

# **MODIFIED SHEARER CLEARER SYSTEM FOR DUST AND METHANE CONTROL**

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# MODIFIED SHEARER CLEARER SYSTEM FOR DUST AND METHANE CONTROL

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The shearer clearer system was designed, tested, and proven to be effective at lowering shearer operator dust exposures during the mid-80's by the U.S. Bureau of Mines. This technique uses a series of water sprays positioned on the shearer body and splitter-arms. These water sprays not only knock down a portion of the dust cloud generated during cutting but also act as small fans that move a substantial amount of air and keep the dust cloud from dispersing over the shearer body and contaminating the operators. At a number of operations, shearer operator respirable dust exposure levels have been lowered approximately 50 to 60 pct using this technique.

Because of the air moving capabilities of this technique, the Bureau of Mines believed that a modified version could also be effective to lower methane levels around the shearer, thus reducing the likelihood of a shearer-generated methane ignition. Two additional spray blocks were added to the system to provide for improved air movement around both cutting drums. A laboratory study performed with the modified version in a full-scale longwall gallery resulted in a 73 pct reduction in methane concentrations at the shearer machine for both cut directions. There have been a number of longwalls that have implemented modified shearer clearer systems over the past few years. Although there has been no detailed field analysis on these systems to statistically provide a percent reduction in methane levels on the machine using the technique, all indications are that the system is effective for both dust and methane control. The air moving capabilities of the system provide more turbulence at the cutting drums and reduce methane levels.

The intent of this report is to provide a detailed description of the modified shearer clearer system. Engineering drawings are provided for all major components of this system to assist operators who may be interested in installing it at their operation.

## INTRODUCTION

Dust and methane levels on longwall sections are two areas that must be constantly addressed by the U.S. mining industry in order to provide a healthy and safe work environment for underground miners. Over the past decade, there have been significant technological advances in both dust and methane control. An effective longwall dust control technique developed during this time has been the shearer clearer system. This system uses a series of water sprays and barriers to hold the dust cloud created during cutting against the face, and away from the shearer operators (Jayaraman, 1985). Numerous installations of the shearer clearer system have been evaluated over the years with the shearer operators respirable dust exposure reduced by 50-60 pct.

In addition to the shearer clearer system, there have been other dust control techniques that have proven to be effective on longwall sections. Research to optimize face ventilation and shearer water usage has been effective at reducing longwall face dust levels (McClelland, 1987). Using reverse drum rotation to reduce dust levels while increasing production has been successful in a number of mines (Bureau of Mines, 1987). The limited application of foams to reduce longwall dust levels has also been successful in a few mines (Bureau of Mines, 1989).

Controlling methane levels on longwalls is also a primary goal and concern to all longwall operators. Methane ignitions remain one of the most serious hazards facing longwall operators. There are three ways to control longwall face ignitions. The first way is to effectively monitor for methane so as to inform workers of potentially dangerous methane concentrations and to automatically de-energize equipment when such levels exist. The Bureau recently performed a study to determine optimal locations for face methane monitoring equipment (Cecala, 1993). Since most longwall ignitions are caused by the shearer, placing a methane monitor on the machine to detect when a potentially explosive concentration is present was investigated and holds promise.

The second method to reduce longwall ignitions is to control the ignition source. The most significant ignition source is the cutting bits on the shearer. One approach is to control this with the use of an anti-ignition drum design that uses a water spray behind each cutter bit to quench the hot streak created when cutting non-coal material (Courtney, 1990). This technique has been shown to be effective at reducing shearer-generated frictional ignitions. Advances have also been made in bit design and bit lacing (Wirch, 1988).

The last, but probably the most important method to control longwall ignitions, is to remove or dilute the methane to safe concentrations. Advances have been made in methane drainage in which the methane is extracted before or during mining (McCall, 1984; Ely, 1989). Increasing total ventilation air quantities and more effective use of existing air volumes have been successful at reducing methane levels. The ventilated drum concept has been tested on a limited basis in this country and has shown reductions for both dust and methane levels at the longwall shearer (Divers, 1987). An additional approach that has shown potential is the use of a modified shearer clearer system (Cecala, 1986). This system is a modified version of the original system that provides more air movement around the cutting drums, thus lowering methane levels and the potential for frictional ignitions.

This publication provides mine operators with a basic understanding of the functioning of the modified shearer clearer system and with the detailed engineering information to allow them to fabricate and install a system at their operation.

