PROGRAM POLICY LETTER NO. P06-V-2

FROM: RAY McKINNEY
             Administrator for
             Coal Mine Safety and Health

             MARK SKILES
             Director of Technical Support

SUBJECT: Interpretation of 30 CFR 75.1100-1 and 2 Regarding Water Delivery
             Capability of Coal Mine Waterlines When Fighting a Fire with a Firehose
             and Nozzle

Scope
This Program Policy Letter (PPL) applies to all miners, miner's representatives, Coal
Mine Safety and Health (CMS&H) enforcement personnel, and underground coal mine
operators.

Purpose
This PPL clarifies the performance test requirements used by the Mine Safety and
Health Administration (MSHA) for determining compliance with Title 30 Code of
Federal Regulations (30 CFR) §75.1100-1(a) concerning the water delivery capability of
waterlines used for fighting a fire with a firehose and attached nozzle. This PPL also
clarifies the intent of the MSHA Program Policy Manual (PPM), Volume V, Section
75.1100-1 regarding this standard. The PPL is intended to answer questions, eliminate
inconsistencies, and provide guidance to enforcement personnel and the mining
industry. MSHA will be re-evaluating water lines used for fighting a fire with a fire
hose to assure that adequate fire protection is afforded under the standard.

Policy
The standards contained in §75.1100 are derived from the statutory provisions in
Section 311(a) of the Federal Mine Safety and Health Act of 1977. The statutory
provision states that: "Each coal mine shall be provided with suitable firefighting

equipment adapted for the size and conditions of the mine. The Secretary shall establish minimum requirements for the type, quality, and quantity of such equipment."

Standard 75.1100-1(a) requires that: "Waterlines shall be capable of delivering 50 gallons of water a minute at a nozzle pressure of 50 pounds per square inch." This is a minimum performance standard and is commonly referred to as the "50/50" rule.

The current PPM policy addressing §75.1100-1(a) states that: "Waterlines, with hoses attached, shall be of sufficient size to deliver 50 gallons of water per minute at a nozzle pressure of 50 psig." (psig means *pounds per square inch gage*) Although the current policy indicates that hose is to be included in the performance evaluation, it does not define the length, size (diameter), or type of hose to be considered. This PPL revises the policy to state that the length of hose used for determining compliance depends upon the location in the mine, which will fall into two categories: the "the working section of the mine" and "all other areas of the mine."

The length, size, and type of hose affect compliance with the performance standard because water flowing through a hose will create pressure loss along the hose due to friction. The magnitude of this friction pressure loss will depend upon the water flow rate and the length, size, and type of hose.

To compensate for pressure friction loss, the available pressure in the waterline at each valved firehose outlet (VFO) must be equal to or greater than the required nozzle pressure plus the expected friction pressure loss. The valved firehose outlet is the point where the firehose is connected to the waterline and is also commonly referred to as a *firehose outlet, hose tap, fire tap, fire valve, outlet valve, or fire hydrant*. For the intent and purpose of the fire protection regulations for underground coal mines (30 CFR, Part 75, Subpart L) all of these terms are synonymous. However, this list is not intended to be all inclusive as some mines may have additional terms for this equipment.

Consideration must also be given to increases in elevation between the VFO and the fire hose nozzle. For each twelve (12) feet of increase in elevation, an additional five (5) psi should be available at the VFO to compensate for the change in elevation. Where elevation changes may be a concern, mine operators should contact their local MSHA field office or the MSHA district office for guidance. MSHA personnel can contact Technical Support for assistance in evaluating the need for elevation pressure adjustments.

Detailed information on calculating friction pressure losses in various hose arrangements, and in making adjustments for elevation, can be found in Appendix A of this PPL.

The Working Section of the Mine
For the working section of the mine, the length and size of hose used for determining compliance with the 50/50 rule shall be the length and size of the continuous miner water supply hose if this hose is also intended for use as a fire fighting hose.
As an example, consider 700 feet of 1.25 inch diameter continuous miner hose also intended to be used for fighting a fire at the face area with negligible elevation change. The calculated friction pressure loss in the hose when flowing 50 gpm is 140 psi. In order to provide 50 psig at the nozzle, the waterline pressure at the VFO must be 190 psig when flowing the required 50 gpm.

When miner hose is also intended for fire fighting, a nozzle must be stored at a readily accessible strategic location and any adapters needed to connect the nozzle to the miner hose should be stored with the nozzle.

