

COMPARTMENTALIZED GAS TURBINES

The *Compartmentalized Gas Turbine Application Profile* (AP 001) provides guidance on fire protection requirements of Gas Turbine applications. In the event of a fire, the Fike Micromist Water Mist Extinguishing System will provide protection for costly hardware, and will also provide a safe working environment.

This Design Guide provides a step by step design process of a Fike Micromist Water Mist Extinguishing System protecting a Gas Turbine Generator. It is intended to be a sample and is not applicable to all Gas Turbine Applications. Fike's Micromist Design, Installation, and Maintenance Manual should be referenced when designing systems.

The sample provided in the design guide will include a Turbine Generator Enclosure, 22 ft (6.71m) long x 18 ft (5.49m) wide x 12 ft (3.66m) high.

STEP #1 - DETERMINE THE HAZARD VOLUME

The first calculation required in the design of a Fike Micromist Fire Extinguishing System for Turbine Generator Enclosures is to determine the volume of the space being protected. Check length and width to confirm enclosure dimensions do not exceed the maximum of 24 ft (7.32m). The 22 ft (6.71m) length and 18 ft (5.49m) width are both less than maximum allowable enclosure dimensions for single system protection. If the dimensions do exceed this limit, see Section 2 of the Fike Micromist Design, Installation, & Maintenance Manual for information on special design parameters.

The volume is determined by multiplying: length x width x height.

$$\text{Volume} = 22 \text{ ft} \times 18 \text{ ft} \times 12 \text{ ft} = 4,752 \text{ ft}^3 \quad (6.71\text{m} \times 5.49\text{m} \times 3.66\text{m} = 134.83 \text{ m}^3)$$

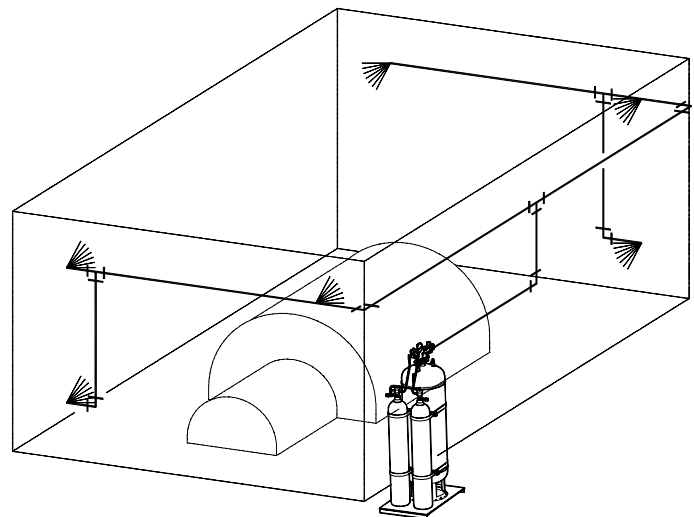
The volume of the enclosure is less than the 9,175 ft³ (260 m³) maximum protected volume allowed for the Fike Micromist Fire Extinguishing System.

STEP #2 - DETERMINE THE NOZZLE GRID

The nozzle grid for Turbine Generator Enclosures is predetermined. All Fike Micromist Systems for Turbine Generator Enclosures consist of six nozzles.