## BACKGROUND

The shearer clearer system was originally developed under a Bureau of Mines contract back in the early 1980's (Foster-Miller, 1983). This system consisted of strategically positioned water sprays and a number of passive barriers located on the shearer. The intent was to reduce dust concentrations at the operator's location by splitting the airflow and keeping the dust-laden air generated during cutting from contaminating the shearer operators. Feedback during testing of this original design indicated that a number of minor modifications could be implemented to improve it's

performance. The system was modified to use fewer water sprays, resulting in a reduction in the amount of water mist at the operator's location. Underground evaluations over the years by the Bureau of Mines, Foster-Miller Inc., the Mine Safety and Health Administration (MSHA), and coal producers have all confirmed the successful performance of the shearer clearer system from a dust control standpoint. The shearer clearer has accounted for a clean-air split in the walkway as far as 40 ft downstream from the machine. MSHA is requiring some mine operators to include shearer clearer systems in their longwall dust control plans.

While working on the development of the shearer clearer system, the Bureau was concurrently researching ways to effectively monitor and control methane levels on longwall sections. As previously noted, one way to control methane is to dilute it to safe concentrations. The shearer clearer system was considered as a possible method to reduce methane levels at the shearer, which is the primary ignition source. The system uses a number of water sprays that act as small fans, thus moving air and holding the dust cloud against the face. It was proposed that the system could be modified to increase the air moving characteristics around both cutting drums, thus lowering methane levels in these ignition-prone areas. A study was initiated to investigate this.

Laboratory tests were conducted in a full-scale longwall gallery to define the size of the poorly ventilated areas around the shearer body (Foster-Miller, 1983). Tests were conducted over a wide range of conditions, including various levels of primary airflow and gob leakage in both cut directions. Methane gas was released at the cutting drums to simulate methane liberated during the cutting process. Methane was monitored from the floor to the roof, from the headside drum to 4 ft downstream of the tailside drum, and from the face to past the shearer operator. Baseline tests showed that the face side area around both cutting drums, and the entire area between the drums, was not ventilated adequately. Increasing the primary airflow or changing the cutting direction had little impact on improving the ventilation in these areas. After experimenting with several different concepts, one effective modification was to implement two additional spray blocks on the original shearer clearer design. One spray block was positioned near each cutting drum to increase the air-moving capabilities at the drums and to more effectively dilute the methane being liberated during cutting. This system with the two additional spray manifolds was named the "modified shearer clearer system" and was intended for both dust and methane control.

Methane concentrations were reduced by approximately 73 pct with the modified shearer clearer for both cut directions during laboratory testing. The additional sprays included in the modified shearer clearer system decreased methane concentrations behind the cutting drums by as much as 40 pct from concentrations recorded with the standard shearer clearer. The modified shearer clearer not only holds the dust cloud against the face, but it also causes additional air to sweep the area on the face side of the shearer body, especially around the cutting drums, thus reducing methane levels at the machine and lessening the potential of a frictional ignition.

## ACKNOWLEDGMENT

The authors would like to thank Marion B. Molchen, design draftsman for SSI, for his efforts in preparing the art work for this report.

## SYSTEM DESIGN

The intent of this report is to provide operators with sufficient information about the modified shearer clearer system to allow them to fabricate and install a system at their operation. A number of design drawings showing the various components of the system are presented.

Figure 1 shows the perspective of all illustrations in this report. All illustrations are designed for a "left-handed" shearer clearer system. This is for longwall faces that are ventilated from right to left when looking at the face from the walkway area. If a face is ventilated from left to right, then a "right-handed" system is necessary and is just a mirror image of the drawings provided.

There are 9 different spray manifolds that comprise the modified shearer clearer system. Figure 2 shows the location and mounting position of all nine of these spray manifolds. Figures 3, 4, and 5 are design drawings of spray manifolds #1, #2, and #3, respectively, which are located on the headside splitter arm. It is recommended that all spray manifolds be fabricated using some type of carbon steel. Carbon steel is relatively inexpensive and easier to machine and weld than many other metals. Stainless steel can be used if an operation is concerned with corrosion problems, but this will substantially increase the cost. Figure 6 shows a design of a headside splitter arm used to mount the three spray manifolds. It is recommended that the splitter arm be hinged to the shearer to deflect when large pieces of coal or roof rock strike it. The use of a spring loading type splitter arm has proven effective at a number of operations and should be used on the headside splitter arm. The splitter arm should extend approximately 8 to 12 inches past the edge of the headside drum. This headside splitter arm is critical in that it starts the air split action and keeps the contaminated air close to the face. It is also recommended that all spray manifolds be bolted to the machine, not welded. This allows for easier replacement of worn or broken parts and hardware when needed.

