisoned (one died and one survived) while they slept in the cabin of an anchored (at shore) 25' 1981 Sea Ray Cabin Cruiser. The source of CO was an on-board gasoline-powered generator. No loose fittings or leaks were found. (Source: Review of NPS EMS records) **– Rear-directed generator exhaust terminus**

In May 2002, 3 people (ages 4, 28, and 51) survived CO poisoning while inside a beached 1989 30' Sea Ray cabin cruiser with an inboard propulsion engine and an onboard generator. The boat's generator had been operated for about 7 hours the evening before, and was deactivated at about midnight. At approximately 9:00 am, one boat occupant awoke with a headache and a child work up sick and vomiting. The family believed they were suffering from food poisoning. At about 11:00 am, the generator was activated again to provide power for the air-conditioner and television, and all windows in the cabin of the vessel were closed at that time. About an hour later, one of the boat occupants left the cabin to relax on the bridge. About two hours later, he returned to the cabin to see if the other occupants were ready to return to the marina. He found all three occupants asleep and non-responsive to his attempts to waken them. He deactivated the generator, and called for assistance. He then removed them from the cabin, at which point they were breathing, but still unconscious. They were transported to the hospital for treatment by emergency responders. There was a CO alarm on the vessel, but it had been disengaged the previous year because it "kept going off for no reason". Investigators measured 660 and 1000 parts per million CO in the cabin of the boat shortly after the generator was activated and operated as it had when the people were overcome. (Source: Nevada Division of Wildlife Law Enforcement Bureau investigative report) **Generator exhaust**

In May 2003, three people (ages 8, 31, and 40) survived poisoning while occupying the cabin of a beached 32' 1999 Sea Ray cabin cruiser. The boat occupants were unconscious and unresponsive when recovered, and were in critical condition despite oxygen therapy. None showed any significant response to on-scene EMS treatment. They were transported to a nearby hospital, where all recovered. The source of exhaust was a generator. (Source: Nevada State Boating Law Administrator and US NPS) **Generator exhaust**

Nevada – Lake Tahoe

In 1997, 10 passengers (children aged 12, 13, 15, and 15, and adults ranging from 35 to 49 years old) on a cabin cruiser boat powered by an inboard engine were treated for CO poisoning at a local hospital. The weather was adverse with choppy water and moderate winds. Thunderstorms were present with occasional rain. The canvas side curtains were lowered and the vessel proceeded slowly. The stern area of the vessel was not covered by canvas. The side curtain canvas configuration allowed CO from the exhaust ports to be drawn over the transom and back into the boat. This tunnel effect or back drafting exposed the people on board to dangerous levels of CO. Passengers were in various degrees of nausea, unconsciousness, and convulsions. Medics were summoned and passengers were treated with 100% oxygen at the site. They were transported to a local hospital. The Fire Department detected elevated CO concentrations below deck, especially in closed cabinets and spaces. (Source: US Coast Guard Database; Nevada State Boating Law Administrator)

New Jersey – Delaware River

In September 1999, 2 adults died and 1 adult survived CO poisoning inside the cabin of a Sun Runner Ultra 292 29' Euphemia cabin cruiser. Their ages were 28, 34, and 54. Two were found dead in the cabin after the third passenger notified authorities. The boat was moored with the propulsion engine operating to generate electrical power because there had been a problem with the battery. The cabin curtains and hatches were closed, and the blower used to ventilate exhaust was not operating. (Source: The Philadelphia Inquirer newspaper) **Propulsion engine exhaust**

North Carolina – Intracoastal Waterway

In June 2002, one person died and another survived CO poisoning while sleeping aboard a 1980 cabin cruiser powered by an inboard engine. The onboard gas generator was operating to power the air conditioning. The generator was located under the floor inside the cabin area, exhausting outside the vessel. Subsequent investigation failed to identify internal CO leaks. The owner had operated engine blowers through the night with all doors and hatches closed. This was thought to have created an internal vacuum which was may have drawn CO from outside into the cabin. There were no CO detectors on the boat at the time of the incident. (Source: US Coast Guard Database) **Gasoline powered generator exhaust**