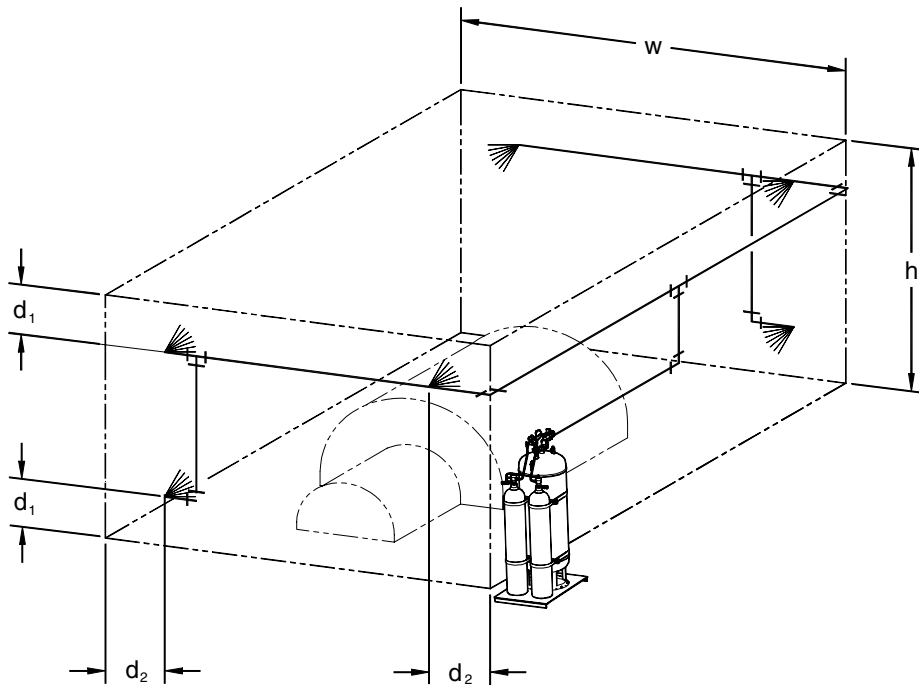
One end wall of the enclosure has two nozzles near the top corners of the wall and one nozzle near one of the bottom corners.

The opposite end wall also has two nozzles near the top corners of the wall, however, the nozzle near the bottom corner is diagonally opposite the nozzle near the bottom corner of the opposite end wall.



STEP #3 - DETERMINE THE NOZZLE SPACING

Calculate the distance from the ceiling down to the upper nozzles. The same formula is used to determine the distance from the floor up to the bottom nozzles.



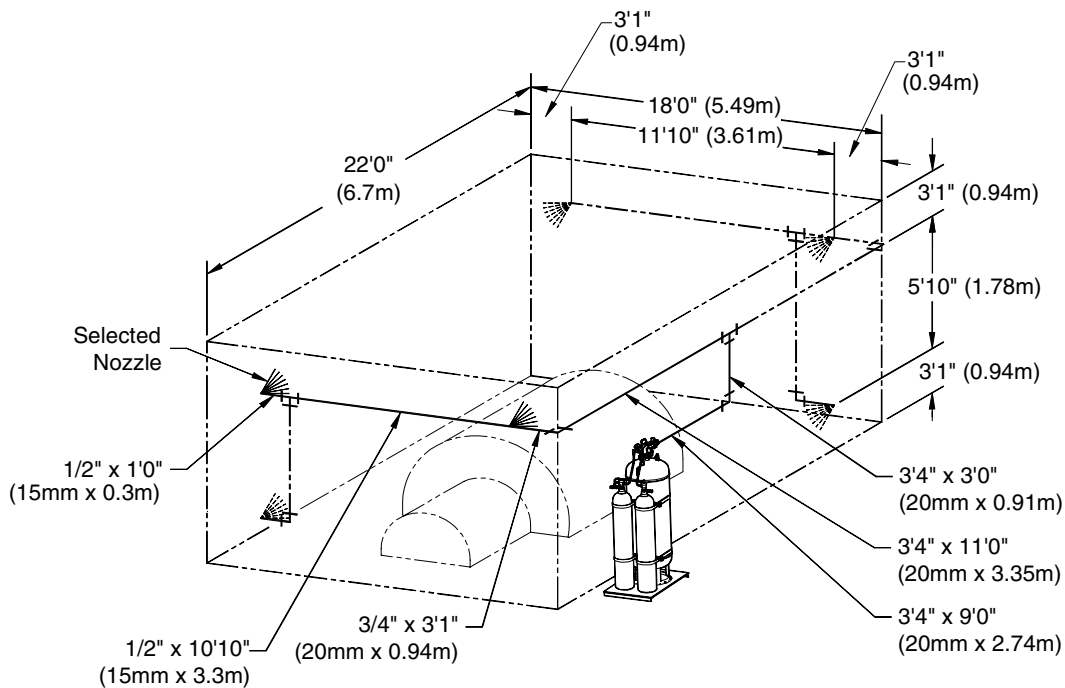
ENGLISH UNITS	METRIC UNITS
Distance: ceiling to upper nozzle and floor to lower nozzle	Distance: ceiling to upper nozzle and floor to lower nozzle
$d_1 = 0.26 \times h$ $d_1 = 0.26 \times 12\text{ft} = 3.12\text{ft} \cong 3'-1''$	$d_1 = 0.26 \times h$ $d_1 = 0.26 \times 3.66\text{m} = 0.95\text{m} \cong 0.94\text{m}$

Calculate the distance from the wall to adjacent nozzles.