There are four spray manifolds that are directly attached to the shearer body; figures 7, 8, 9, and 10 show these spray manifolds (#4 through #7, respectively). Manifold #4 is mounted directly on the top, front edge of the shearer and is used to ventilate the area behind the headside cutting drum. Manifolds #5 and #6 are recommended to be located along the front, top edge of the shearer and are used to keep the air split maintained over the main body of the shearer. Figures 11 and 12 indicate the recommended mounting method for attaching spray manifolds #5 and #6, respectively, to the machine. A bracket assembly was designed to mount the spray manifold to the bracket and then attach that assembly to the machine. Manifold #7 is mounted vertically at the tail end of the shearer and is used to improve the ventilation at the tailside drum. Since many of the shearer mining machines differ as to the design on the tail end of the machine body, manifold #7 can be attached by the operator at the most advantageous location. Two factors to be considered are an uninterrupted spray pattern for the nozzle to be effective and ability of the manifold to be durable and not to be ripped off or damaged during mining. Figure 13 shows spray manifolds #8 and #9. Both of these manifolds are mounted on the tailside splitter

arm (figure 14). It is not necessary for the tailside splitter-arm to use the spring-loading technique.

In this application, there are 9 spray manifolds encompassing 15 separate water sprays. In extensive testing by the Bureau, success was achieved using Spraying Systems Company's 3/8 BD20 whirljet spray nozzles.<sup>1</sup> Using the BD20 inserts provides dual inlets and thus reduces the possibility of clogging. The recommended operating pressure at the spray nozzles is between 120 psi and 150 psi.

The spray nozzle tips to be used with the modified shearer clearer system are dependant on the volume of water available for use. The nozzle tips can vary between a #10 spray tip that will deliver approximately 5 gpm per nozzle to a #3 spray tip that will deliver approximately 1 gpm. The range in operating volumes for the modified system will vary from 75 gpm with the #10 spray tips to 15 gpm for #3 spray tips. The actual spray nozzle tip size needs to be evaluated along with other water usage parameters on the shearer and thus the wide range of spray nozzle sizes presented. A #8 spray tip delivering approximately 3.5 gpm per nozzle at a total system volume of 50 gpm is recommended.

It is also advisable to use a good water filtration system since the water quality in most mines is poor. The modified shearer clearer system is composed of 15 different water sprays and contaminated water will cause clogging problems and cost system efficiency. A filtration system successfully used in many field evaluations is a hydrocyclone system (Bureau of Mines, 1981). These devices will remove product from 1/8 inch in size all the way down to 60 mesh particulate. The particles are trapped on the bottom of the unit and are flushed out by simply opening a ball valve once per shift.

The effectiveness of the modified shearer clearer system will vary from face to face dependant on a number of factors and conditions. Some of these factors include geological conditions, equipment layout and dimensions, ventilation rates, water pressure, and water flow rates to name just a few. The system can be modified slightly to address these conditions on each face to optimize its performance.

Another consideration is turning off some of the water sprays on the system on bi-directional faces when cutting from headgate to tailgate or with ventilating airflow. At some operations, dust levels recorded at the headside drum operator's position were increased when cutting with the airflow (Jayaraman, 1985). By eliminating spray manifolds #1, #2, #3, and #5, conditions at the headside drum operator's position improved significantly. On bi-directional faces, the full system would be used when cutting from tailgate to headgate or when cutting against the airflow direction. Spray manifolds #4, #6, #7, #8, and #9 would be used when cutting from headgate to tailgate, or with the direction of the ventilating airflow. A determination of the best approach to use must be made for each individual longwall.

## CONCLUSIONS

The modified shearer clearer system is designed to provide both dust and methane control for longwall shearers. The system is composed of strategically

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<sup>1</sup>Reference to specific manufacturers is for information only and does not imply endorsement by the Bureau of Mines.

located water sprays that act as small fans to hold the dust cloud generated during cutting against the face and away from the shearer operators. Two additional spray manifolds (#4 and #7) have been added to the original system, providing more ventilation in and around the cutting drums, thus lowering methane concentrations and reducing the possibility of shearer-generated frictional ignitions. From a dust control standpoint, this system has proven itself over the past decade to be a mechanically dependable system at lowering shearer operators' respirable dust exposures. Regarding methane control, laboratory tests have shown increases in ventilation volumes and decreases in methane levels around the cutting drums by as much as 40 pct. The modified shearer clearer system is a supplemental system that works with other dust and methane control systems on longwall sections in an effort to improve the health and safety of all longwall workers.

