

**WESTERN REGIONAL CONVEYANCE TUNNEL PROJECT**

**Purpose:**

The purpose of this guideline is to provide basic information about the District's overall approach to the Western Regional Conveyance Tunnel Project.

**Project Information:**

- A. The project consists of the excavation of a 6.2 mile, 12' diameter tunnel varying in depth from 60' to 300' under the surface running from the 7700 block of Camp Ernst Road within the Burlington Fire Protection District (BFPD) to the 5500 block of Belleview Road within the Belleview/McVille Fire Protection District (BMFPD). This tunnel when completed will carry sewage waste water to the Western Regional Sewer Treatment Plant located along the Ohio River in western Boone County.
- B. Shafts will be located along the 6.2 miles of the project in the following locations:
  - a. Shaft #1 is located at 7721 Camp Ernst Road within the BFPD, has a finished diameter of 24' and a depth of 130'.
  - b. Shaft #2 is located at 3699 Possum Path within the BFPD, has a finished diameter of 6' 10" and a depth of 190'.
  - c. Shaft #3 is located at 4625 Burlington Pike within the BFPD, has a finished diameter of 6' 10" and a depth of 300'.
  - d. Shaft #4 is located at 5250 Burlington Pike within the BMFPD, has a finished diameter of 6' 10" and a depth of 115'.
  - e. Shaft #5 is located at 5500 Belleview Road within the BMFPD, has a finished diameter of 45' 6" and a depth of 60'.
- C. A Tunnel Portal is located adjacent to Shaft #5. This portal is used to remove the muck that is being generated by the Tunnel Boring Machine (TBM) using a system of rail cars within the tunnel itself.
- D. Distances between the shafts are as follows:
  - a. Shaft #1 to Shaft #2 – 13,900'
  - b. Shaft #2 to Shaft #3 – 4,500'
  - c. Shaft #3 to Shaft #4 – 8,200'
  - d. Shaft #4 to Shaft #5 – 6,300'
- E. Methane pockets are expected along the entire length of the project. This is why real-time gas monitoring meters will be deployed every 1,000', plus additional monitoring devices are attached to the TBM.
- F. Negative pressure ventilation is being provided to the face (front or working end) of the tunnel at a rate of 17,000 cubic feet per minute through a 36" diameter tube attached to the back (top) of the tunnel. As the TBM passes a shaft the ventilation fans will be moved up from the previous shaft and provide ventilation to the face from that point forward.

- G. The TBM is powered by a 3 phase @ 4,160 volt electric line that runs down the right side of the tunnel, transformers attached to the TBM step-down the electric to 575 volts. As with the ventilation system, electric for the TBM will be moved up from the previous shaft after the TBM passes a shaft.
- H. All lighting and associated wiring runs on the left side of the tunnel with all utilities running on the right side.
- I. Steel ribs and oak lagging will be used as the primary shaft lining with the potential for shotcrete and rockbolts along the length of the tunnel. Caution must be observed while walking/working in the tunnel as rockbolts protrude from the right side of the tunnel wall and they may or may not be readily visible while in the tunnel. Protective caps cover most but not all of the rockbolts.
- J. A minimum of three full train switches (elevated ramp that turns 1 set of rails into a side by side set of rails so that trains can pass each other in the tunnel) will be provided in the tunnel (five trains will be used on the last drive from Shaft #2 to Shaft #1 to maintain the target advance of 515 ft/week.
- K. Colored lights are provided in the tunnel at various locations and they indicate the following:
  - a. Red Light – Mine Phone. These are located every 2,000’
  - b. Blue Light – Switch for the Loci’s

**Surface Preparation/Organization:**

- A. Tunnel Rescue Operations Manual – McNally/Kiewit has prepared an Operations Manual for notifying necessary personnel when there is an emergency in the tunnel. The plan lists the various supervisors, administrators, and emergency response personnel that must be notified in case of an emergency.
- B. Upon notification, the first arriving unit should check the brass board located at the entrance to the shaft and take a picture, if possible. Photos of each brass board should be taken as soon as possible and delivered to the Unified Command Post; the main portal located at 5500 Bellevue Road should be a priority, as this is where workers enter the tunnel on a more regular basis. Interviews should be contacted with workers on scene to determine the type/severity of the incident and who may still be missing or if the topman has been in communication with anyone in the tunnel since the emergency took place. Ensure that the TRT has been requested through PSCC and is responding. Activation of the TRT through PSCC can be done by requesting that the “Rescue Team” be notified using the paging system.
- C. The mine phone, if not already being done, should be manned and continuously monitored for activity. The person manning the phone should make attempts to contact missing tunnelers every few minutes until the TRT is deployed.

