HOSE STREAM MECHANICS

LESSON PLAN

HYDRAULIC VENTILATION

STUDENT OBJECTIVE

Given the information from discussion, handouts, and video references, the student will demonstrate knowledge of utilizing different nozzle and hose stream types, along with varying application patterns, to employ hydraulic ventilation out of the window opening in the water mapping prop.

The student will also examine the impact of distance from the nozzle to the window opening and its impact on the resulting entrainment.

MOTIVATION

Although the coordination of ventilation prior to and during suppression is important for an effective fire attack, the coordination of ventilation post suppression is equally as important for the removal of smoke, enabling a quick return to tenable conditions throughout the structure, and providing better visibility for firefighters conducting interior operations.

Hydraulic ventilation uses the flow of water from the hose stream to entrain air. As the water droplets move forward, an area of low pressure is created in their wake, which draws in surrounding fire gases that are a higher pressure in the direction of the water flow. Essentially, hydraulic ventilation can be thought of as a pull source or negative pressure ventilation. As soon as the fire is knocked-down, firefighters should employ hydraulic ventilation from any available opening in the fire compartment.

INSTRUCTOR NOTES

Single 1½ or 1¾ inch handline with either a combination or smooth bore nozzle set to a flow and pressure of your choice.

Full personal protective ensemble (PPE) recommended.

The streamer flags to visualize air entrainment should be installed and in place at the entrance of the hallway prior to the start of this evolution.

The door from the hallway to the room should be open and the door from the end of the hallway to the outside of the prop should be closed.

ASSOCIATED REFERENCES

Fire Attack Study
Coordinated Fire Attack Study

LEARN MORE

Visit fsri.org/hose-stream-mechanics

1 COMBINATION NOZZLE, FIXED FOG PATTERN

Watch a Demonstration of this Exercise

Technique
Position near the wall of the compartment, opposite the window in the prop and flow water, in a narrow fog pattern, out of the opening.

Nozzle Setting: Narrow Fog Stream

Outcome
The streamers at the start of the hallway will draw into the prop, indicating air entrainment from the hose stream and providing a visualization of the effectiveness of hydraulic ventilation.

Discussion
Hydraulic ventilation uses the flow of water from the hose stream to entrain air. As the water droplets move forward, an area of low pressure is created in their wake, which draws surrounding fire gases that are a higher pressure in the direction of the water flow.

Essentially, hydraulic ventilation can be thought of as a pull source or negative pressure ventilation. The air entrainment experiments tell us this can entrain upwards of 10,000 cubic feet per minute of air.

2 COMBINATION NOZZLE ROTATING FOG PATTERN

Watch a Demonstration of this Exercise

Technique
Position near the wall of the compartment, opposite the window in the prop and flow water, rotating a narrow fog stream into an O pattern, out of the opening.

Nozzle Setting: Narrow Fog Stream

Outcome
The streamers at the start of the hallway will draw into the prop, indicating air entrainment from the hose stream and providing a visualization of the effectiveness of hydraulic ventilation.

Discussion
With a combination nozzle, the most effective means of venting hydraulically is with a narrow fog stream rotated in an O pattern. The air entrainment experiments tell us this can entrain upwards of 10,000 to 15,000+ cubic feet per minute of air.

3 COMBINATION NOZZLE ROTATING STRAIGHT STREAM

Watch a Demonstration of this Exercise

Technique
Position to the rear wall of the compartment, opposite the window in the prop and flow water, rotating a straight stream into an O pattern, out of the opening.

Nozzle Setting: Straight Stream

Outcome
The streamers at the start of the hallway will draw into the prop, indicating air entrainment from the hose stream and providing a visualization of the effectiveness of hydraulic ventilation.

Discussion
The nozzle operator can employ a straight stream, rotated in an O pattern out of the opening as an alternative means of hydraulic ventilation. The air entrainment experiments tell us this can entrain between 4,000 to 6,000 cubic feet per minute of air.

4 SMOOTH BORE NOZZLE, TIP REMOVED

Watch a Demonstration of this Exercise

Technique
Position near the wall of the compartment, opposite the window in the prop and flow water with the smooth bore tip removed, opening the bale 1/3 to 1/2, and rotating the broken stream out of the opening.

Nozzle Setting: 1/2 Bale Broken Stream

Outcome
The streamers at the start of the hallway will draw into the prop, indicating air entrainment from the hose stream and providing a visualization of the effectiveness of hydraulic ventilation.

Discussion
With a smooth bore nozzle, the most effective method is to remove the tip, open the bale to between1/3 and 1/2, and rotate the broken stream into an O pattern out of the opening.

5 SMOOTH BORE NOZZLE, ROTATING SOLID STREAM

Watch a Demonstration of this Exercise

Technique
Position near the wall of the compartment, opposite the window in the prop, and flow water, rotating a solid stream into an O pattern, out of the opening.

Nozzle Setting: Solid Stream

Outcome
The streamers at the start of the hallway will draw into the prop, indicating air entrainment from the hose stream and providing a visualization of the effectiveness of hydraulic ventilation.

Discussion
The nozzle operator can also elect to keep the tip on, open the bale fully, and rotate the solid stream out of the opening in the fire compartment. This is comparable to the rotating straight stream from a combination nozzle and will entrain between 4,000 to 6,000 cubic feet per minute of air.

6 COMBINATION NOZZLE ADJUSTING DISTANCE TO OPENING

Watch a Demonstration of this Exercise

Technique
Position at the threshold of the window and flow water with the nozzle initially outside of the opening. Slowly back up into the compartment, increasing the distance between the nozzle and the window opening.

Nozzle Setting: Narrow Fog Stream

Outcome
Observe streamer movement at the entrance. Initially, there will be little to no movement on the streamers, indicating minimal air entrainment from the hose stream. As the distance between the nozzle and the window opening increases and the hose stream fills up more of the opening, the streamer movement towards the inside of the prop will increase, indicating increasing air entrainment.

Discussion
Air entrainment principles tell us that the more broken the stream and the more the stream is manipulated, the more air that will be drawn forward with the droplets. It should also be noted that the further the nozzle operator is from the opening, the more air that will be entrained.

Creating a larger distance from the end of the nozzle to the threshold in which the water leaves the fire compartment allows for more entrainment. The nozzle operator must prevent the hose stream from impacting the frame surrounding the exhaust opening as this will stop the entrainment.