North Carolina - Lake Norman

In 1999, 6 boaters became ill from CO that leaked into the cabin of a 36-foot cabin cruiser docked at a restaurant. The boat's onboard generator was operating to power the boat air conditioner. Four adults and two girls, aged 8 and 9, were treated for CO poisonings at Carolinas Medical Center and Presbytarian Hospital. (Source: News clips forwarded by AP) – **Unspecified generator exhaust terminus location**

Tennessee - Chickamauga Lake

In July 2001, 3 people survived CO poisoning while sleeping in the cabin of a moored 1987 34' Sea Ray Sundancer cabin cruiser. The boat was anchored in a cove tied to a second occupied vessel. When the occupants of the first vessel failed to come out of their cabin in the morning, someone from the other vessel went in to find them. As he entered, he noticed all three were still in bed. When he tried to wake them, they were very confused and nearly unconscious. They were transported to a nearby hospital emergency department where they were diagnosed with CO poisoning. (Source: Tennessee Boating Accident report)

Tennessee - Kentucky Lake

In November 1999, 2 people died of CO poisoning while aboard an "abandoned" 1966 36' Chris Craft cabin cruiser near the mouth of Standing Rock Creek on this lake. When investigators entered the boat, two deceased occupants were found in the living quarters of the boat. An autopsy was ordered because CO poisoning was suspected as the cause of death. (No results are referred to in the available record.) An inspection of the boat indicated that a coupling on the hose leading from the generator exhaust port to the stern bulkhead was damaged, with an open area approximately 8-10 inches long. An onboard CO detector was found near the entry into the living quarters. The test button did not work. The wiring was traced to the port engine switch. When this switch was turned to the "on" position, the detector received power and the test button worked. A review of the travel log on the vessel indicated that the temperature on the night of the last entry was in the low 30 degrees F to high 20 degrees. The vessel was found anchored at both ends, with all hatches and covers closed tight. (Source: Tennessee Boating Accident Investigation Record) **Unspecified generator exhaust terminus location**

Tennessee - Mississippi River

In August 1990, 2 people aged 28 and 55 died and another was seriously injured as a result of CO exposure on their 32' Trojan cabin cruiser. Witnesses heard someone calling for help from aboard the boats. When a witness arrived at the boat, the injured person was found trying to revive one of the victims by giving her mouth-to-mouth resuscitation. The injured person was removed from the vessel, and the other two people on board the boat were found to be dead. A small dog on board was alive, but unable to walk. The injured person was flown to a nearby hospital and treated for CO poisoning. The county coroner determined that the cause of death for both of the other victims was CO poisoning. Inspection of the exhaust system of the boat's onboard generator indicated that there was a leak in the line from the generator to the rear of the boat that could have resulted in exhaust "backing up" into the cabin area of the boat. The survivor of the incident was interviewed, and revealed that the generator had been operating for over 8 hours when the boat occupants began watching a movie. The next thing the survivor remembered was waking up on the floor after daylight, vomiting. He left the boat to wash himself. When he got back on the boat, he tried unsuccessfully to wake the other occupants. (Source: Tennessee Boating Accident Investigation Record) **Rear-directed generator exhaust terminus**

Tennessee - Tellico Lake

In June 2001, 3 people were poisoned while sleeping in the cabin of a 1986 36' Sea Ray cabin cruiser. (Source: Tennessee Boating Accident Report)

Tennessee – Watts Bar Lake

In August 2003, 3 people survived CO poisoning while inside a boat. They were transported to hospitals for treatment for CO poisoning. (Source: Daily Post-Athenian newspaper)

