Claims

1. A ceiling-only storage occupancy fire protection system comprising:

a grid of pendent fire protection sprinklers defining a sprinkler-to-sprinkler spacing ranging from eight feet to twelve feet (8 ft.-12 ft.), each pendent sprinkler being a quick response storage sprinkler, each sprinkler including:

a sprinkler body having an inlet and an outlet with a passageway disposed therebetween along a sprinkler axis and a nominal K-factor of 22.4 [GPM/(psi)$^{1/2}$] to 33.6 [GPM/(psi)$^{1/2}$];

a closure assembly including a plug;

a thermally responsive trigger assembly to support the closure assembly adjacent the outlet of the sprinkler body, the trigger assembly having a temperature rating in a range of 155° F. to 210° F.; and

a deflector coupled to the body and spaced from the outlet; and

a network of pipes including at least one main pipe and a plurality of spaced apart branch lines interconnecting and locating the grid of pendent quick response storage sprinklers beneath a ceiling having a ceiling height, the network of pipes being filled with a firefighting fluid and locating the grid of sprinklers relative to a source of the firefighting fluid in which a number of hydraulically most remote sprinklers in the grid of sprinklers define a hydraulic design area of the system, the network of pipes delivering to each sprinkler in the hydraulic design area at least a minimum flowing pressure of forty to one hundred pounds per square inch (40-100 psi.) upon sprinkler actuation in order to provide protection of high-piled storage including at least one commodity including any one of Class 1, Class 2, Class 3, Class 4 and cartoned unexpanded plastic commodities and combinations thereof, stored beneath the ceiling, the at least one commodity having a maximum storage height, the storage having a configuration of rack storage or non-rack storage, the rack storage being any one of single-row, double-row, and multi-row rack storage, the non-rack storage being any one of palletized, solid-piled, shelf, and bin-box storage;

wherein the number of hydraulically most remote sprinklers defining the hydraulic design area is nine to less than twelve (9-12) and the ceiling has a ceiling height of up to a maximum fifty-five feet (55 ft.) and the at least one commodity has a maximum storage height of fifty feet (50 ft.) with the ceiling height being at least five (5) feet greater than the maximum storage height;

wherein the hydraulically most remote sprinklers defining the hydraulic design area comprise at least (1) a first group of three sprinklers on a first branch line, a second group of three sprinklers on a second branch line, a third group of three sprinklers on a third branch line, the first, second, and third branch lines being separate branch lines of the plurality of spaced apart branch lines, or (2) a first group of four sprinklers on a first branch line and a second group of four sprinklers on a second line, the first and second branch lines being separate branch lines of the plurality of spaced apart branch lines.

2. The ceiling-only storage occupancy fire protection system of claim 1, wherein the nominal K-factor comprises 25.2 [GPM/(psi)$^{1/2}$], and wherein the minimum flowing

pressure of each pendent sprinkler in the hydraulic design area comprises a minimum flowing pressure of fifty pounds per square inch (50 psi.).

3. The ceiling-only storage occupancy fire protection system of claim 1, wherein the nominal K-factor comprises 28.0 [GPM/(psi)$^{1/2}$], wherein the minimum flowing pressure of each pendent sprinkler in the hydraulic design area comprises a minimum flowing pressure of forty pounds per square inch (40 psi.).

4. The ceiling-only storage occupancy fire protection system of claim 3, wherein the minimum flowing pressure of each pendent sprinkler in the hydraulic design area provides a minimum flow in gallons per minute (GPM) from the hydraulic design area, wherein the minimum flow comprises less than 2500 GPM.

5. The ceiling-only storage occupancy fire protection system of claim 1, wherein the deflector has a perimeter portion and a central portion with the perimeter portion including a plurality of spaced apart tines defining a slot between adjacent tines, each slot having a first width at the perimeter of the deflector and radiused portion between the first width and the central portion, a terminal end of each tine being located on a circle concentric to the sprinkler axis, a first group of tines being located on a first circle having a first diameter, and a second group of tines being located on a second circle having a second diameter less than the first diameter.

6. The ceiling-only storage occupancy fire protection system of claim 1, wherein the thermally responsive trigger assembly of each sprinkler includes a strut lever arrangement with a fusible link.

7. The ceiling-only storage occupancy fire protection system of claim 6, wherein the fusible links of the sprinklers have a consistent operability with an RTI ranging from 19 to 36 (m*s)$^{1/2}$ [35-65 (ft.*s)$^{1/2}$].