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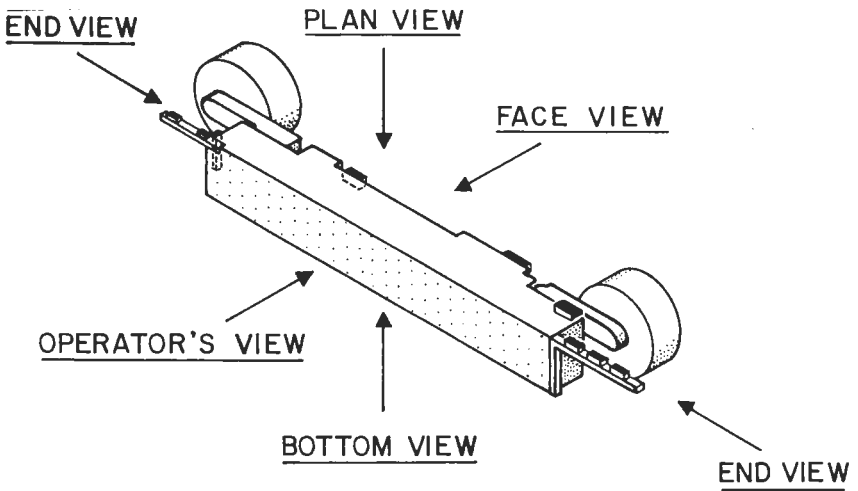


Figure 1. Perspective of all illustrations.

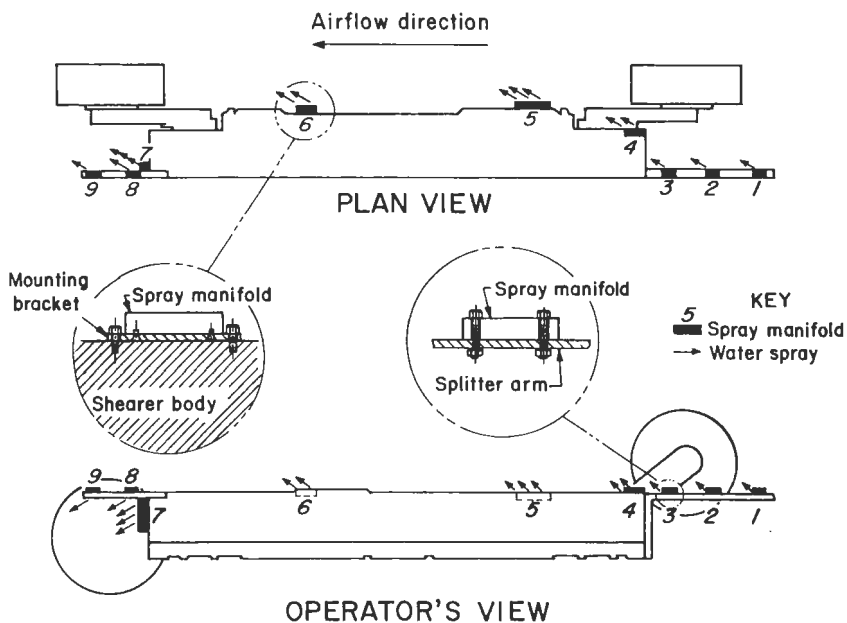


Figure 2. Location and mounting positions of spray manifolds on modified shearer clearer system.

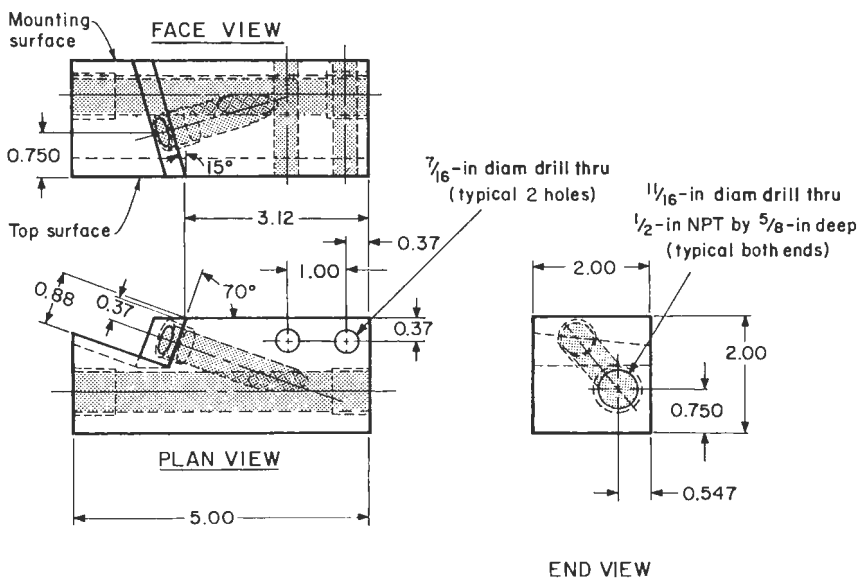


Figure 3. Water spray manifold #1.