- D. Inventory all equipment, calibrate instruments, assemble SCBA and rescue equipment.
- E. Create a log book and establish a rescuer tagging system. Ensure that the TRT members are clear on the communication signals as well as the meaning of glow sticks, spray paint and chalk.
- F. Surface Arrangements – Cover a wide range of activities and require the coordinated efforts of many people. They include such tasks as establishing a Unified Command Post where all decisions are made, providing an adequate information center from which all public information is released, and obtaining and distributing necessary supplies and equipment.
  - a. Unified Command Post:
    - i. Upon activation of the Tunnel Rescue Team (TRT) and/or any serious incident involving this project Command 100 should be requested immediately to respond as directed below:
      - 1. For incidents involving the portal, Shaft #5 and Shaft #4 Command 100 should respond to the main construction site located at 5500 Belleview Road and be set-up as close to the main construction trailer located near the entrance to the site on the left hand side to allow for the establishment of communication within the tunnel using the mine phone.
      - 2. For incidents involving Shaft #3, Shaft #2 and Shaft #1 Command 100 should be positioned as close to the shaft as possible (but no closer than 300’) to allow for the establishment of communication within the tunnel using the mine phone.
    - ii. The Unified Command Post is the hub of rescue and recovery operations and it should be staffed by McNally/Kiewit personnel, District personnel, Boone County Sheriffs Department personnel and Boone County Emergency Management personnel, as needed, using the “Unified Command” system.
    - iii. The Unified Command Post will receive a tremendous amount of information and therefore will require secure communications to enable the command staff to communicate vital information throughout the incident. The decision making process will be slow; it is important to understand the impact a single decision may have on the entire operation.
  - b. Security:
    - i. Having good security at the tunnel is important in order to keep the roads open and to ensure that curious bystanders do not hinder the tunnel rescue effort.
    - ii. Incoming traffic on the roads leading to the tunnel property should also be regulated to authorized personnel only to keep

unnecessary vehicles off the roads so that they can remain open for needed personnel, supplies and emergency vehicles.

1. For incidents involving Shaft #5 at 5500 Belleview Road; sheriff's deputies should be requested to shut down Belleview Road between Burlington Pike and Chinquapin Hill Road to control access to the site.
2. For incidents involving Shaft #4 at 5250 Burlington Pike; a sheriff's deputy should be posted at the intersection of Burlington Pike and Woolper Road to control access to the site, at the intersection of Burlington Pike and Botts Lane to divert traffic away from the scene and at the main construction site at 5500 Belleview Road. Parking is extremely limited at this shaft and good traffic control is a must.
3. For incidents involving Shaft #3 at 4625 Burlington Pike, the shaft sits approximately 3,500 feet off of Burlington Pike; a sheriff's deputy should be posted at the entrance to the site and at the main construction site at 5500 Belleview Road.
4. For incidents involving Shaft #2 at 3699 Possum Path, a sheriff's deputy should be posted at the intersection of Possum Path and East Bend Road to control access to the site and at the main construction site at 5500 Belleview Road.
5. For incidents involving Shaft #1 at 7721 Camp Ernst Road, request that the sheriff's department shut down Camp Ernst Road between Pebble Creek Way and Camp Ernst Lane to limit access to the shaft. Deputies should also be posted at the main construction site at 5500 Belleview Road.

c. Staging Area:

- i. For incidents involving the portal and/or Shaft #5 at 5500 Belleview Road, a staging area should be established in the parking lot near the main construction trailer at the entrance to the site on the left hand side.
- ii. For incidents involving Shaft #4 at 5250 Burlington Pike, a staging area should be established at Woolper Road and Burlington Pike.
- iii. For incidents involving Shaft #3 at 4625 Burlington Pike, a staging area should be established at Vice Lane and Burlington Pike.
- iv. For incidents involving Shaft #2 at 3699 Possum Path, a staging area should be established at Snow Road and East Bend Road.

