nozzles are believed to be ineffective in the protection of equipment in cable tunnels and other similarly situated equipment and occupied areas. It is believed that in the presence of a fire in certain equipment and/or occupied areas, the generated mist from total flooding nozzle heads are not sufficient to cool the surrounding environment or control the fire within desired limits. It is believed that a likely cause for the performance deficiency is that the droplets in the total flooding, homogenous mist lose their velocity shortly after leaving the nozzle heads. The low velocity droplets tend to get pushed away from the fire by the air currents. Thus for certain applications, it is believed that the total flooding mist does not actively or directly impinge the fire and instead only cools the upper gas layer above the fire.

Disclosure of the Invention

[0004] Preferred embodiments of a water mist nozzle device generate a mist that provides a mixture of droplet sizes for both indirect impingement mist protection (total flooding) and additionally direct impingement mist and/or spray protection to address a fire. The preferred devices include a main body with multiple orifice nozzles or orifice inserts secured to the body. Differently configured orifice inserts are used to provide the varying spray patterns and mist from a single device. In preferred embodiments of the device, one type of orifice insert discharges a mist that includes a droplet size that is larger the droplet size of a mist discharged from the another type of orifice insert of the device.

[0004a] According to one aspect, a water mist nozzle comprises a body having a central bore extending along a central longitudinal nozzle axis, the body including a plurality of sockets formed about the central bore, each socket including a lateral bore extending between the socket and the central bore along a lateral axis. The water mist nozzle also comprises a plurality of orifice inserts, each orifice insert having at least one inlet, at least one outlet and an internal

chamber disposed along a central insert axis for fluid communication with the at least one inlet and the at least one outlet, each orifice insert being disposed in one of the plurality of sockets so as to axially align the insert axis with the lateral bore of the socket obliquely intersecting the central longitudinal nozzle axis, the plurality of orifice inserts including indirect impingement orifice inserts and at least one direct impingement orifice insert. The at least one direct impingement orifice insert includes a plurality of outlets surrounding the central insert axis, each outlet extending obliquely with respect to the central insert axis to define an included angle ranging from 20° to 25°, and discharging a mist with a droplet size greater than the droplet size of a mist discharged from at least one outlet of the indirect impingement orifice inserts.

[0004b] According to another aspect, a water mist nozzle comprises a body having a central bore extending along a central longitudinal nozzle axis, the body including a plurality of sockets formed about the central bore, each socket including a lateral bore extending between the socket and the central bore along a lateral axis. The water mist nozzle also comprises a plurality of orifice inserts, each orifice insert having at least one inlet, at least one outlet and an internal chamber extending axially between the at least one inlet and the at least one outlet along a central insert axis, each orifice insert being disposed in one of the plurality of sockets so as to axially align the insert axis with the lateral bore of the socket obliquely intersecting the central longitudinal nozzle axis, the plurality of orifice inserts including orifice inserts of a first type and orifice inserts of at least a second type different than the first type, the at least one inlet of the first type of orifice insert including a plurality of inlets having a portion extending transversely with respect to the insert axis, the at least one inlet of the second type of orifice being coaxially aligned with the insert axis. The second type of orifice insert includes a plurality of outlets surrounding the central insert axis, each outlet extending obliquely with respect to the central

insert axis to define an included angle ranging from 20° to 25°, and discharging a mist with a droplet size greater than the droplet size of a mist discharged from at least one outlet of the first type of orifice inserts.

[0004c] According to another aspect, a water mist nozzle comprises a body having a central bore extending along a central longitudinal nozzle axis. The water mist nozzle also comprises a plurality of orifice inserts disposed about the central bore, each orifice insert having at least one inlet, at least one outlet and an internal chamber extending axially between the inlet and the at least one outlet along a central insert axis, the plurality of orifice inserts including orifice inserts of a first type and orifice inserts of at least a second type, the at least one outlet of the first type of orifice insert being axially aligned along the insert axis, the at least one outlet of the second type of orifice insert including a plurality of outlets surrounding the insert axis, each extending obliquely with respect to the insert axis to define an included angle ranging from 20° to 25°, and each discharging a mist with a droplet size greater than the droplet size of a mist discharged from at least one outlet of the first type of orifice insert.