Tennessee - Unspecified water body

In 1999, the Tennessee Wildlife Resources Agency investigated the death of 2 people who were aboard a large cabin cruiser. The investigation indicated that the fatalities resulted from generator exhaust leaking from a faulty seal between an operating generator and the transom of the vessel. (Source: Tennessee Boating Accident summary report) **Generator exhaust**

Utah - Bear Lake

In April 1995, 5 children were poisoned while riding within the canopy of a 1994 32' Maxum cabin motorboat with two inboard gasoline engines. The boat was trolling with the canvas cabin enclosed but not buttoned. There were no mechanical problems identified. It appeared that the exhaust came up from the outdrives of the engines, flowing under the canvas and into the cabin where the children were riding. They were taken outside into open air and kept awake by family members until the ambulance arrived. Oxygen was administered to all five, who were then transported to a nearby hospital, treated, and released. (Source: Utah Division of Parks and Recreation Incident/Accident Report) **Propulsion engine exhaust**

Utah - Flaming Gorge National Recreation Area

In 1995, 4 children were poisoned inside a cabin cruiser boat powered by an inboard engine. Three of the boys were hospitalized and the fourth boy (aged 14) died. The boys were using a warm-water shower device attached to the boat's propulsion engine. This device drew heated water from the propulsion engine, which meant that the engine had to be operated for the device to work. The boat had been completely covered because of rain. When the boat was occupied, a panel was unzipped and a door to the rear of the boat was opened to allow access to the ski platform. All four boys were discovered unconscious inside the boat. The coroner reported that the boy that died had a COHb of 46.6%. (Source: US Coast Guard Database; Utah Division of Parks and Recreation Incident/Accident Report) **Propulsion engine exhaust**

Utah - Unspecified water body

In 1991, 1 person died aboard a Sea Ray Sundancer cabin cruiser with 2 inboard/outboard Mercruiser engines. The boat occupant was in the cabin when the engines started, and was overcome by CO. Improper ventilation, improper choke adjustment, and heavy air were thought to be related to the incident. (Source: US Coast Guard Database) **Propulsion engine exhaust**

Virginia - Hampton Creek

In May 2000, 2 42-year-old people died of CO poisoning while occupying the cabin of a 1995 32' Wellcraft St. Tropez cabin cruiser. The source of CO was an onboard generator that was found to be improperly installed. (Source: Virginia Marine Resources Commission) **Generator exhaust**

Washington – Gig Harbor

In 1996, 2 people (ages 38 and 39) were poisoned while riding in a cabin cruiser boat powered by an inboard engine. After reporting engine trouble, one of the people crawled into the engine cavity to check on the problem. He was overcome and passed out from exposure to the exhaust. The second person was also overcome. Occupants of another boat came along side and saw the victims. He radioed for assistance. The victims were flown to a local hospital where they were treated for CO poisoning. (Source: US Coast Guard Database)

In November 1998, 1 person was found dead on the floor of the cabin of a 26' 1979 Sea Ray cabin cruiser pleasure craft with an inboard stern drive engine. The boat was moored and the engine continued to operate until all the fuel was consumed. The on-board CO detector was in the "OFF" position. The cause of death was ruled to be CO poisoning. (Source: US Coast Guard Database)

Washington - Puget Sound

In 2002, 1 person survived CO poisoning while aboard a Bayliner cabin cruiser pleasure craft. While preparing for an outing, the victim kept the engine idling to keep the heater on and ward off the moring chill. He began to feel sick, like he had the flu, and thinking perhaps he was having a heart attack. He was able to call for help before losing consciousness, which is how he was found by responding paramedics. He was transported to the hospital where he spent 8 hours in the hyberbaric medicine chamber. (Source: Tribune News article, Tacoma WA) **Propulsion engine exhaust**

Washington - Saratoga Passage

In June 2001, 3 people aboard a cabin cruiser pleasure craft lost consciousness as a result of CO exposure. The vessel was traveling South apparently with a following wind. The operator went below from the fly bridge and lost consciousness as did one other crew member. (Source: US Coast Guard Database)

Washington – Snake River

In July 2002, 2 people died of CO poisoning while sleeping in the cabin of a 1986 Bayliner cabin cruiser. The vessel was found anchored with the victims inside the closed cabin. Upon investigation it was determined that the couple had anchored the boat, with the generator and air conditioning operating. It was found that the generator had an exhaust leak.