- v. For incidents involving Shaft #1 at 7721 Camp Ernst Road, a staging area should be established at the Vineyard Christian Church located at 7101 Pleasant Valley Road.
- d. TRT Staging Area and Bench Test Area for Apparatus:
  - i. Once activated, members of the TRT should report to the main construction site at 5500 Belleview Road so they can be checked in and assigned to a team. Depending on the anticipated duration of the incident a “rotation schedule” should be developed for the deployment of each team.
  - ii. An area is available at the main construction site where the breathing apparatus can be cleaned, tested and prepared for use by the bench person or by the individual team members.
- e. Food and Sleeping Quarters:
  - i. Arrangements for food and sleeping quarters should be made for all personnel at the tunnel. Food can be brought in by members of the American Red Cross initially until other arrangements are made.
  - ii. Nearby motels in either Hebron or Florence can be reserved depending on the anticipated duration of the incident.
- f. Medical:
  - i. A minimum of one ALS squad should be on scene at all times and one ALS squad should be available in staging.
  - ii. At least one aero medical helicopter should be requested to the scene and landed at one of the locations listed below:
    1. For incidents involving the portal and/or Shaft #5 depending on the time of year there are numerous sites available along Belleview Road or Kelly Elementary School at 6775 McVille Road the can be used.
    2. For incidents involving Shaft #4 at 5250 Burlington Pike depending on the time of year there are various sites available near the Dinsmore Homestead at 5656 Burlington Pike, Middle Creek Park at 5570 Burlington Pike or Kelly Elementary School at 6775 McVille Road.
    3. For incidents involving Shaft #3 at 4625 Burlington Pike depending on the time of year there are various sites available on the property where this shaft is located, an alternate property is available at the intersection of Burlington Pike and Rocky Springs Road.
    4. For incidents involving Shaft #2 at 3699 Possum Path there is property available around the site that could be used, as an alternate the cul-de-sac at King Oak Drive off East Bend Road could also be used.
    5. For incidents involving Shaft #1 at 7721 Camp Ernst Road the soccer fields at Camp Ernst Lake could be

used, as an alternate the clubhouse parking lot within the Pebble Creek subdivision could be used, it is located at Pebble Creek Way and Blacktail Way.

- g. Communicating Information Related to the Emergency:
    - i. An information center (which is directed by the Unified Command Post) should be established to release information related to the emergency to families and the public.
    - ii. An Information Center should be established at the Boone County Sheriff's Department located at 3000 Conrad Lane to ensure that accurate and appropriate information is disseminated. The information center must be secured, staffed and controlled by authorized personnel only.
  - h. Liaison Function – the liaison function serves to maintain a point-of-contact between the Unified Command Post and the other concerned parties.
  - i. Relaying Information to Family Members – a special room at either the Belleview Baptist Church, Kelly Elementary School, First Church of Christ or the Vineyard Christian Church should be set aside as a waiting room for families and friends of any trapped or otherwise involved tunnelers. They should be kept informed as to the progress of the rescue and recovery operation with hourly or periodic progress reports issued from the information center.
  - j. Press Room – an area should be set up at the Boone County Sheriff's Department located at 3000 Conrad Lane where media representatives can gather to receive the news releases issued from the information center.
- G. Establishing a Chain-of-Command:
- a. A great number of people will be doing many different jobs during a rescue and recovery operation. Therefore, it is important to establish a clear chain-of-command so that rescue and recovery work can be well coordinated.
  - b. Located at the top of the chain-of-command will be a McNally/Kiewit manager, a District representative, a sheriff's department representative, and an emergency management representative. These people must know exactly what their duties and responsibilities are, who to report to, and who reports to them.
  - c. Other officials will arrive at the tunnel site to advise and observe. Normally their role is to consult with and advise the command team on how the rescue and recovery work might best be carried out safely.
- H. Other Key Personnel and Their Responsibilities:
- a. Superintendent – will likely oversee numerous aspects of rescue and recovery operations.
  - b. Electrician – pull and immediately lock all electric switches controlling the electricity to the tunnel and provide additional mine phones for communication, as needed.