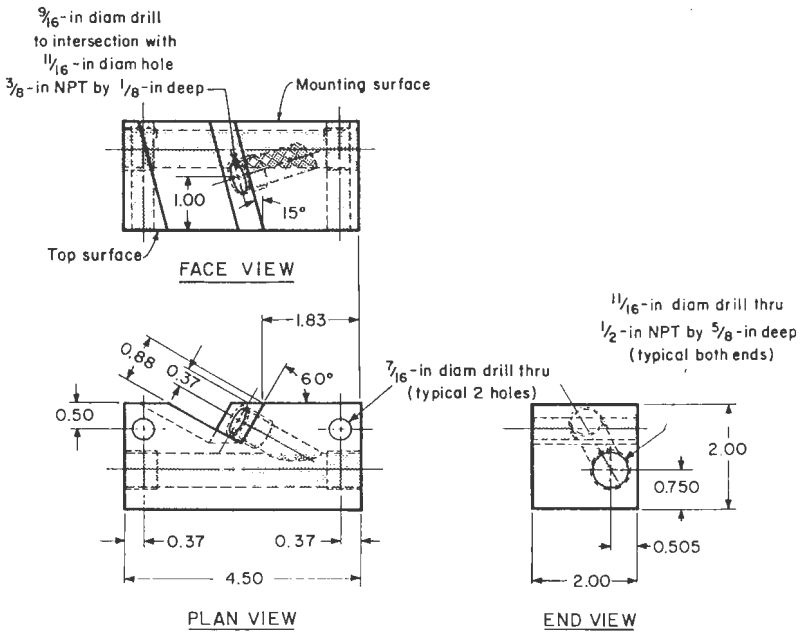


Figure 4. Water spray manifold #2.

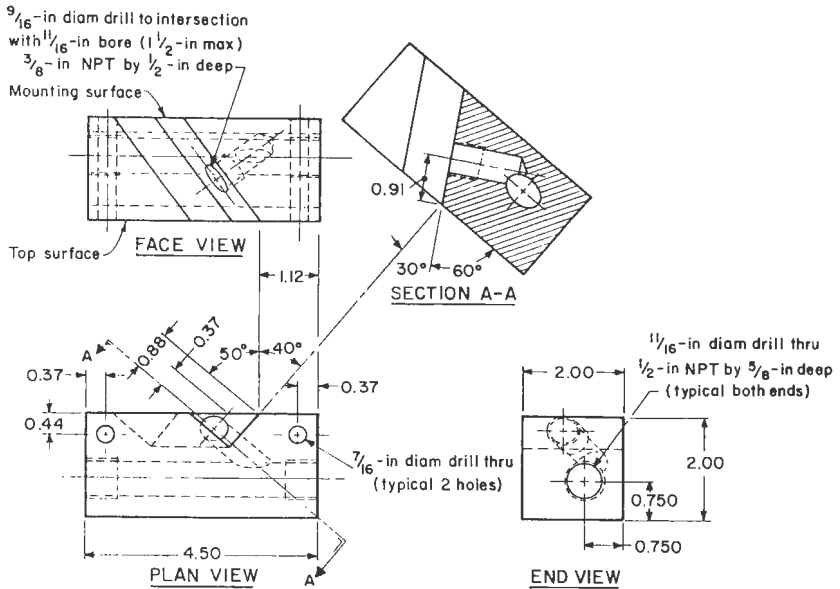


Figure 5. Water spray manifold #3.

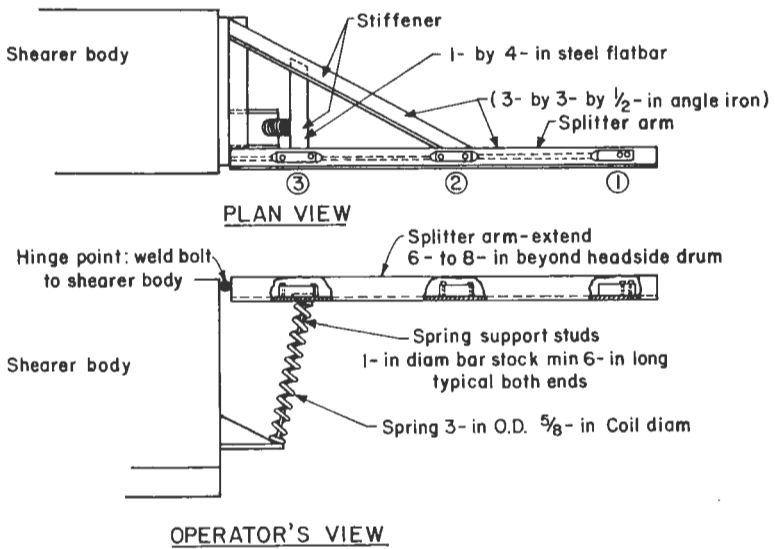


Figure 6. Design for headside splitter arm.

