



**WATER MIST FIRE PROTECTION**

**General Specification for Self Contained System**



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# WATER MIST FIRE PROTECTION

## PART 1 GENERAL

### 1.1 REFERENCES

- A. Publications listed below form part of specification to the extent referenced. Publications are referenced in text by basic designation only. Use latest approved revision of all references.
1. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
    - a. ANSI/ASME B31.1 Power Piping Code.
  2. DIN STANDARDS (EUROPEAN COMPONENTS)
    - a. DIN 2391, 3861, 3865, 20078, 17457, 17458  
As referenced for European fittings pipe, and tube.
  3. FACTORY MUTUAL APPROVALS (FM)
    - a. FM Approval Standard for Water Mist Systems Class Number 5560.
  4. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
    - a. NFPA 13 Standard for the Installation of Sprinkler Systems.
    - b. ANSI/NFPA 70 National Electrical Code.
    - c. NFPA 72 National Fire Alarm Code.
    - d. NFPA 750 Standard on Water Mist Fire Protection Systems.
    - e. NFPA 25 Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
  5. INTERNATIONAL STANDARDS ORGANIZATION (ISO)
    - a. ISO 261 Standards for Ermetto (EO) high-pressure compression fittings SEE PARKER Fluid Connectors Catalog: Flareless DIN 3861, 3865 and 20078; Weld nipple DIN 3865.

- b. ISO 8434-1, Tube/Hose Connections.

## 1.2 SYSTEM COMPLETENESS

- A. Provide systems complete, workable, and ready for operation.

## 1.3 DESIGN REQUIREMENTS

- A. General
  - 1. This Specification applies to the design, installation and commissioning of a Pre-Engineered high-pressure self-contained water mist fire protection system for the total compartment protection of Machinery Spaces, Turbine Enclosures and Special Hazard Machinery Spaces Applications.
  - 2. Design and installation of the water mist systems shall meet the applicable requirements of NFPA 750 and FM Approval Standard 5560 except where variances are permitted by this Specification.
  - 3. The Pre-Engineered System shall have passed the fire test portion of the FM Approval Standard 5560 or other international standards for High Pressure Water Mist Systems for the Hazard being protected.

## 1.4 SYSTEM DESCRIPTION

- A. Supply and install a HI-FOG<sup>®</sup> water mist fire protection system to protect gas machinery type spaces where Class B combustibles offer a fire hazard. The system shall be of the high pressure type, single tubing and the water application rate shall not exceed 0.055 l/m<sup>3</sup>/min.
- B. The water droplet shall have a volumetric diameter where  $Dv_{0.99}$  shall be less than 100  $\mu\text{m}$  at the beginning of the discharge and it shall not be more than 50  $\mu\text{m}$  after eight minutes of discharge.
- C. The system shall be fitted with water reservoirs designed for high pressure operation (up to 4000 psi). The maximum volume of water, for every 10 minutes of protection required and a volume of 260 m<sup>3</sup> (9,175 ft<sup>3</sup>), shall not exceed 150 liters (40 US gallons)
- D. The minimum period of protection shall be 10 minutes or that established by the turbine manufacturer as the required or minimum coast down period of the turbine.
- E. The system shall be completely modular and shall be supplied in skids containing no more than 3 water cylinders each factory assembled and tested.