Wisconsin - Unspecified water body

In 1998, 4 people (ages 7, 14, 34, and unspecified) were poisoned while riding in a cabin cruiser boat powered by an inboard engine. The boat was traveling southbound on a river and due to a tailwind, coverings on the boat, and how the boat was operated, carbon monoxide built up in the lower berth of the boat where the people were poisoned. (Source: US Coast Guard Database)

V. CO Poisonings on Unspecified Boats

■ *11 Fatal CO Poisonings in this Category* ‣ *11 Non-Fatal CO Poisonings in this Category*

New information (post October 2004 update)

Kansas – Perry Lake

‣‣In July 2005, two children (aged 7 and 9) survived CO poisoning while sleeping in the lower cabin area of an unspecified type of boat. The two children were in critical condition when ambulances responded to the family's call. The girl's had been napping inside the moored boat while the boat's generator operated. Fortunately, their parents went to check on them, discovering them disoriented and poisoned. The children were transported to a local hospital where they were treated for CO poisoning and released. (Source: Lawrence Journal World newspaper) **Generator exhaust**

Arizona/Utah - Lake Powell

‣‣‣‣Since 1990, there have been 4 non-fatal poisonings on this lake that occurred on a boat, but the type of boat was not specified in the record. (Source: Review of NPS EMS Records, Glen Canyon National Recreation Area)

California - Catalina Channel

‣‣In 1999, 2 passengers on an unspecified type of boat with a cabin were poisoned by CO. One of the exhaust hoses from an unspecified engine (propulsion or generator) had become disconnected and caused exhaust to come into the cabin. The passenger was subjected to the most fumes and lost consciousness for a short period. They returned to shore and both were hospitalized. (Source: US Coast Guard Database)

California - Pacific Ocean

■■In 1999, the operator and passenger of an unspecified boat type were discovered aboard the vessel dead from CO poisoning. It appeared that a heater may have malfunctioned. (Source: US Coast Guard Database)

‣In 1999, 1 person aboard an unspecified boat type survived CO poisoning. No further details were given. (Source: US Coast Guard Database)

California – Unspecified waterbody

■ In 2003, an occupant of an unspecified type of boat died as a result of inhalation of CO while leaning over the stern of the vessel while the engine was engaged. (Source: 2003 California Boating Safety Report at www.dbw.ca.gov) **Propulsion engine exhaust**

■ In 2003, an occupant of an unspecified type of boat died as a result of inhalation of CO while in an enclosed cabin that was improperly ventilated (Source: 2003 California Boating Safety Report at www.dbw.ca.gov) **Unspecified exhaust source**

■ In 2003, a person died as a result of inhalation of CO while swimming near the stern of a vessel while the engine was engaged. (Source: 2003 California Boating Safety Report at www.dbw.ca.gov) **Propulsion engine exhaust**

Maryland - Wicomico River

‣In 1999, a 3-year-old passenger of an unspecified boat with a cabin lost consciousness as a result of CO poisoning. In this incident, the boat operator was trolling for fish at the mouth of the river. He and his 3 passengers were seated on the deck, outside the cabin. The 3-year-old passenger was moving around in and out of the cabin. After being in the cabin for a few minutes, she came out and said her stomach hurt. Simultaneously, her eyes rolled back in her head and she became limp. After an inspection of the vessel, it was found to be in compliance with ventilation and safety requirements. The cabin area is slightly below the upper deck, and the windows were closed. This along with the slow speed and the exhaust fumes being blown into the vessel from a slight wind were thought to be possible reasons for the child's elevated level of CO. (Source: US Coast Guard Database)