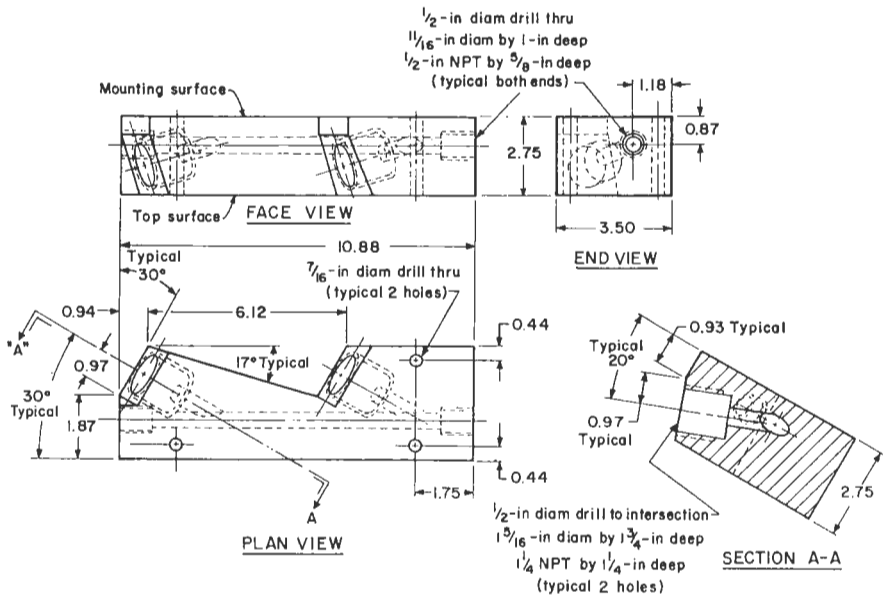


Figure 7. Water spray manifold #4.

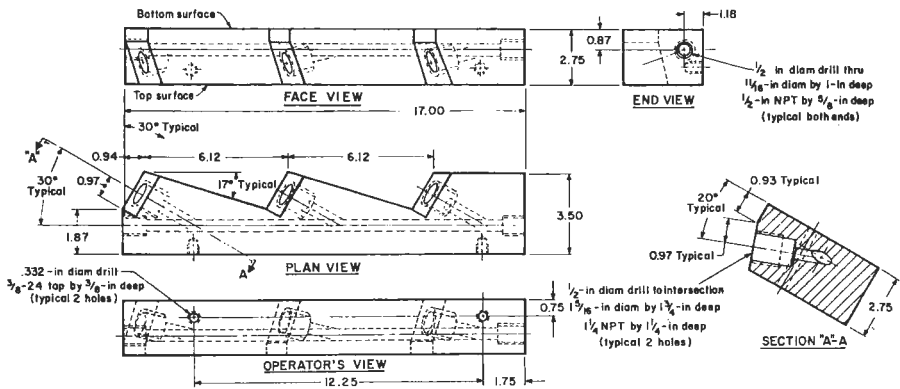


Figure 8. Water spray manifold #5.

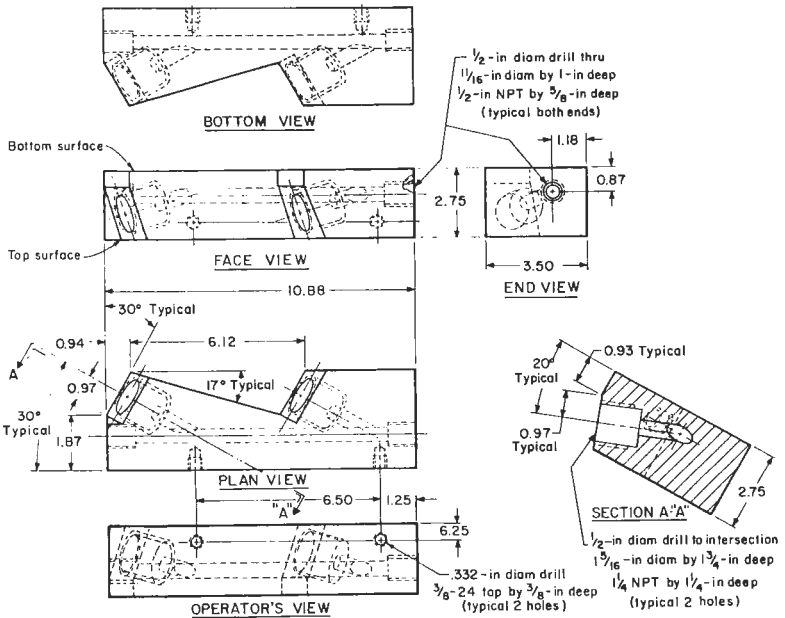


Figure 9. Water spray manifold #6.