For fighting purposes on the section, MSHA prefers the use of dedicated firehose over the use of the continuous miner hose. When such firehose is provided on the section, its size shall be used for determining compliance. The length of firehose stored shall be at least the same length as that of the continuous miner hose. Continuous miner hoses often exceed 500 feet in length. The 700 feet of 1.25 inch hose in the cited example above represents a typical continuous miner hose arrangement.
Additional technical considerations in using miner hoses for fighting a fire on the working section are discussed in Appendix B.

All Other Areas of the Mine
For all other areas of the mine, the length and size of firehose considered in the compliance determination shall be 500 feet of the size and type of firehose being stored along the belt conveyor line.

For belt conveyors, §75.1100-2(b) requires a minimum of 500 feet of firehose to be stored at a strategic location along each belt flight. To effectively utilize this hose, valved firehose outlets connected to the waterline must be provided at a spacing of no greater than every 300 feet along the belt entry.

Furthermore, §75.1100-2(c) requires that each haulage track entry must also have valved firehose outlets spaced no greater than every 500 feet apart. When the haulage track entry is adjacent to the belt entry, the belt entry hose outlets can often fulfill the track entry hose outlet requirement as long as the maximum travel distances between hose outlets is not exceeded for either entry. Operators should contact their local MSHA field or district offices for additional guidance on this issue.

In order to fight a fire in areas other than the working section, it may be necessary to connect the full 500 feet of firehose stored at one location into a single hose lay with

attached nozzle. Therefore, MSHA requires that 500 feet of firehose be included when evaluating the compliance of the waterline with the performance standard.

As another example, consider 500 feet of 1.5 inch diameter firehose with negligible elevation change. The calculated friction pressure loss when flowing 50 gpm is 30 psi. Therefore, in order to provide 50 psig at the nozzle, the waterline pressure at the VFO must be 80 psig when flowing the required 50 gpm.

Additional important information on issues involving firehose sizes, lengths, and types can be found in Appendix B. Appendix B also includes several examples of compliance determination.

Water Flow Measurements

The PPM for §75.1100-1 states that, "Water flow through the nozzle can be measured by a pitot tube instrument if the diameter of the nozzle orifice is known." The revised policy now includes additional recognized test methods and devices, such as in-line flow meters and pressure gages in conjunction with known orifices, as acceptable for determining compliance with the performance standard. Appendix C describes an example of one test device that may be used by MSHA compliance officers and technical support personnel.

Background

Questions have been raised concerning the important need for testing and evaluating the capability of mine water systems to supply adequate water for fire fighting purposes in light of the number of recent belt conveyor fires.

The performance standard in §75.1100-1(a) requires that waterlines be capable of delivering 50 gpm at a nozzle pressure of 50 psig. Neither the performance standard nor the Program Policy Manual provides details on how to determine compliance with this rule. Of particular concern has been the use of undersized waterlines in some coal mines (typically three-inch diameter and smaller pipes, but in some cases also four-inch lines). While small waterlines may be capable of providing sufficient water for dust control during mining operations, these smaller lines typically create excessive pressure losses at water flow rates adequate for fighting a mine fire. The use of either small waterlines or small firehoses, or both, increases the difficulty of complying with the 50/50 rule.

It is important to note that compliance with the 50/50 rule does not waive compliance requirements with other fire protection water supply performance standards. These include the requirements established for deluge-type water spray systems (§75.1101-1(b)), and water sprinklers systems (§75.1101-8(c)) used to protect belt conveyor drives. It also includes requirements for sprinkler or water spray systems used to protect electrical equipment containing hydraulic fluids (§75.1107-1). Determination of

compliance with these other fire protection water requirements may require additional considerations, methods, equipment, and/or analysis.

Authority
The Federal Mine Safety and Health Act of 1977, and 30 CFR §§ 75.1100-1(a), 75.1100-2(b), and 75.1100-2(c).

Filing Instructions
This policy letter should be filed behind the tab marked "Program Policy Letters" at the back of Volume V of the Program Policy Manual.

Internet Availability
This policy letter may be viewed on the Internet by accessing the MSHA Home Page (http://www.msha.gov) and then choosing "Compliance Info" and "Program Policy Letters."