8. The ceiling-only storage occupancy fire protection system of claim 1, wherein the deflector of each sprinkler in the grid of pendent quick response storage sprinklers is located up to fourteen inches (14″) below the ceiling.

9. The suppression mode ceiling-only storage occupancy fire protection system of claim 8, wherein the deflector of each sprinkler in the grid of pendent quick response storage sprinklers is located up to eighteen inches (18″) below the ceiling.

10. The ceiling-only storage occupancy fire protection system of claim 1, wherein the rack storage has an aisle width that ranges from 4-8 ft.

11. The ceiling-only storage occupancy fire protection system of claim 10, wherein the aisle width is 6 ft.

12. A method of providing a ceiling-only storage occupancy fire protection system, the method comprising:

installing a grid of pendent quick response storage sprinklers in a network of pipes, the sprinklers defining a sprinkler-to-sprinkler spacing ranging from eight feet to twelve feet (8 ft.-12 ft.) within two feet of a ceiling, each sprinkler including: a sprinkler body having an orifice with an inlet and an outlet with a passageway disposed therebetween along a sprinkler axis, the orifice defining a nominal K-factor in a range of 22.4 [GPM/(psi)$^{1/2}$] to 33.6 [GPM/(psi)$^{1/2}$], a closure assembly including a plug; a thermally rated trigger assembly to support the closure assembly adjacent the outlet of the sprinkler body, the trigger assembly having a temperature rating in a range of 155° F. to 210° F., and a deflector coupled to the body and spaced from the outlet; and

connecting the network of pipes to a source of firefighting fluid in which hydraulically remote sprinklers in the grid of quick response storage sprinklers define a hydraulic design area of the system, the network of pipes configured to supply to each sprinkler in the hydraulic design area at least a minimum flowing pressure of forty to less than one hundred per square inch (40-100 psi.) upon sprinkler actuation to provide protection of high-piled storage including at least one commodity including any one of Class 1, Class 2, Class 3, Class 4 and cartoned unexpanded plastic commodities and combinations thereof, stored beneath a ceiling having a ceiling height, the commodity having a maximum storage height, the storage having a configuration of rack storage or non-rack storage, the rack storage being any one of single-row, double-row, and multi-row rack storage, the non-rack storage being any one of palletized, solid-piled, shelf, and bin-box storage, and the ceiling having a maximum ceiling height of up to fifty-five feet (55 ft.) and the storage commodity having a maximum storage height of up to fifty feet (50 ft.) with the ceiling height being at least five (5) feet greater than the maximum storage height;

wherein the number of hydraulically remote sprinklers defining the hydraulic design area is less than twelve (12) and wherein the hydraulically remote sprinklers defining the hydraulic design area comprise at least (1) a first group of three sprinklers on a first branch line, a second group of three sprinklers on a second branch line, a third group of three sprinklers on a third branch line, the first, second, and third branch lines being separate branch lines of a plurality of spaced apart branch lines, or (2) a first group of four sprinklers on a first branch line and a second group of four sprinklers on a second branch line, the first and second branch lines being separate branch lines of a plurality of spaced apart branch lines.

13. The method of claim 12, wherein the nominal K-factor comprises 25.2 [GPM/(psi)$^{1/2}$], and the connecting the network of pipes is configured to supply to each sprinkler in the hydraulic design area with the minimum flowing pressure of fifty pounds per square inch (50 psi.).

14. The method of claim 12, wherein the installing defines the sprinkler-to-sprinkler spacing at eight feet (8 ft.).

15. The method of claim 12, wherein the connecting defines that each pendent quick response storage sprinkler in the hydraulic design area provides a minimum flow in gallons per minute (GPM) less than 2500 GPM.

16. The method of claim 12, wherein the nominal K-factor comprises 28.0 [GPM/(psi)$^{1/2}$], and the connecting the network of pipes is configured to supply to each sprinkler in the hydraulic design area with a minimum flowing pressure of forty pounds per square inch (40 psi.).

17. The method of claim 12, wherein the deflector has a perimeter portion and a central portion with the perimeter portion including a plurality of spaced apart tines defining a slot between adjacent tines, each slot having a first width at the perimeter of the deflector and radiused portion between the first width and the central portion, a terminal end of each tine being located on a circle concentric to the sprinkler axis, a first group of tines being located on a first circle having a first diameter, and a second group of tines being located on a second circle having a second diameter less than the first diameter.