New York – Queens

In August 2003, 2 adults died of CO poisoning while inside an unspecified boat with a cabin. The source of CO was a gasoline-powered generator that was being used during a large electrical blackout. According to relatives, they usually powered the boat from an onshore landline, and wouldn't have needed the generator if the blackout hadn't happened. (Source: AP news clipping) **Generator exhaust**

Texas - Lake Meredith

In March 1984, 3 people died from CO poisoning as they slept in the cabin of an unspecified type of boat. The boat was docked in a marina at the time. A faulty exhaust manifold on a generator was thought to be the source of CO. (Source: Amarillo Globe-News, September 4, 1999) **Generator exhaust**

Texas – Private water body

In August 1999, a 15-year-old girl died of drowning associated with the toxic effects of carbon monoxide. The death certificate states that the death was caused by a boat motor that caused the poisoning. No further details are given. (Source: Death certificate forwarded by Consumer Product Safety Commission)

Utah - Unspecified water body

In 1996, a 24-year old person survived poisoning while aboard an unspecified boat. (Source: US Coast Guard database)

VI. CO Poisonings, Location of Person Unspecified

3 Fatal CO Poisonings in this Category *29 Non-Fatal CO Poisonings in this Category*

New information (post October 2004 update)

Missouri – Table RockLake

In August 2004, two men (aged 50 and 55) survived CO poisoning while somewhere aboard a Sea Ray 29' 1977 open motorboat with an inboard propulsion engine. The boat was moving at about 10 – 20 miles per hour, with wind directed toward the stern of the boat. It was believed that the wind blew exhaust into the rear area of the boat. Lack of narrative makes it difficult to tell where the occupants were when they were poisoned. (Source: USCG BARD)

Rhode Island – Pawcatuck River

In September 2004, a 69-year-old man died of CO poisoning while making repairs on a Carver 1971 21' cabin cruiser boat that was moored at a boat dock. Lack of narrative makes if difficult to tell where the victim was when he died. (Source: USCG BARD)

Arizona/Utah - Lake Powell

Since 1990, there has been 1 non-fatal poisoning on this lake that occurred on a houseboat, but the location of the poisoned person was not specified in the record. (Source: Review of NPS EMS Records, Glen Canyon National Recreation Area)

California - Bodega Bay

In September 2001, 1 person lost consciousness as a result of CO poisoning aboard a cabin cruiser pleasure craft with an inboard stern drive propulsion engine. The rubber exhaust boot had burned due to a restricted heat riser. The operator was returning to shore after this occurrence, and was then overcome by CO, possibly due to the accumulation of CO through the damaged boot. This caused him to lose consciousness and the vessel grounded. It is not clear where he was when he lost consciousness. (Source: US Coast Guard Database)

California – Dutch Slough

In March 2002, a passenger aboard a Chris Craft cabin cruiser with an inboard propulsion engine became ill from CO poisoning. No other details were provided. (Source: US Coast Guard Database)

Missouri – Lake of the Ozarks

In May 2002, three passengers of a 1991 Baja open motorboat powered by an inboard stern drive propulsion engine survived CO poisoning. No other details were available. (Source: US Coast Guard Database)

In August 2002, a passenger of a 1991 Wellcraft open motorboat powered by an inboard stern drive propulsion engine survived CO poisoning. No other details were available. (Source: US Coast Guard Database)

In October 2004, a 36-year-old woman and a 35-year-old man survived CO poisoning on a 1996 Celebrity boat. At 11:00 am, the pair started the boat to recharge the batteries, and then began to clean the boat. The man commented that he didn't feel well, and laid down. When the woman checked on him, she found that he did not respond. Because she also did not feel well, she called 911 for assistance. The boat had been operating for about two hours. At the hospital, it was determined that both victims suffered from CO poisoning. (Source: Three newspapers in the area).