Issuing Office and Contact Persons
Coal Mine Safety and Health, Safety Division
Terry L. Bentley, (202) 693-9521
E-mail: bentley.terry@dol.gov

Salwa El Bassioni, (202) 693-9525
E-mail: el-bassioni.salwa@dol.gov

Technical Support – Approval & Certification Center
Derrick M. Tjernlund (304) 547-2301
E-mail: tjernlund.derrick@dol.gov

Michael Hockenberry (304) 547-2075
E-mail: hockenberry.michael@dol.gov

Distribution
Underground Coal Mine Operators
Miners' Representatives
Independent Contractors
Mining Product Manufacturers
Special Interest Groups
Coal and All-Volume Program Policy Manual Holders

PROGRAM POLICY LETTER NO. P06-V-2 – APPENDIX A

SUBJECT: Interpretation of 30 CFR 75.1100-1 and 2 Regarding Water Delivery
Capability of Coal Mine Waterlines When Fighting a Fire with a Firehose
and Nozzle

Fire Hose Friction Loss
The standard formula for calculating pressure friction losses in firehose is:

$$FL = cq^2l$$

Where

   FL = friction pressure loss in pounds per square inch.
   c = constant of proportionality that changes for different hose
          diameters and types.
   q = water flow rate through the hose in gallons per minute divided by 100
   l = hose length in feet divided by 100

Typical values of c for commonly used rubber-lined hoses are as follows:

Hose diameter	c value
1	150
1-1/4	80
1-1/2	24
1-3/4	15.5
2	8

The above equation, along with values of c for various hoses, can be found in the Fire
Protection Handbook published by the National Fire Protection Association (NFPA).
Note that the two smallest hose sizes listed above are not normally associated with
firehose.

EXAMPLE CALCULATION
Calculate the friction loss in 500 feet of 1-1/2 inch hose flowing 50 gpm.

From the chart above, c = 24 for 1-1/2 inch hose.
q = 50gpm÷100 = 0.5
l = 500feet÷100 = 5

$$FL = cq^2l = (24)(0.5)^2(5) = (24)(0.25)(5) = 30 \text{ psi}$$

The total required pressure at the hose outlet then becomes:

30psi + 50psig = 80 psig.

As indicated under the Background heading of this PPL, the 1-inch and 1-1/4-inch hoses above are not normally available firehose sizes. These hose sizes would typically be represented by the rubber-lined pressure hoses used to supply a continuous miner with dust suppression water. These small hose sizes typically create excessive friction loss and reduce the likelihood of compliance with the 50/50 rule. Also note that the full length of the miner hose must be accounted for in the friction loss calculation, especially since it is not unusual for these hoses to exceed 500 feet in length.

The c values for other firehose sizes can be found in the referenced NFPA Fire Protection Handbook. However, as an alternative source for this data, the mine operator can contact the hose manufacturer directly.

Using the NFPA methodology and c values, the needed pressures at the hose outlet for various hose sizes and lengths, with 50 gpm flowing, are:

Table of hose friction losses and pressure requirements

hose diameter (inches)	hose length (feet)	friction loss in hose (psi)	total pressure required at hose outlet [1] (psig)
1	500	188	238
1	700	263	313
1.25	500	100	150
1.25	700	140	190
1.5	500	30	80
1.5	700	42	92
1.75	500	19	69
1.75	700	27	77
2	500	10	60
2	700	14	64

Note that 700 feet represents the length of a typical continuous miner hose. If a mine is using a different length miner hose, the methods provided in this appendix can be used to determine the friction pressure loss and the pressure required at the hose outlet.

---

[1] Friction loss plus 50 psi nozzle pressure

It is also very important to note that the presence of water pumps in the water system, including underground water pumps, adds additional issues of complexity in evaluating both the capacity and reliability of the water supply for firefighting. MSHA Technical Support should be contacted where concerns exist for these issues.

Changes in Elevation
Most coal mines are relatively level. However, some mines can have a noticeable change in elevation within the length of a lay of fire hose or miner hose. Generally, changes in elevation over this distance exceeding about ten (10) feet should be included in the analysis. Since uphill directions from the VFO represent the worst case situation, only uphill changes in elevation should be included in the analysis.

For each vertical change in elevation of one foot, an additional pressure of 0.434 psi must be added to the pressure requirement at the VFO. This works out to approximately 5 psi for each twelve feet of elevation increase.

REVISED EXAMPLE CALCULATION

Using the previous example, assume that the belt entry is on a ten percent slope. For a 500 foot hose lay, this would represent an elevation change of approximately 50 feet from the VFO to the nozzle. The elevation pressure can be found by multiplying the elevation change by 0.434, or by dividing the elevation change by 12 and then multiplying by 5.