ENGLISH UNITS	METRIC UNITS
Distance: Wall to adjacent nozzle	Distance: Wall to adjacent nozzle
$d_2 = 0.17 \times w$ $d_2 = 0.17 \times 18\text{ft} = 3.06\text{ft} \cong 3'-1''$	$d_2 = 0.17 \times w$ $d_2 = 0.17 \times 5.49\text{m} = 0.93\text{m} \cong 0.94\text{m}$

STEP #4 - DETERMINE THE PIPING NETWORK

Calculations must be made to verify that the water will be delivered to the nozzles at the correct pressure.



Example of Turbine Generator Nozzle Piping System

In the example Turbine Generator Enclosure above, the enclosure is 22 ft (6.71m) long by 18 ft (5.49m) wide by 12 ft (3.66m) high. We determined the distance from the ceiling down to the upper nozzles and the floor up to the lower nozzles is 3.12 ft or approximately 3'-1" (0.94m). Also, the distance from the adjacent wall to the nozzles is 3.06 ft or approximately 3'-1" (0.94m). It is now possible to determine our piping system sizing to supply these nozzles. The figure above illustrates a possible piping arrangement for our example enclosure.

STEP #5 - DETERMINE THE PIPE SIZE

In the example shown above, the selected nozzle, or the nozzle to be calculated will be one that is on the end wall near the Water Storage Tank, but farthest from the tank. The lower nozzle is actually farther away, however, there will be a pressure increase gained at this nozzle due to the elevation drop to the nozzle. Therefore, the upper nozzle will have the greater pressure drop. If you are uncertain as to which nozzle is the worst case, you must perform the calculations for each nozzle.

Refer to section 2.2.3.2 in the Micromist Design Manual for the table of Equivalent Lengths of Threaded Pipe Fittings and Bends for the values used in the calculations below. This calculation is made to determine the equivalent length of the piping that connects the selected nozzle to the Water Storage Tank. The equivalent length for a section of pipe is determined by adding the straight length of pipe to the equivalent length of all the fittings in the section. Begin with the section of pipe directly connected to the selected nozzle and proceed with the calculations for each pipe section all the way to the Water Storage Tank. The first section of pipe supplying the selected nozzle consists of a 1'-0" (0.30m) length of 1/2" (15 mm) pipe as well as a 1/2" (15 mm) thru tee and a 1/2" (15 mm) 90° elbow.

The equivalent pipe length for the first pipe section is tabulated below:

ENGLISH UNITS			METRIC UNITS		
Single Nozzle Flow			Single Nozzle Flow		
1'-0" of ½" pipe	=	1.0 ft	0.30 m of 15 mm pipe	=	0.30 m
1pc. ½", 90° elbow	=	1.7 ft	1pc. 15 mm, 90° elbow	=	0.52 m
1pc. ½" thru tee	=	<u>1.0 ft</u>	1pc. 15 mm thru tee	=	<u>0.30 m</u>
Total	=	3.7 ft	Total	=	1.12 m

✘ NOTE: The thru tee is counted in this section because the water flowing thru it supplies a single nozzle.

Now proceed to the next section of pipe. This section is supplying two (2) nozzles and consists of a 10'-10" (3.30 m) length of ½" (15 mm) pipe as well as a ¾" (20 mm) thru tee. Therefore, our equivalent lengths are:

ENGLISH UNITS			METRIC UNITS		
Two (2) Nozzle Flow			Two (2) Nozzle Flow		
10'-10" of ½" pipe	=	10.8 ft	3.30 m of 15 mm pipe	=	3.30 m
1pc. ¾" thru tee	=	1.4 ft	1pc. 20 mm thru tee	=	0.43 m

✘ NOTE: In the two (2) nozzle flow we did not total the equivalent lengths since they are for different sizes of pipe.