- c. Mechanic/Mechanical – monitor the operation of the fan and the atmosphere in and around the fan house if the fan is exhausting.
- d. Project Safety Manager:
  - i. Provide facilities and equipment for testing, cleaning, and recharging the breathing apparatus.
  - ii. Assign personnel to issue, record and return tunnel rescue equipment.
- e. Project Engineer – provide copies of up-to-date maps showing the regular flow of air and the location of all controls and machinery within the tunnel.

## **Gases:**

- A. Gas Detection – is an important part of any rescue or recovery operation.
  - a. Vent line and shaft gas readings must be taken immediately after arrival at a reported explosion and/or fire when the TRT is going to be deployed. The readings must be taken at the same place everything.
  - b. The TRT must make frequent stops to test for gases as it advances beyond the portal/shaft or fresh air base. For the safety of the team, they will want to know what harmful gases are present, how much oxygen is in the atmosphere, and whether or not gas levels are within the explosive range.
  - c. Knowing what gases are present and in what concentrations provides important clues as to what has happened in the tunnel. Test results can also give you an idea about existing conditions. For example – if you get carbon monoxide (CO) readings, there’s probably a fire. The amount of carbon monoxide indicates something about the extent of a possible fire.
  - d. Detectors are located every 2,000 feet in the tunnel and on the TBM at various points near the cutting head. Readouts for these detectors can be obtained in the main construction trailer located at 5500 Belleview Road.
  - e. When changing PPM to %, move the decimal four places to the left and when changing % to PPM, move the decimal four places to the right.
- B. Gases Likely to be Encountered in this Tunnel:
  - a. Oxygen (O<sub>2</sub>):
    - i. Specific Gravity – 1.1054
    - ii. Explosive Range and Flammability – Oxygen is not an explosive gas, but it does support combustion.
    - iii. Color/Odor/Taste – Colorless, odorless, and tasteless.
    - iv. Meaning of Findings – If the fan is still operating, an oxygen-deficient atmosphere could indicate that an explosion has taken place, or that a fire somewhere in the tunnel is consuming oxygen. Oxygen deficiency may also indicate that the ventilation system has been disrupted.

- b. Nitrogen (N<sub>2</sub>):
  - i. Specific Gravity – 0.9674
  - ii. Explosive Range and Flammability – Nitrogen is not an explosive gas and it will not burn.
  - iii. Meaning of Findings – Elevated nitrogen content indicates an oxygen-deficient atmosphere.
- c. Carbon Dioxide (CO<sub>2</sub>):
  - i. Specific Gravity – 1.5291
  - ii. Explosive Range and Flammability – Carbon dioxide will neither burn nor explode.
  - iii. Color/Odor/Taste – Carbon dioxide is colorless and odorless. High concentrations may produce an acid taste.
  - iv. Meaning of Findings – Elevated CO<sub>2</sub> readings may indicate that a fire or explosion has taken place somewhere in the tunnel. High readings may also indicate an oxygen-deficient atmosphere.
- d. Carbon Monoxide (CO):
  - i. Specific Gravity – 0.9672
  - ii. Explosive Range and Flammability – Carbon monoxide is explosive and flammable. Its explosive range in normal air is 12.5 to 74.2%.
  - iii. Meaning of Findings – The presence of CO above normal ambient levels for a continued period of time definitely indicates there is a fire somewhere in the tunnel.
- e. Hydrogen (H<sub>2</sub>):
  - i. Specific Gravity – 0.0695
  - ii. Explosive Range and Flammability – Hydrogen is a highly explosive gas. Air containing 4 to 74.2% hydrogen will explode even when there is as little as 5% oxygen present. Very violent explosions are possible when air contains more than 7 to 8% hydrogen. The presence of small quantities of hydrogen greatly increases the explosive range of other gases.
  - iii. Color/Odor/Taste – Colorless, odorless, and tasteless.
  - iv. Meaning of Findings – The presence of hydrogen could indicate that a fire or explosion has taken place.
- f. Hydrogen Sulfide (H<sub>2</sub>S):
  - i. Specific Gravity – 1.1906
  - ii. Explosive Range and Flammability – Hydrogen sulfide is flammable and explosive in concentrations from 4.3 to 45.5% in normal air. It is most explosive at 14.2%
  - iii. Color/Odor/Taste – Hydrogen sulfide is colorless, has the odor of rotten eggs, and a slight sweetish taste.
  - iv. Meaning of Findings – A buildup of hydrogen sulfide could indicate that ventilation is inadequate.
- g. Methane (CH<sub>4</sub>):
  - i. Specific Gravity – 0.5545