Rhode Island - Atlantic Ocean near Norfolk

In September 2002, 5 U.S. Coast Guard Auxiliary members were poisoned aboard a U.S. Coast Guard security transport vessel. The vessel was standing by downwind of a tanker that was maneuvering to moor at a docking facility, when one auxilliarist lost consciousness (his location at this time was not specified in the report). When he regained consciousness, he was dizzy and nauseous. EMS responders transported him to a nearby hospital. When the vessel began to motor back to refuel, the trip was aborted due to engine problems. The vessel returned to home port. While the crew was securing the vessel, four of the five remaining crew members experienced the same symptoms, with one crew member

also vomiting. EMS responders transported these 4 crew members to the hospital. Hospital tests on the 5 crew members determined that CO poisoning was the cause of their illness. (Source: U.S. Coast Guard incident report) **Propulsion engine exhaust**

Tennessee – Old Hickory Lake

In May 2002, a person aboard a Gibson houseboat survived CO poisoning. No further details were available. (Source: US Coast Guard Database)

Texas - Unspecified water body

In 1995, 2 people aboard a cabin cruiser pleasure craft died from CO poisoning. It is unknown what caused the equipment failure. (Source: US Coast Guard Database)

In July 2001, 8 people survived CO poisoning while aboard a cabin cruiser powered by an inboard stern drive propulsion engine. The report does not say whether the source of CO was the propulsion engine or a generator. (Source US Coast Guard Database)

Utah - Unspecified water body

In 1997, a 1-year-old survived CO poisoning while aboard a cabin cruiser. (Source: US Coast Guard Database)

Virginia - Atlantic Ocean

In 2002, 3 employees survived CO poisoning while conducting a coastal survey. They were aboard a 1994 22' aluminum hull Sea Ark cabin cruiser pleasure craft with a Genset Microlite 2800 series gasoline-powered generator and 2 90-horsepower Honda outboard propulsion engines. The add-on air conditioner was being used, powered by the generator which was located on the well deck. It was suspected that the exhaust from the generator either entered the cabin when the door was opened and shut, or leaked into the cabin through cable and wire channels. The employees were feeling sick and went to shore where their short crew met them and took them to the hospital. One of the employees was released after several hours. The other two employees had to be transported to another hospital that had a hyperbaric chamber. They were released about 7 to 8 hours later. COHb concentrations (measured after oxygen therapy) were 43.3%, 32.2%, and 25.5%. COHb concentrations at the time of symptom onset were calculated to be 50.7%, 37.2%, and 29.1%. (Source: Occupational Safety and Health Administration)

VII. CO Poisonings in the U. S. Coast Guard Database Unaccounted for Elsewhere in this Listing (insufficient detail to allow categorization)

18 Fatal CO poisonings in this category ***21 Non-fatal CO poisonings in this category***

1990 - Fourteen people unaccounted for elsewhere in this listing; 8 of these people died.

1992 - Eleven people unaccounted for elsewhere in this listing; 3 of these people died.