First method
elevation pressure = 0.434 ×50 = 22 psi

Second method
$$\text{elevation pressure} = \frac{50}{12} \times 5 = 21 \, \text{psi}$$

Either value can be rounded down to 20 psi since pressure gages are generally read to the nearest 5 psi value.

The total required pressure is now the sum or the nozzle pressure, friction loss, and elevation pressure or:

50psi + 30psi + 20psi = 100 psig.

Hence, the FVO must be capable flowing 50 gpm at a pressure of 100 psi.

PROGRAM POLICY LETTER NO. P06-V-2 – APPENDIX B

SUBJECT: Interpretation of 30 CFR 75.1100-1 and 2 Regarding Water Delivery
             Capability of Coal Mine Waterlines When Fighting a Fire with a Firehose
             and Nozzle

<u>Technical Issues Involving Mine Water Supplies Used for Fire Fighting and Compliance Assistance Examples</u>

GENERIC ISSUES ON PERFORMANCE CAPABILITY
In order to fight a fire using a hose line and nozzle, an adequate rate of water flow,
along with sufficient pressure, must be available at the nozzle. Sufficient flow rate must
be available to effectively cool and quench the heat generated by the burning material.
This material can typically include coal, conveyor belting, hydraulic fluids and greases,
paper and cardboard packaging for mining supplies, and wood cribbing.

Sufficient pressure must be available to ensure that the water flow pattern from the
nozzle has the proper shape and reach. Effective nozzle pattern shape helps ensure
efficient use of the water being applied to burning surfaces. Effective reach helps ensure
that those fighting the fire can maintain a safe distance from the effects of the fire
during firefighting operations. Fires in underground coal mines not only produce
deadly smoke and heat, they can also cause dangerous roof conditions in close
proximity to the fire. Therefore, being able to fight the fire from a distance is a crucial
safety issue.

HOSE DIAMETER ISSUES
The most common firehose used for manual firefighting has a diameter of one-and-one-
half inches (a.k.a. 1-1/2 or 1.5). This size of hose is reasonably easy to handle while still
delivering flow rates capable of suppressing many fires. Larger diameter firehoses are
also available and have the benefit of yielding lower friction losses or higher water flow
rates, which ever is deemed more beneficial by the mine operator. However, larger
firehoses also have the disadvantages of being heavier, thus requiring greater
manpower, effort, and time to layout during a fire or clean and return to service after a
fire. These hoses also have a higher initial cost and can require additional training.

The only official firehose smaller than 1.5 inch is one-inch diameter hose. It is intended
only for wild land firefighting and is often referred to as "forestry hose." It is <u>not</u>
suitable for fighting fires in mines or structures since it generally cannot deliver the
flow and nozzle pressure needed to meet the performance standard.

CONTINUOUS MINER HOSE ISSUES
For dealing with fires at the working section and face, many mines have made plans for
using the rubber hose supplying water to the continuous miner as the hose for fighting
a working section fire. For modern continuous miners, this hose is typically 1-1/4
inches in diameter, although some mines may still be using older one-inch diameter

hose. Although MSHA currently accepts this practice, there are several issues that mine operators must address when considering this option.

1. The smaller diameter of the continuous miner hose may cause substantial friction losses for which the water system may not be able to compensate for, thus preventing compliance. The mine operator must be acutely aware of this potential problem. For continuous miners using one-inch diameter hose, compliance is extremely unlikely.
2. The booster pump often provided on the section for supplying the miner hose may not be capable of providing either the pressure _or_ the flow required for firefighting. The pump must be capable of providing at least 50 gpm at the required hose outlet pressure.
3. A means must be available to quickly disconnect the miner hose from the continuous miner and permit the attachment of a firefighting nozzle.
4. The miner hose can get tangled up with the miner trailing cable or hydraulic hoses during normal operations, thus preventing or impeding the ability to quickly advance this hose to other parts of the working section should a fire occur away from the continuous miner.

COMPLIANCE ASSISTANCE EXAMPLES

Example 1

The XYZ Coal Company's No. 1 mine stores 1-3/4 inch firehose along the belt flights. A water flow test at the farthest hose outlet not located on the section indicates that at 50 gpm, 75 psig is available. Does this comply with the standard?

From the table in Appendix A, the friction loss in 500 feet of 1-3/4 inch firehose is 19 psi, for a minimum required available pressure of 69 psig. Since the available pressure (75 psig) is greater than the required pressure (69 psig), the mine is in compliance with the standard for all other areas of the mine.