- ii. Explosive Range and Flammability – Methane is flammable. Its explosive range is 5 to 15% when there is at least 12.1% oxygen. Methane is most explosive, however in the 9.5 to 10% range. The presence of other combustible gases with wider explosive ranges or lower ignition points than methane may result in a more highly explosive mixture.
- iii. Color/Odor/Taste – Colorless, odorless, and tasteless.
- iv. Meaning of Findings – If methane is present, it's important to monitor it carefully because it is potentially explosive if there is enough oxygen present.

**Ventilation:**

- A. General:
  - a. The status of the ventilation system should be assessed as soon as possible, noting whether the system is functioning either in positive (fan is blowing into the ventilation line) or negative (fan is exhausting air from the ventilation line) pressure.
  - b. The ventilation fan should be monitored and guarded by an authorized individual to make sure that it operates continuously. If the fan goes down while the TRT is in the tunnel, they should be recalled to the surface until repairs are made to the fan to ensure its continued operation.
- B. Auxiliary Fans and Tubing:
  - a. Auxiliary ventilation fans may be used at times to effect additional ventilation at the face of the tunnel, these auxiliary systems usually consist of a small, portable fan and tubing, sometimes referred to as a vent bag or a jockey fan mounted to the TBM.
  - b. The auxiliary fan can be used to either exhaust or force the air.
- C. Assessing Ventilation:
  - a. As the TRT advances through the tunnel during exploration, they should be instructed to check the status of the ventilation system and report any type of damage, as well as the extent of damage.
  - b. The TRT should never alter ventilation without direct orders from the Unified Command Post. The wrong alternations could cause changes in the air at the fresh air base, push deadly gases or smoke into areas where survivors are located, force explosive gases back over fire areas or hot spots and cause an explosion, or redirect and feed air to a fire.
- D. Measuring Airflow:
  - a. One of the first duties that must be completed is determining the velocity of the airflow within the tunnel. Knowing the velocity is important because the quantity of airflow can be calculated from it.
  - b. Being able to determine the direction and velocity of the airflow enables the command staff to determine whether the ventilation system is functioning as a whole and/or whether it is functioning as it should in a given area.

- c. Measurements must be taken from the same location in the vent line every time using an anemometer.

**Exploration:**

- A. General – “Exploration” is the term used to describe the process of assessing conditions in the tunnel and locating victims (or clues to their whereabouts) during a rescue and recovery operation.
- B. Examination of Tunnel Portal and/or Shaft Openings:
  - a. Before anyone goes into the tunnel, it’s important to examine the tunnel opening to determine the safest route for entering the tunnel. Tests should be conducted for the presence of gases and to ensure the ventilation system is functioning.
  - b. Whenever possible, it’s best to enter the tunnel by way of the portal and/or shaft closest to the reported emergency. Visible smoke and/or fire exiting the tunnel and entering the shaft under pressure means a non-entry environment for the TRT.
  - c. A gas monitor should be attached to the crane and lowered into the shaft so readings can be taken at the entrance to the tunnel prior to sending any crews down into the tunnel.
- C. Initial Exploration/Barefaced Exploration:
  - a. The initial TRT should never enter the tunnel barefaced after a fire or explosion, even if readings indicate there are no gases present. This is done to ensure the safety of the team. Advancement of the initial team will be slowed down quite a bit; however, this is necessary because the team will be entering an area that has far more unknowns than knowns.
  - b. Once the team has entered the tunnel via the shaft the man cage must be left at the bottom of the shaft for emergency egress of the team. The lattice-work on the man cage should also be cut away, as needed to allow for the equipment needed by the TRT.
  - c. If the team should reach a victim or the face of the tunnel while still receiving no indications of gases present, they may then take off their facepieces and work as necessary to remove and/or locate missing victims. This action should be communicated to the surface as soon as possible.
  - d. Barefaced exploration should only be conducted by teams that enter the tunnel after the initial team has cleared the air and established a fresh air base. Barefaced exploration is conducted with apparatus on, ready to function. This allows the team to quickly put on their facepieces and get under oxygen if conditions make it necessary.
  - e. During barefaced exploration, the crew should use the tunnel’s communication system to report their progress and findings to the surface. This lets the backup team know where the barefaced team is located and whether it’s necessary to go in after them.