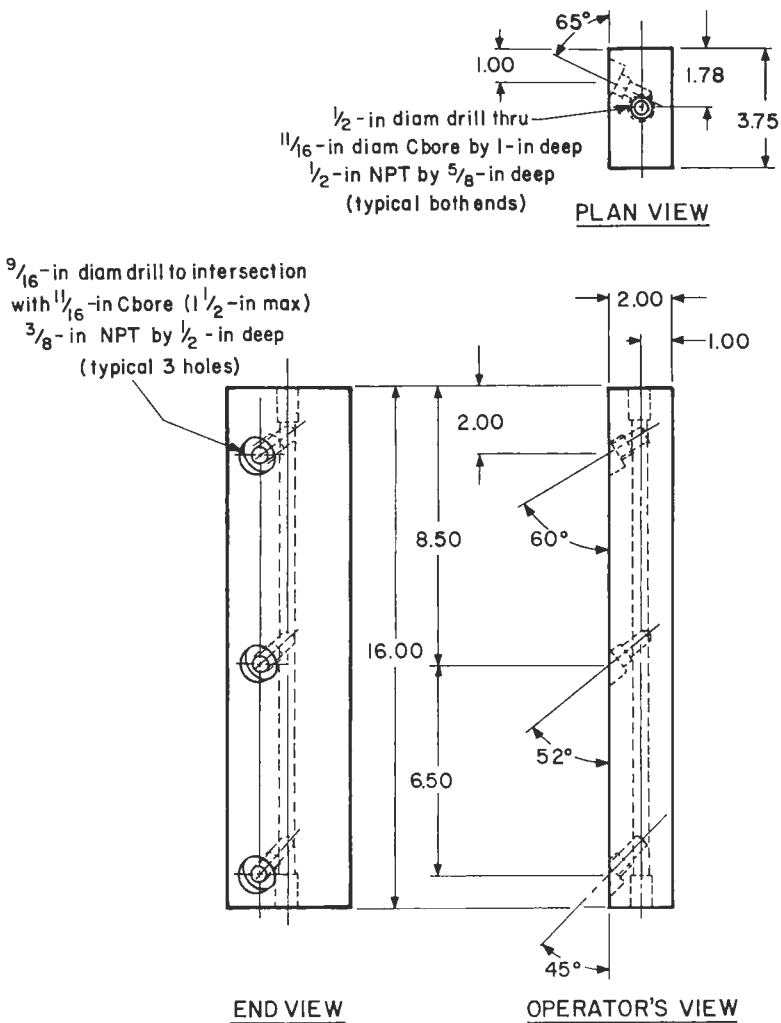


Figure 10. Water spray manifold #7.

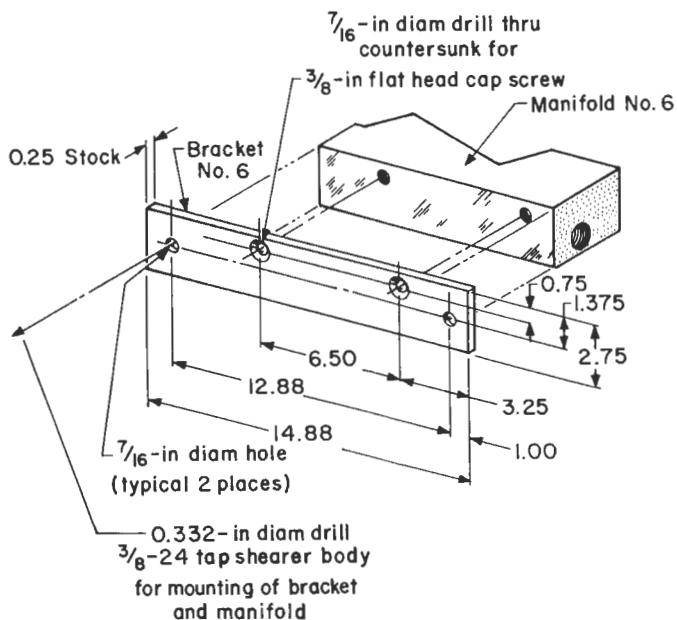


Figure 11. Mounting bracket for water spray manifold #5.