[0004d] According to another aspect, a water mist nozzle comprises a body having a central bore extending along a central longitudinal nozzle axis. The water mist nozzle also comprises a plurality of nozzles disposed about the central bore including a plurality of indirect impingement nozzles and at least one direct impingement nozzle.

[0005] One preferred embodiment of a water mist nozzle includes a body having a central bore extending along a central longitudinal nozzle axis. The body includes a plurality of sockets formed about the central bore. Each socket includes a lateral bore extending between the socket and the central bore. The nozzle also includes a plurality of orifice inserts. Each orifice insert has at least one inlet, at least one outlet and an internal chamber disposed along a central insert

What is Claimed Is:

1. A water mist nozzle comprising:

a body having a central bore extending along a central longitudinal nozzle axis, the body including a plurality of sockets formed about the central bore, each socket including a lateral bore extending between the socket and the central bore along a lateral axis; and

a plurality of orifice inserts, each orifice insert having at least one inlet, at least one outlet and an internal chamber disposed along a central insert axis for fluid communication with the at least one inlet and the at least one outlet, each orifice insert being disposed in one of the plurality of sockets so as to axially align the central insert axis with the lateral bore of the socket obliquely intersecting the central longitudinal nozzle axis, the plurality of orifice inserts including indirect impingement orifice inserts and at least one direct impingement orifice insert, wherein at least one outlet of the at least one direct impingement orifice insert includes a plurality of outlets surrounding the central insert axis, wherein each of the plurality of outlets extends obliquely with respect to the central insert axis to define an included angle ranging from 20° to 25°, and wherein each of the plurality of outlets discharges a mist with a droplet size greater than the droplet size of a mist discharged from at least one outlet of the indirect impingement orifice inserts.

2. The nozzle of claim 1, wherein the at least one inlet of the at least one direct impingement orifice insert is a single inlet extending coaxially with the central insert axis.

3. The nozzle of claim 1, wherein the plurality of outlets of the at least one direct impingement orifice insert include four outlets.

4. The nozzle of any one of the above claims, wherein the at least one direct impingement orifice insert defines an installation orientation with respect to a ground such that the at least one direct impingement orifice insert is oriented to the ground with the central longitudinal nozzle axis being disposed at a downward angle ranging from 5°-20° with respect to a horizontal parallel to ground.

5. The nozzle of claim 4, wherein the downward angle ranges from 8°-18°.

6. The nozzle of any one of the above claims, wherein the body includes a socket axially aligned with the central longitudinal nozzle axis in communication with the central bore, the nozzle further comprising a central orifice insert axially aligned with the central longitudinal nozzle axis.

7. The nozzle of claim 6, wherein the central orifice insert is a direct impingement orifice insert.

8. The nozzle of claim 6, wherein the central orifice insert is an indirect impingement orifice insert.

9. The nozzle of any one of the above claims, wherein at least one of the indirect impingement orifice inserts includes at least one inlet with a transversely extending portion extending transversely with respect to the central insert axis and in fluid communication with the internal chamber.

10. The nozzle of claim 9, wherein the at least one inlet of the at least one of the indirect impingement orifice inserts includes a pair of inlets disposed about the central insert axis with the transversely extending portions extending in opposite directions.

11. The nozzle of claim 10, wherein the internal chamber is defined by an internal wall circumscribed about the central insert axis, the transversely extending portions being disposed to discharge fluids therefrom substantially tangentially.

12. The nozzle of any one of the above claims, wherein at least one of the indirect impingement orifice inserts includes a cap member disposed within the internal chamber, the at least one inlet of the at least one of the indirect impingement orifice inserts being disposed about the periphery of the cap member.

13. The nozzle of any one of the above claims, wherein the at least one inlet of the at least one direct impingement orifice insert extends substantially parallel to the central insert axis.

14. The nozzle of any one of the above claims, wherein the plurality of orifice inserts includes three indirect impingement orifice inserts and one direct impingement orifice insert equiangularly spaced about the central longitudinal nozzle axis.