Our next section of pipe is for the three (3) nozzle flow:

ENGLISH UNITS			METRIC UNITS		
Three (3) Nozzle Flow			Three (3) Nozzle Flow		
14'-1" of ¾" pipe	=	14.1 ft	4.29 m of 20 mm pipe	=	4.29 m
1pc. ¾" 90° elbow	=	2.2 ft	1pc. 20 mm 90° elbow	=	0.67 m
1pc. ¾" side tee	=	<u>4.5 ft</u>	1pc. 20 mm side tee	=	<u>1.37 m</u>
Total	=	20.8 ft	Total	=	6.33 m

The last section of pipe is for six (6) nozzle flow:

ENGLISH UNITS			METRIC UNITS		
Six (6) Nozzle Flow			Six (6) Nozzle Flow		
12'-0" of ¾" pipe	=	12.0 ft	3.66 m of 20 mm pipe	=	3.66 m
1pc. ¾" 90° elbows	=	<u>2.2 ft</u>	1pc. 20 mm 90° elbows	=	<u>0.67 m</u>
Total	=	14.2 ft	Total	=	4.33 m

To determine the pressure drop for the piping system, we multiply the equivalent lengths for each of the different nozzle flows by their corresponding pressure drop factors.

The pressure drop for each nozzle flow in our example is calculated below:

ENGLISH UNITS			METRIC UNITS		
Pressure Drop			Pressure Drop		
½" @ 1 nozzle flow	-	3.7' x 0.02 = 0.07	15mm @ 1 nozzle flow	-	1.12m x 0.066 = 0.07
½" @ 2 nozzle flow	-	10.8' x 0.08 = 0.86	15mm @ 2 nozzle flow	-	3.30m x 0.262 = 0.86
¾" @ 2 nozzle flow	-	1.4' x 0.02 = 0.03	20mm @ 2 nozzle flow	-	0.43m x 0.066 = 0.03
¾" @ 3 nozzle flow	-	20.8' x 0.04 = 0.83	20mm @ 3 nozzle flow	-	6.33m x 0.131 = 0.83
¾" @ 6 nozzle flow	-	14.2' x 0.16 = <u>2.27</u>	20mm @ 6 nozzle flow	-	4.33m x 0.525 = <u>2.27</u>
		Pressure Drop, psi = 4.06			Pressure Drop, psi = 4.06

The final consideration is the change in system pressure due to elevation. Pressure is changed + 0.43 psi per foot (+ 1.41 psi per meter) of decrease in elevation. Pressure is changed - 0.43 psi per foot (- 1.41 psi per meter) of increase of elevation. The net elevation change to the selected nozzle in our example is an increase of elevation of 3' 4" (1.02 m). This results in a pressure drop, (3.3 ft x -0.43 psi/ft = -1.42 psi or 1.01 m x - 1.41 psi/m = -1.42 psi). This value is added to the Pressure Drop determined above. The Pressure Drop from the example is 4.06 psi. Since pressure drops are negative values, the Total System Pressure Drop = (-4.06) psi + (-1.42) psi = -5.48 psi (37.8 kPa). This is the Total System Pressure Drop, from the Water Storage tank to the selected or worst case nozzle.

Therefore, our example system meets the requirement of a total pressure drop less than 20 psi (138 kPa).

STEP #6 – DEVELOP A FIKE MICROMIST PARTS LIST

Fike Micromist <i>Sample</i> Parts List – Gas Turbine Application		
Quantity	Description	Part Number
1	107 (405liter) Gallon System w/LPS	73-002
6	Turbine Generator Nozzles	73-0023
1	Cheetah Control System, 110VAC	10-052-R-1
1	Battery Assembly, 7AH	10-2190-1
2	325° Thermal Detectors	60-022
2	Manual Release Station	10-1638
2	Horn/Strobe Device, 15/75 Candela	20-098
5	Fast Response Contact Module (FRCM)	55-019
1	Supervised Output Module (SOM)	55-021
1	Solenoid Releasing Module (SRM)	55-022
1	Dual Relay Module (R2M)	55-023



NOTES:

- Fast Response Contact Module Count:
 2 – Thermal Detectors
 1 – Micromist Low Pressure Switch
 1 – Micromist Liquid Level Indicator
 1 – Manual Release Station Circuit

 5 – FRCM's Total
- The Micromist System has two 12V DC solenoids. One (1) on the high-pressure side (Nitrogen) and one (1) on the low pressure side (Water). The two (2) solenoids are wired in series. They energize and de-energize simultaneously; therefore only one (1) Solenoid Releasing Module (SRM) is required per Micromist System.