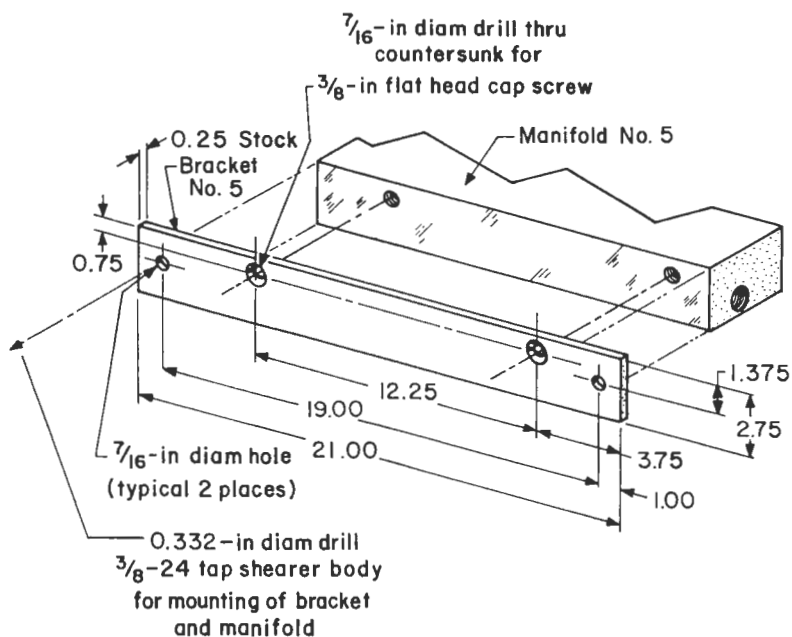


Figure 12. Mounting bracket for water spray manifold #6.

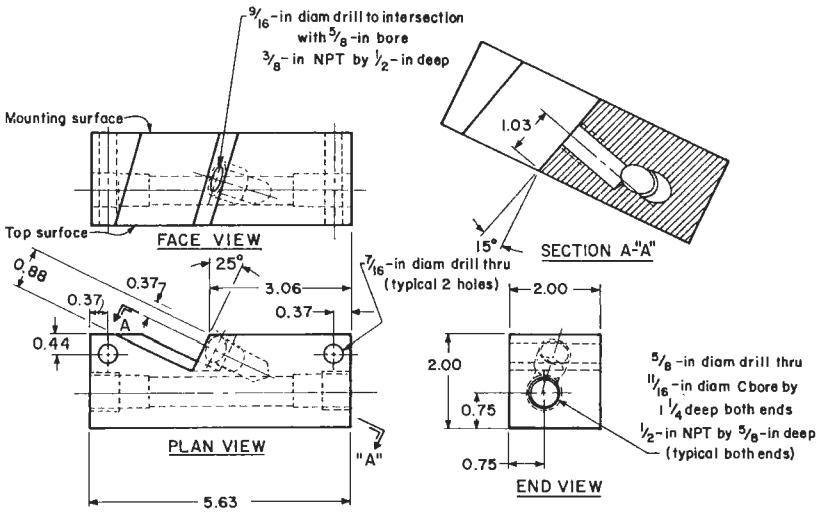


Figure 13. Water spray manifolds #8 and #9.

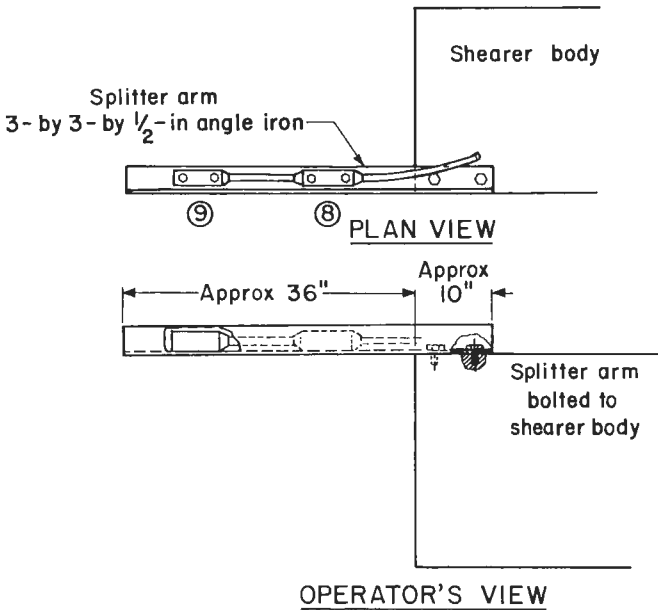


Figure 14. Design for tailside splitter arm.

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