Example 2

At this same mine above, the continuous miner hose is planned for use as the fire fighting hose on the section. The miner hose is 700 feet of 1-1/4 inch rubber hose. The hose is fed by a booster pump at the section mouth. The discharge from the pump is tested and found to produce a pressure of 175 psig at 50 gpm. Does this comply with the standard?

From the table in Appendix A, the friction loss in 700 feet of 1-1/4 inch hose is 140 psi, for a minimum required available pressure of 190 psig. Since the available pressure (175 psig) is less than the required pressure (190 psig), the mine is _not_ in compliance with the standard for the working section of the mine.

One solution in this particular case would be to store 700 feet of 1-3/4 inch firehose on the section with the intent of using the firehose instead of the miner hose to fight a fire.

In this case, the required pressure is found from the table to be 77 psig at 50 gpm, well within the capability of the given arrangement.

WATER SYSTEM IMPROVEMENTS
It should be noted with great caution that where compliance does not exist, the solution may not always be as simple as changing the size of the hose. An engineering evaluation of the water system may be necessary and may reveal a more extensive solution is necessary. The evaluation may also highlight the availability of more than one possible solution, or the potential use of a combination of solutions for the most economical and reliable fix.

When the mine cannot meet the performance standard, the water system must be modified or enhanced sufficiently to bring the mine water supply back into compliance. Improvement strategies can sometimes include changing water lines to bigger pipes, adding parallel water lines, relocating gravity fed sources to higher elevations, adding booster pumps, or adding additional water sources.

In planning mine water system improvements, mine operators must take into account the requirement for fire hose to have burst pressure ratings at least four times the maximum expected working pressure available at each VFO. Additionally, the maximum pressure available at the nozzle must not exceed 100 psig.

Where improvements are needed to the water system, MSHA Technical Support can be contacted for additional assistance.

NATIONALLY RECOGNIZED CONSESUS STANDARDS
Nothing in any of the regulatory standards prohibits the mine operator from having waterlines capable of delivering a greater flow or having more outlets than required. In fact, experience has shown that it is often necessary to provide adequate flow and pressure to three or more hose lines simultaneously in order to effectively fight an underground coal mine fire. This expectation of flowing at least three hose lines for a total of at least 150 gpm at nozzle pressures of at least 50 psig, is reflected in the national consensus standard on underground coal mine fire protection published by the National Fire Protection Association. [NFPA 120-2004: Standard for Fire Prevention and Control in Coal Mines.]

MSHA _highly recommends_ that when mine operators are evaluating the needs of planned new mines, or re-evaluating the needs of existing mines, they should give serious consideration to meeting the recommendations of the NFPA 120 standard.

PROGRAM POLICY LETTER NO. XXXXXXXX – APPENDIX C

SUBJECT: Water Delivery Capability of Underground Coal Mine Waterlines Used
             for Firefighting Purposes When Fighting a Fire with a Firehose and
             Attached Nozzle