18. The method of claim 12, wherein the rack storage has an aisle width that ranges from 4-8 ft.

19. The method of claim 12, wherein the thermally rated trigger assembly of each sprinkler includes a strut lever arrangement with a fusible link or a frangible glass bulb.

20. A method of supplying a ceiling-only storage occupancy fire protection system, the method comprising:

obtaining a plurality of pendent quick response storage sprinklers, each sprinkler including: a sprinkler body having an orifice with an inlet and an outlet with a passageway disposed therebetween along a sprinkler axis, the orifice defining a nominal K-factor in a range of 22.4 [GPM/(psi)$^{1/2}$] to 33.6 [GPM/(psi)$^{1/2}$], a closure assembly including a plug; a thermally rated trigger assembly to support the closure assembly adjacent the outlet of the sprinkler body, the trigger assembly having a temperature rating in a range of 155° F. to 210° F., and a deflector coupled to the body and spaced from the outlet; and

providing the plurality of pendent quick response storage sprinklers for installation in a grid of sprinklers relative to a source of firefighting fluid in which hydraulically remote sprinklers in the grid of sprinklers define a hydraulic design area of the system of no more than ten (10) sprinklers with each sprinkler in the grid of sprinklers being provided with at least a minimum flowing pressure upon sprinkler actuation to provide fire protection of high-piled storage including at least one commodity of one of Class 1, Class 2, Class 3, Class 4 and cartoned unexpanded plastic and combinations thereof stored beneath a ceiling having a ceiling height, the commodity having a maximum storage height of up to fifty feet (50 ft.), the storage having a configuration of rack storage or non-rack storage, the rack storage being any one of single-row, double-row, and multi-row rack storage, the non-rack storage being any one of palletized, solid-piled, shelf, and bin-box storage, and with the ceiling height being at least five (5) feet greater than the maximum storage height up to a maximum ceiling height of fifty-five feet (55 ft.);

wherein the hydraulically remote sprinklers defining the hydraulic design area comprise at least (1) a first group of three sprinklers on a first branch line, a second group of three sprinklers on a second branch line, a third group of three sprinklers on a

third branch line, the first, second, and third branch lines being separate branch lines of a plurality of spaced apart branch lines, or (2) a first group of four sprinklers on a first branch line and a second group of four sprinklers on a second branch line, the first and second branch lines being separate branch lines of a plurality of spaced apart branch lines.

21. The method of claim 20, wherein the obtaining includes obtaining each of the plurality of pendent sprinklers having the nominal K-factor comprising 25.2 [GPM/(psi)$^{1/2}$], and the providing includes providing the plurality of sprinklers for connection to a network of pipes configured to supply to each sprinkler in the hydraulic design area with the minimum flowing pressure of fifty pounds per square inch (50 psi.).

22. The method of claim 20, wherein the providing includes providing the plurality of sprinklers for installation to define that the pendent sprinklers in the hydraulic design area provides a minimum flow in gallons per minute (GPM) less than 2500 GPM.

23. The method of claim 20, wherein the nominal K-factor comprises 28.0 [GPM/(psi)$^{1/2}$], and the providing includes providing the plurality of sprinklers for connection to a network of pipes to supply to each sprinkler in the hydraulic design area with the minimum flowing pressure of forty pounds per square inch (40 psi.).

24. The method of claim 20, wherein the deflector has a perimeter portion and a central portion with the perimeter portion including a plurality of spaced apart tines defining a slot between adjacent tines, each slot having a first width at the perimeter of the deflector and radiused portion between the first width and the central portion, a terminal end of each tine being located on a circle concentric to the sprinkler axis, a first group of tines being located on a first circle having a first diameter, and a second group of tines being located on a second circle having a second diameter less than the first diameter.

25. The method of claim 20, wherein the rack storage has an aisle width that ranges from 4-8 ft.

26. The method of claim 20, wherein the minimum flowing pressure of each pendent sprinkler in the hydraulic design area provides a minimum flow in gallons per minute (GPM) from the hydraulic design area, wherein the minimum flow comprises no more than 2000 GPM.

27. The method of claim 20, wherein the thermally rated trigger assembly of each sprinkler includes a strut lever arrangement with a fusible link or a frangible glass bulb.