- f. A fresh air base is usually established at the point where conditions no longer permit barefaced exploration. Because the area has already been explored, TRT personnel are then free to travel to and from the fresh air base without breathing apparatus.
- D. Establishing a Fresh Air Base:
- a. The initial fresh air base should be located above ground near the entrance to the shaft. Establishing a fresh air base underground may only be done once the area has been deemed safe by the initial TRT and the ventilation system is on negative pressure.
  - b. Whether the fresh air base is located underground or on the surface, it should be located as close as possible to the affected area of the tunnel, but situated where it's assured a supply of good air.
  - c. Here are some specific factors to consider when selecting a site for a fresh air base:
    - i. Be sure the fresh air base is located where it's assured positive ventilation and fresh air.
    - ii. If the fresh air base is underground, it should be located where it's assured a fresh air travelway to the surface. This travelway will be used to safely move people and supplies to and from the fresh air base.
    - iii. The site should be situated where it can be linked to the Unified Command Post by means of a communication system.
- E. Briefing information for the TRT:
- a. Is the evacuation complete? Are any tunnelers missing? If so, how many and what are their possible locations? Check the brass board and/or review photos taken upon arrival.
  - b. What is known about the cause of the emergency?
  - c. Have the shaft and hoist been checked and, if so, what condition are they in?
  - d. Is the ventilation system operating? Is it in negative or positive pressure? Have air samples been taken? If so, what are the results?
  - e. Will there be a backup team standing by at the fresh air base?
  - f. What are the team's objectives and what is their time limit?
  - g. What conditions are known to exist underground?
  - h. Is the tunnel's communication system operating? Is it being monitored?
  - i. Is power to the affected area off?
  - j. Is there diesel or battery-powered equipment or a charging station in the affected area?
  - k. What type of equipment is in the area? Where is it located?
  - l. Where are compressed air and/or water lines located? Are they in operation? Are valves known to be open or closed?
  - m. What tools and supplies are available underground? Where are they?
- F. As the team advances, it must stay in contact with the fresh air base at all times to report the team's progress and to receive further instructions from

the Unified Command Post. To communicate with the fresh air base, mine phones in place in the tunnel can be used.

- G. Traveling in Smoke – The Unified Command Post should be notified immediately if the team encounters smoke of any kind while exploring. Traveling in smoke presents difficulties to the team, the worst being no visibility. When smoke so dense that it conceals the back and sides and other reference points is encountered a decision must be made whether or not to allow the team to continue and this decision must come from the Unified Command Post.
- H. Traveling Through Water – When the team encounters water during exploration, the Unified Command Post must be notified and should decide how to deal with this problem. The captain should probe the water depth with a walking stick, if available. If the water isn't too deep and the team can proceed they may be instructed to travel through it. If the team encounters water that is more than knee deep they must turn around and return to the fresh air base.
- I. Testing for Gases – The shaft ventilation fan must be continually monitored for gases present in the tunnel. The TRT should also make frequent stops within the tunnel and report conditions to the fresh air base.
- J. Progress Reporting – Information the team relays to the fresh air base as it proceeds is known as the “progress report”. Progress reports keep the fresh air base up-to-date on what the team is doing, where they are going and what they have found. This information may then be used as a basis for making further rescue and recovery plans.
- K. Mapping – As the team advances, the map person records what the team encounters. At the same time, a person at the fresh air base marks a tunnel map based on information provided in the progress report. The Unified Command Post should then mark a tunnel map based on information received from both the team and the person at the fresh air base.
- L. Return to the Fresh Air Base:
  - a. It's very important for the team to pace its work so that it can return to the fresh air base on time. Enough time must be left to allow an ample supply of oxygen for the return trip to the fresh air base plus an extra “margin of safety” in case anything unforeseen occurs.
  - b. The 60/40 rule must be followed when sending teams underground.
- M. Debriefing – The team captain should transfer information to the back up team such as traveling conditions encountered, how far they traveled, what gases they encountered and tunnel conditions.