- F. Each skid shall be supplied with a single discharge and control valve. In order to accommodate multi skid systems, the discharge control valve for the slave cylinders shall be pneumatically and manually actuated only while the master cylinder shall be electrically or manually actuated.
- G. The discharge control valve shall be fitted with a pressure gauge and a pressure switch that provide information on the status of the nitrogen cylinder pressure.
- H. A pressure switch shall be fitted on the discharge manifold to provide indication of discharge, in case of manual discharge.
- I. The HI-FOG<sup>®</sup> system shall be automatically actuated by means of a fire detection and control panel. The means to release the system manually at the skid shall be provided.
- J. The HI-FOG<sup>®</sup> system shall be fitted with one high pressure nitrogen cylinder. The nitrogen cylinder shall be of the off-the-shelf type and shall be fitted with standard hand wheel type valves. The nitrogen cylinder shall be sized in accordance with the system approval
- K. For spaces less than or equal to 65 m<sup>3</sup> the system installation shall require a maximum number of 1 spray heads which shall be mounted in accordance with the system approval.
- L. For spaces greater than 65 m<sup>3</sup> and less than or equal to 130 m<sup>3</sup> the system installation shall require a maximum number of 2 spray heads which shall be mounted on the end walls of the enclosure such that the discharge is along the turbine casing, parallel to the center line of the turbine. The spray heads shall be mounted in accordance with the system approval.
- M. For spaces greater than 130 m<sup>3</sup> and less than or equal to 260 m<sup>3</sup>, the system installation shall require a maximum of 4 spray heads which shall be mounted on the end walls of the enclosure such that the discharge is along the turbine casing, parallel to the center line of the turbine. The spray heads shall be mounted in accordance with the system approval.
- N. In auxiliary and machinery spaces, the spray heads shall be ceiling mounted with a maximum spacing of 2.5 meters (8 ft.) and a distance from the wall of 2.5 meters (8 ft.).
- O. The system tubing shall be small bore stainless steel designed to withstand a bursting pressure 4 times the operating pressure. The fittings shall be of the compression type and shall be stainless steel. The maximum OD of the stainless steel tubing shall not exceed 16 mm (5/8") and the OD of the tubing connecting to the spray heads shall not exceed 12 mm (15/32").
- P. The spray heads shall be stainless steel and shall consist of a main body fitted with 9 single orifice nozzles. Each spray head shall be supplied with a mounting

adaptor which will be complete with a blocking plug for purposes of testing and commissioning.

- Q. The water cylinders shall be internally coated with a plastic or PVC based material to prevent corrosion build up. All system components shall be non-corrosive.
- R. For pneumatically operated louvers, an 8 mm (5/16") may be connected to the nitrogen discharge line located on the discharge control valve
- S. The system shall be Factory Mutual approved for the protection of gas turbine enclosures, machinery spaces and special hazard machinery spaces and it shall cause no thermal damage on the turbine casing as demonstrated through performance testing conducted by the Factory Mutual fire test protocol.
- T. The system shall use water which meets the manufactures requirements. As a minimum the water shall meet the following requirements:
  - Equivalent of a potable water supply
  - Colorless and odorless
  - Non corrosive
  - Chloride concentration < 50ppm (=50mg/l)
  - pH value 7.0 – 9.0
  - Iron (Fe) and Manganese (mN); sum < 0.3mg/l
  - No free chlorine

## 1.5 SYSTEM OPERATION

- A. Upon fire detection, the fire detection and control panel shall provide a signal to the control system to shut down all machinery, shut off all fuel supply lines, shut down ventilation and to close all doors and louvers followed immediately by the water mist system activation. The water mist control signal shall remain energized for 15 seconds (the system control valve is a self-latching/self-resetting valve).
- B. For systems protecting more than one space, the designated selector control valve shall be released (open) at the same time as the discharge control valve mounted on the system skid.
- C. The system shall discharge completely over a period of 10 minutes (single skid) or multiples thereof (multiple skids connected in series for longer periods of protection).

## 1.6 PRINCIPLE OF EXTINGUISHMENT

- A. The extinguishment of fire by water mist is based on the principles of cooling and oxygen depletion. Based on the triangle of fire, i.e., fuel, oxygen and heat, if any of the three elements is removed, the fire should in principle extinguish itself. It is necessary however that the cooling be not only of the fuel, thus the evaporating combustible fumes, but that also of the radiant heat which will prevent re-ignition from taking place.
- B. The fine water droplets offer a very large surface area per unit volume thus affording a very efficient thermal transfer.
- C. The water droplet shall have a volumetric diameter where  $Dv_{0.99}$  shall be less than  $100\ \mu\text{m}$  at the beginning of the discharge and it shall not be more than  $50\ \mu\text{m}$  after eight minutes of discharge.
- D. The rapid thermal transfer causes the water to change from the liquid to the vapor phase which, being an inert gas, causes the oxygen depletion at the core of the fire and extinguishment
- E. Three major characteristics establish the uniqueness of every water mist system: droplet size, flux density and spray momentum. A high pressure system offers the advantage of a finer and more efficient water droplet combined with the high pressure discharge which translates into higher momentum and more efficient fire plume penetration.
- F. The relativistic aspects of the drop size are also very important. Therefore for larger fires, larger droplets ( $100\ \mu\text{m}$ ) are essential while for smaller fires it is very important to have a large fraction of smaller droplets than can easily be entrained by small, less dynamic flamelet type or residual fires (these flamelets can be the source of re-ignition if not completely extinguished).