Waterline Compliance Test Device and Bill of Material
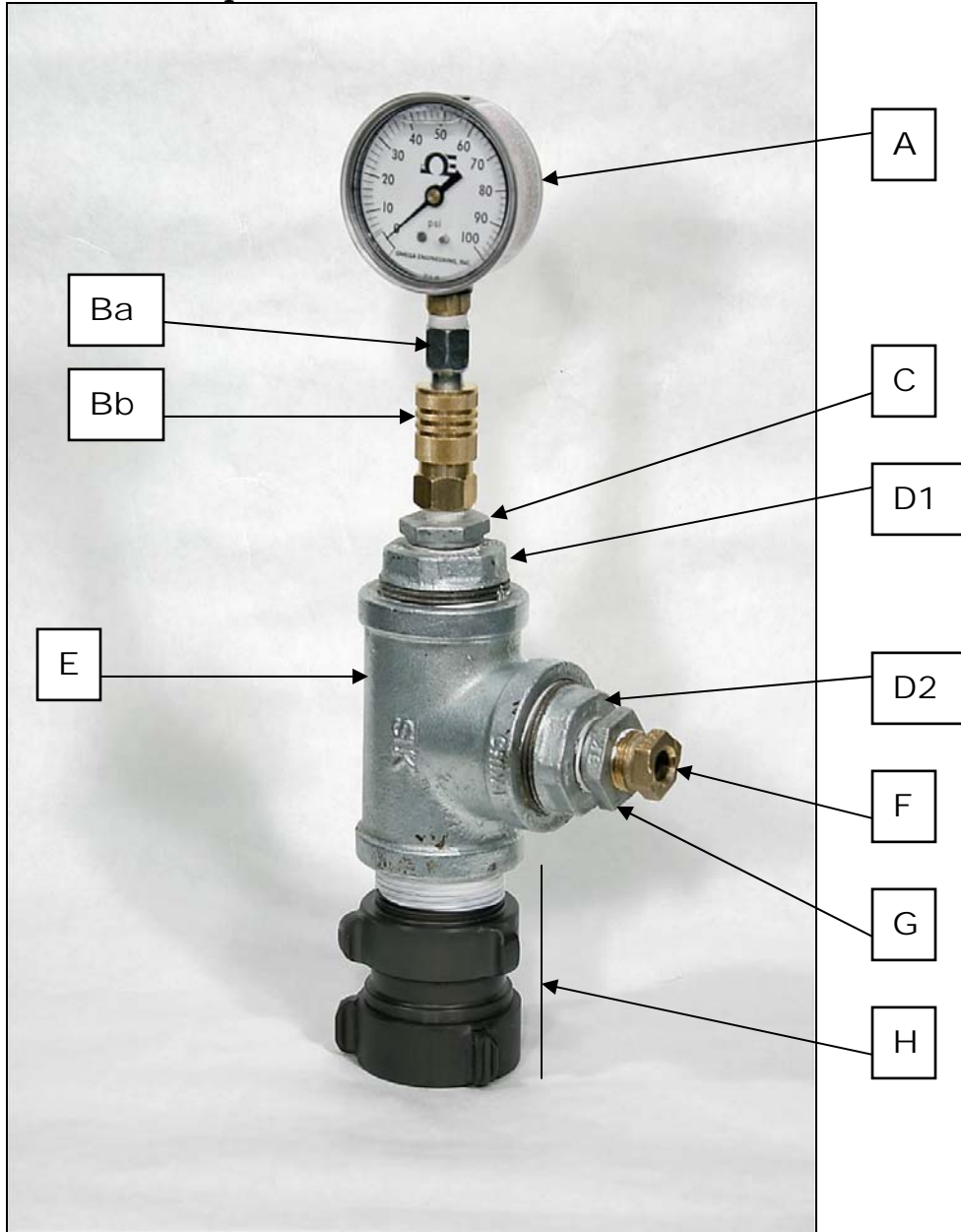
BILL OF MATERIAL

Item ID	Description	Notes
A	Liquid filled bourdon tube pressure gage	1
Ba	¼″ female NPT by ¼″ industrial male quick connect plug	2
Bb	¼″ male NPT by ¼″ universal female quick connect recepticle	2
C	¾″ by ¼″ hexnut reducer bushing	3
D1	1-1/2″ by ¾″ hexnut reducer bushing	3
D2	1-1/2″ by ¾″ hexnut reducer bushing	3
E	1-1/2″ threaded straight pipe tee	3
F	Calibrated orifice with ½″ NPT male threads	5
G	¾″ by ½″ hexnut reducer bushing	3
H	light-weight anodized aluminum hose/pipe adapter, Redhead Model 54RL, 1-1/2″ male NPT by 1-1/2″ female NPSH swivel with gasket (or equivalent)	4

NOTE 1: Pressure gage scale should be such that the required flow pressure should be approximately at half scale, or greater.

NOTE 2: The "air chuck quick connection" is optional. The pressure gage can alternatively be screwed directly into the hex reducer bushing (Item C). However, the quick connect allows the gage to be easily turned in any direction for better visibility during the test, and it allows for easy removal for storage.

NOTE 3: The fittings shown are galvanized, threaded Class 125 standard gray cast iron fittings. These fittings have a water pressure rating of 175 psig, which should be adequate for most flow test scenarios. If higher flow pressures are expected, then higher pressure rated fittings must be used.

NOTE 4: This adapter fitting is optional since the pipe tee (Item E) can be threaded directly onto a 1-1/2 inch NPT hose outlet. However, the adapter allows the test device to be easily turned in any direction for aiming the stream in the most appropriate location, and permits tightening/untightening by hand or with a small firehose spanner wrench rather than a pipe wrench.

NOTE 5: Contact MSHA Technical Support for specific information on calibrated orifices.