### **Rescue of Survivors and Recovery of Bodies:**

- A. Rescuing Survivors:
  - a. Survivors may be found along escape routes within the tunnel, injured and unable to walk. They may be trapped by fallen debris or trapped under a piece of equipment.

- b. When searching for survivors, it is important to both look and listen for clues. Look for writing on the sides of the tunnel that may point to where any survivors are.
  - c. When listening for clues, the team should be on the alert for any noises, such as voices or pounding on equipment or the rails. Prior to sending crews into the tunnel, a person outside should continue to try and contact someone inside using the mine phone.
  - d. When survivors are located, their location, identities (if possible), and condition should be reported immediately to the Unified Command Post. The command team may then elect to send in a backup team with additional equipment, if needed.
- B. Psychological Factors:
- a. Psychological – when survivors are found, their behavior may range from apprehension to uncontrollable hysteria.
  - b. The best way to relieve psychological stress in survivors is to try to communicate with them as soon as possible. Survivors found that are acting irrationally may have to be restrained in order to protect the person from injury.
  - c. Whether survivors are showing signs of hysteria or not, they should never be left alone. Survivors should never be allowed to walk out on their own even if they appear to be in good shape.
- C. Tunnelers Found in Open Area – If survivors are found in contaminated or questionable air, they will need to be given breathing protection if they are to be transported to fresh air.
- D. Body Recovery:
- a. When a body is located, report the location to the Unified Command Post. The team should be instructed to mark the body's location and position on the map and on the side of the tunnel where the body is found.
  - b. If there is more than one body found, an identifying number should be given to each one. This number should be marked on the map and on the side of the tunnel close to the body.
  - c. The team should be given orders to make every effort not to disturb any evidence in the area of the body, if possible.
  - d. Bodies found in the tunnel should be placed in rubber body bags and brought out on a stretcher.
  - e. Examination of the body for personal possessions should be discouraged and nothing should be removed from the body.
  - f. All personal belongings that are near the body normally are brought out along with the body. The location of these items should be marked on the map and on the side of the tunnel near where they are found.

## **EMS:**

- A. EMS responses to either a shaft or within the tunnel should be handled with a minimum response of an ALS squad and a single engine company.

- B. Initial dispatches to the shaft and/or tunnel may not provide enough information to determine the best access to the patient. Keep in mind that it may be best to bring the patient out of the tunnel using a loci via the portal at 5500 Belleview Road.
- C. As per the District's Medical Director all care and treatment that is currently acceptable above ground is also acceptable below ground in the tunnel.
- D. The large man cage available at some shafts is large enough to accommodate our stretcher and approximately 4 personnel. Helmets should be worn when entering the tunnel, by all personnel.

**Explosions:**

- A. Explosions can cause significant damage. Lagging may be blown out, ventilation controls damaged or destroyed, machinery twisted and scattered, and numerous fires ignited. The other main problems associated with explosions are hazardous ground conditions and spreading fires.
- B. Once an explosion has occurred, there is always the possibility of further explosions. Further explosions are possible because if the ventilation system is damaged from the first explosion, explosive gases can accumulate and be ignited either by fires that have developed or by some other ignition source, such as arcing from a damaged electric cable.
- C. Before sending any team underground after an explosion has taken place the same types of things that should be addressed prior to exploration need to be addressed here:
  - a. Ensure that the ventilation system is operational and that tests are being conducted for any gases that may be present in the tunnel. Ventilation is necessary to prevent the buildup of explosive gases.
  - b. Power must be cut to the effected area to ensure that arcing from damaged cables does not cause further explosions or fires.
  - c. The team should also know about any possible ignition sources that may exist underground.