15. The nozzle of any one of the above claims, wherein the nozzle is an open nozzle.

16. The nozzle of any one of claims 1-14, wherein the nozzle is an automatic nozzle, the nozzle including a piston disposed in the central bore and a thermally responsive trigger supporting the piston within the central bore to prevent fluid discharge from the nozzle.

17. The nozzle of any one of the above claims, wherein the nozzle has a discharge characteristic quantified by a K-factor of about K-factor of 0.1 gpm/psi$^{(1/2)}$.

18. A water mist nozzle comprising:

a body having a central bore extending along a central longitudinal nozzle axis, the body including a plurality of sockets formed about the central bore, each socket including a lateral bore extending between the socket and the central bore along a lateral axis; and

a plurality of orifice inserts, each orifice insert having at least one inlet, at least one outlet and an internal chamber extending axially between the at least one inlet and the at least one outlet along a central insert axis, each orifice insert being disposed in one of the plurality of sockets so as to axially align the central insert axis with the lateral bore of the socket obliquely intersecting the central longitudinal nozzle axis, the plurality of orifice inserts including orifice inserts of a first type and orifice inserts of a second type different than the first type, at least one inlet of at least one of the orifice inserts of the first type including a plurality of inlets having a transversely extending portion extending transversely with respect to the central insert axis, at least one inlet of at least one of the orifice inserts of the second type being coaxially aligned with the central insert axis, wherein at least one outlet of the at least one of the orifice inserts of the second type includes a plurality of outlets surrounding the central insert axis, wherein each of the plurality of outlets extends obliquely with respect to the central insert axis to define an included angle ranging from 20° to 25°, and wherein each of the plurality of outlets discharges a mist with a droplet size greater than the droplet size of a mist discharged from at least one outlet of the at least one of the orifice inserts of the first type.

19. The nozzle of claim 18, wherein the plurality of inlets of the at least one of the orifice inserts of the first type include a pair of inlets disposed about the central insert axis with the transversely extending portions extending in opposite directions.

20. The nozzle of any one of claims 18-19, further comprising a cap disposed within the internal chamber of the at least one of the orifice inserts of the first type.

21. The nozzle of any one of claims 18-20, further comprising a central orifice insert axially aligned with the central longitudinal nozzle axis.

22. The nozzle of claim 21, wherein the central orifice insert is of the first type.

23. The nozzle of claim 21, wherein the central orifice insert is of the second type.

24. The nozzle of any one of claims 18-23, wherein the plurality of orifice inserts includes three orifice inserts of the first type and one orifice insert of the second type equiangularly spaced about the central longitudinal nozzle axis.

25. The nozzle of any one of claims 18-24, wherein the at least one of the orifice inserts of the second type defines a nozzle orientation with respect to a ground such that the at least one of the orifice inserts of the second type is oriented to the ground with the central longitudinal nozzle axis being disposed at a downward angle ranging from 5°-20° with respect to a horizontal parallel to the ground.

26. The nozzle of any one of claims 18-25, wherein the nozzle is an open nozzle.

27. The nozzle of any one of claims 18-25, wherein the nozzle is an automatic nozzle, the nozzle including a piston disposed in the central bore and a thermally responsive trigger supporting the piston within the central bore to prevent fluid discharge from the nozzle.

28. The nozzle of any one of claims 18-27, wherein the nozzle has a discharge characteristic quantified by a K-factor of about K-factor of 0.1 gpm/psi$^{(1/2)}$.

29. A water mist nozzle comprising:

a body having a central bore extending along a central longitudinal nozzle axis; and

a plurality of orifice inserts disposed about the central bore, each orifice insert having at least one inlet, at least one outlet and an internal chamber extending axially between the at least one inlet and the at least one outlet along a central insert axis, the plurality of orifice inserts including orifice inserts of a first type and orifice inserts of a second type, at least one outlet of at least one of the orifice inserts of the first type being axially aligned along the central insert axis, at least one outlet of at least one of the orifice inserts of the second type including a plurality of outlets surrounding the central insert axis, each of the plurality of outlets extending obliquely with respect to the central insert axis to define an included angle ranging from 20° to 25°, and each of the plurality of outlets discharging a mist with a droplet size greater than the droplet size of a mist discharged from at least one outlet of the at least one of the orifice inserts of the first type.