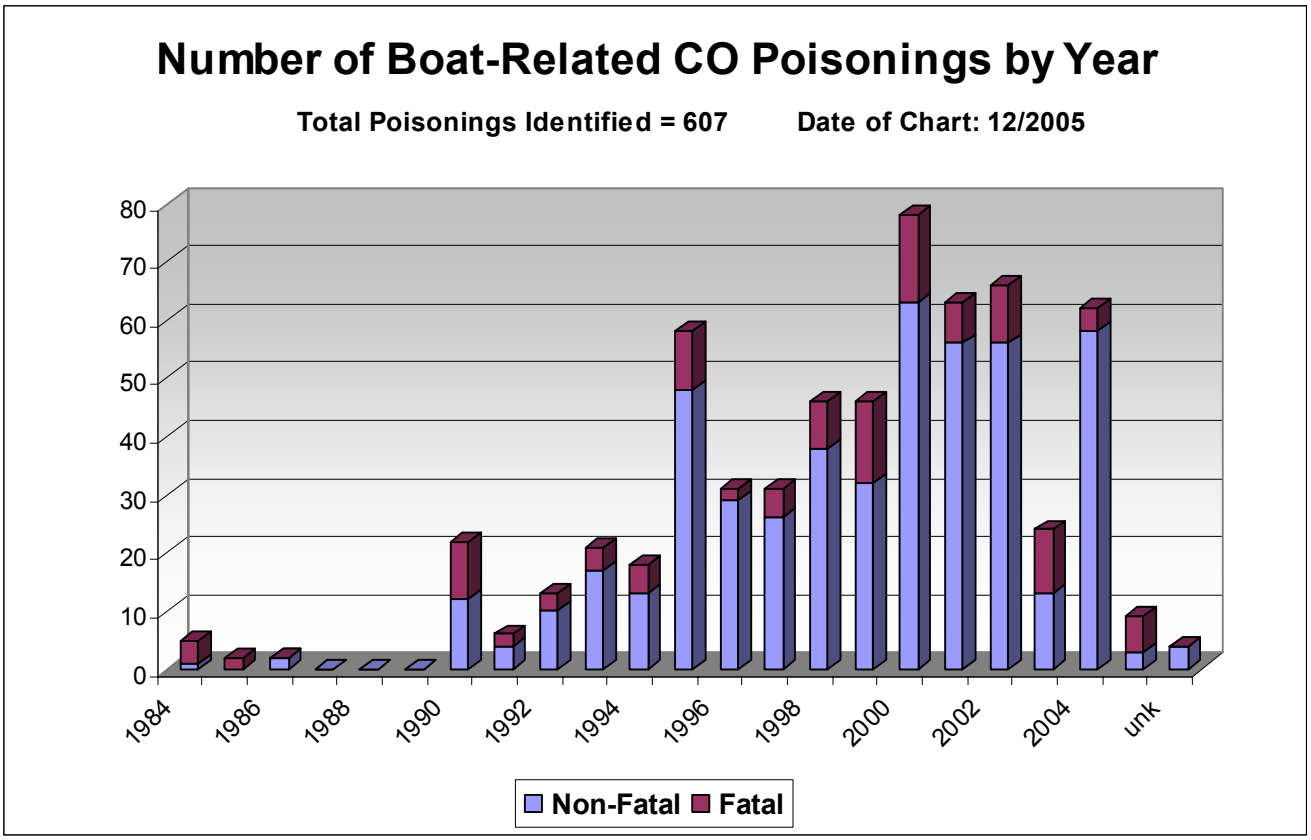
1993 - Six people unaccounted for elsewhere in this listing; 3 of these people died

1994 - Eight people unaccounted for elsewhere in this listing; 4 of these people died.

Number of Recognized Poisonings by Category*

Category	CO-Related Deaths	Non-Fatal Poisonings
I – Outside houseboats	23	53
II – Outside other boats	31	81
III – Inside houseboats	3	178
IV – Inside other boats	33	112
V – Unknown boat type	11	11
VI – Unknown location of victim	3	29
VII – USCG data – unclassified	18	21
TOTAL – 607	122	485

*596 of these poisonings occurred in 1990 – 2004; 7 occurred in the 1980's; and 4 have no specified date.



Number of Recognized Poisonings by State

Alabama	4
Alaska	1
Arizona	22
AZ/UT – Lake Powell	176
California	45
Colorado	1
Connecticut	1
Florida	17
Georgia	12
Idaho	1
Illinois	1
Kansas	5
Kentucky	43
Louisiana	1
Maine	1
Maryland	15
Michigan	4
Minnesota	15
Missouri	30
North Carolina	10
Nevada	30
New Jersey	3
New Mexico	2
New York	3
Ohio	2
Oklahoma	2
Oregon	7
Rhode Island	6
Tennessee	44
Texas	20
Utah	19
Virginia	5
Washington	13
Wisconsin	7
Unknown	39
Total	607