**Firefighting:**

- A. For any reports of fire involving the tunnel within the District a minimum of a structural fire response should be dispatched along with an engine from the BMFPD to report to the portal/shaft at 5500 Belleview Road. If the fire is located between shafts, an engine should respond to each shaft with a priority placed on the shaft closest to the TBM.
- B. When dealing with fires within the tunnel, before extinguishment can ever be achieved a determination must be made with regards to what is burning and at what distance away from the shaft/portal it is located. This basic information will allow the command staff to make a decision about whether or not extinguishment of the fire is possible and to what degree resources will be committed. The following factors should be considered:

- a. The potential risk of collapse within the tunnel from the fire that could endanger fire service personnel.
  - b. The potential that tunnelers are trapped beyond the fire, at the face of the tunnel and cannot self-evacuate.
  - c. Potential loss of the ventilation system caused by the fire that would further endanger trapped tunnelers.
- C. When a fire is burning in a confined area, care must be taken to prevent extra oxygen from reaching the fire, assuming no lives are in danger. Smoke from the fire can potentially become explosive or backdraft when oxygen is starved by the production of carbon monoxide.
- D. Electrical transformers on fire present a great hazard other than the risk of electrocution because they contain oil that is potentially explosive as well as highly poisonous and corrosive. The TBM has several transformers attached to it and holds approximately 400 gallons of hydraulic fluid.
- E. The following extinguishing agents have been used successfully to combat tunnel fires, however each one also has limits.
- a. Water has the effect of removing heat, applied as a spray to increase the surface area to improve the cooling effect. The risks involved in fighting fire with water are:
    - i. Electrocution;
    - ii. Scalding from steam;
    - iii. Heat exhaustion from raised humidity;
    - iv. Flooding.
  - b. Dry chemicals are probably the most useful extinguishing agents and are the first line of defense, as extinguishers are mounted on each Loci and at various places on the TBM. Employees working in the tunnel are encouraged to dump an extinguisher on a fire while exiting in hopes that they extinguish a small fire before it grows.
  - c. Vaporizing Liquids (non-halon type) – There are a number of environmentally friendly vaporizing liquids available. Generally, they are much more effective than carbon dioxide but not as effective as dry chemical.
  - d. Carbon Dioxide – Is safe to use on any class of fire, but is only effective on small fires due to its short range and the fact that it disperses quickly. Sealing the tunnel and pumping in CO<sub>2</sub> to extinguish a fire could be accomplished if the incident was located near a shaft/portal and the tunnel could be sealed tight. For fires a long distance from the shaft/portal the use of CO<sub>2</sub> may not be practical because of the amount needed.
  - e. Low Expansion Foam – Is very effective on Class A and B fires because it smothers the fire to exclude oxygen. Delivery of low expansion foam would be difficult because of the depths of the shafts and the distances that may be traveled within the tunnel.
  - f. High Expansion Foam – Its main use is for fighting fires in confined inaccessible places, but is only moderately effective. The amount of

foam that would be required for this operations would make it near impossible for use.

- F. As stated above, life safety is the most important thing when dealing with fires inside the tunnel, both of the rescuers and tunnelers. It may be possible to use a Loci to transport a team as close to the fire as possible, so personnel could use fire extinguishers to knockdown as much fire as possible to remove any trapped tunnelers. When worker life safety is not an issue property conservation must be considered, keeping in mind that nothing at all may be done.
- G. Monitoring of the ventilation system and gas levels present must be accomplished prior to entry of any personnel and every 10 minutes after personnel have entered the tunnel. A significant fire will damage the ventilation system and will render it useless.

**Technical Rescue:**

- A. For incidents involving any type of specialized rigging and/or rope set-up the Northern Kentucky Technical Rescue Team (NKTRT) should be notified immediately upon dispatch or after determining a specialized system is needed.
- B. Incidents within the tunnel should not require the activation of the NKTRT, unless an unusual extrication is involved and additional equipment is needed that is not currently available through normal mutual aid.