30. The nozzle of claim 29, wherein the at least one of the orifice inserts of the second type defines a nozzle orientation with respect to a ground such that the at least one of the orifice inserts of the second type is oriented to the ground with the central longitudinal nozzle axis being disposed at a downward angle ranging from 5°-20° with respect to a horizontal parallel to ground.

31. The nozzle of claim 30, wherein the downward angle ranges from 8°-18°.

32. The nozzle of any one claims 29-31, wherein the nozzle is an open nozzle.

33. The nozzle of any one of claims 29-31, wherein the nozzle is an automatic nozzle, the nozzle including a piston disposed in the central bore and a thermally responsive trigger supporting the piston within the central bore to prevent fluid discharge from the nozzle.

34. A method of water mist nozzle protection comprising:

generating a first type of fluid mist from a first type of orifice insert disposed in one of a plurality of sockets formed in a nozzle body into which a firefighting fluid is introduced; and

generating a second type of fluid mist from a second type of orifice insert disposed in another one of the plurality of sockets formed in the nozzle body, the second type of fluid mist having a droplet size that is greater than the first type of fluid mist to directly impinge a fire, wherein the second type of orifice insert includes at least one inlet, a plurality of outlets and an internal chamber extending axially between the at least one inlet and the plurality of outlets along a central insert axis, and wherein each of the plurality of outlets extends obliquely with respect to the central insert axis to define an included angle ranging from 20° to 25°.

35. The method of claim 34, wherein the generating the second type of fluid mist includes introducing the firefighting fluid into the at least one inlet and through the internal chamber extending along the central insert axis of the second type of orifice insert; and discharging the fluid out of at least one of the plurality of outlets extending through a floor of the internal chamber of the second type of orifice insert.

36. The method of claim 35, wherein the discharging includes discharging out of the plurality of outlets obliquely with respect to the central insert axis to define an included angle ranging from 22°-22.5°.

37. The method of any one of claims 34-36, wherein generating the first type of fluid mist includes introducing the firefighting fluid into an inlet of the first type of orifice insert and through an internal chamber of the first type of orifice insert with a swirling effect.

38. A method of water mist nozzle protection comprising:

installing at least two water mist nozzles above a ground to protect an area or object, each nozzle having a plurality of orifice inserts about a nozzle axis with at least one orifice insert configured for generating a first mist to address a fire with indirect impingement and at least one orifice insert facing the floor and configured for generating a second mist to address a fire with direct impingement; and

orienting each nozzle so that the nozzle axis of each of the at least two nozzles defines an included angle ranging from 5°-20° with respect to a horizontal parallel to ground, the included angles of the at least two nozzles being different from one another.

39. The method of claim 38, wherein each of the at least two nozzles is oriented one of 8° or 18°.

40. The method of claim 39, wherein the installing includes spacing the at least two nozzles five feet apart and disposed ten feet (10ft.) above the ground to define a collection density of 0.12 gpm/sq ft. of water between the two nozzles three feet in front and three feet offset from one of the two nozzles.

41. The method of any one of claims 38-40, wherein the generating the second mist includes generating a droplet size greater than a droplet size of the first mist, generating the second mist includes introducing the firefighting fluid into an inlet and through an internal chamber extending along an insert axis of the at least one orifice insert facing the floor; and discharging the fluid out of at least one outlet extending through a floor of the internal chamber.

42. The method of claim 41, wherein the discharging the fluid out of at least one outlet includes discharging the fluid out of a plurality of outlets.

43. The method of claim 42, wherein the discharging include discharging out of the plurality of outlets obliquely with respect to the insert axis to define at an included angle ranging from 22°-22.5°.

44. The method of any one of claims 38-43, wherein generating the first mist includes introducing the firefighting fluid into an inlet of the at least one orifice insert configured for generating the first mist and through an internal chamber of the at least one orifice insert configured for generating the first mist with a swirling effect.