## 1.7 DRAWINGS and MANUALS

- A. Shop drawings shall be submitted and shall include but not limited to: space layout, piping layout and nozzle location
- B. Operation and Maintenance Manual
  - 1. Submit written instructions on how to operate and maintain the system
  - 2. Provide a Matrix of Scheduled Maintenance Actions for inspection and maintenance requirements in conformance with NFPA 750, NFPA 25, and the Manufacturer's recommendations. Identify actions for weekly, monthly, semi-annual and/or annual intervals.

## **1.8 QUALITY ASSURANCE**

- A. This Specification intends conformance with NFPA 750, which requires that all components of a water mist system be “listed for their intended use”.

## **1.9 QUALIFICATIONS**

- C. Manufacturer shall have the following background:
  - 3. Specialist in manufacturing water mist nozzles and high-pressure pumping equipment and valves for water mist fire protection systems.
  - 4. Demonstrated evidence of fire tests of their equipment conducted to FM Approval Standard 5560 fire test or other international protocols for applicable fire hazards.
- D. Installer shall have the following background:
  - 1. Specialists in the design and installation of high pressure water mist fire protection systems.
  - 2. Received recent training in installation of high-pressure tubing systems. Training shall include make-up of progressive ring compression fittings, use of hydraulic tools for setting ferrules, use of hydraulic tube-bending tools, storage and handling of stainless steel tubing, proper methods of cutting, reaming, swabbing and cleaning stainless steel tubing; and proper installation of pipe clamps and supports.

## **1.10 REGULATORY REQUIREMENTS**

- A. Comply with all regulatory requirements.

## **1.11 DELIVERY, STORAGE AND HANDLING**

- A. Deliver products to site, store, protect and handle in accordance with clients recommendations and instructions.
- B. Deliver materials to Project site in original packaging, containers or bundles labeled with manufacturer’s name and product identification information.
- C. Store pipe and stainless steel tubing in a clean, dry area protected from construction traffic. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Store materials, fittings, valves, and nozzles in clean, dry, secure area.
- E. Use proper tools for handling bundles of pipe or tubing, and for accurate placement and support of heavy equipment.



## 1.12 COORDINATION

- A. Coordinate all work including coring, cutting and patching, welding and electrical work with the General Contractor.

## PART 2 PRODUCTS

### 2.1 STORAGE CONTAINERS

- A. Nitrogen high pressure cylinders having a nominal working pressure as required by the system design and approval.
- B. High pressure water cylinders with a nominal volume of 50 liters (13 US gallons), inside surface shall be plastic coated
- C. The water cylinders shall be rack mounted and interconnected using stainless steel tubing and high pressure compression fittings
- D. The water cylinders shall be fitted with a special brass header designed to deliver the appropriate water discharge and flow rate
- E. The discharge manifold shall be fitted with a pressure switch rated for 50 bar (750 psi) designed to close upon system discharge and pressurization
- F. The water cylinders shall be maintained under normal atmospheric pressure until such time as the system is activated and the nitrogen is released.

### 2.2 INSTRUMENTATION

- A. Provide all instrumentation associated with the proper functioning of the MAU and pre-wired into the supervisory pressure switches and level switches.

### 2.3 PIPING AND TUBING

- A. Pipe and tubing shall be suitable for the working pressure of 2,900 psig (200 bar).
- B. Galvanized pipe shall not be used for any part of the water mist system.
- C. Metric Stainless Steel Tubing shall be used for all system piping. Use only metric size tubing meeting European DIN standards, in order to permit connection to European manufactured water mist system fittings including distribution blocks, sectional control valves, ball valves, and nozzle mounting adapters.
  - 1. Tube OD and wall thickness to DIN 17457 or DIN 17458.

16-mm x 1.5-mm	DIN 17457
12 mm x 1.2-mm	DIN 17457
  - 2. Maximum hardness of stainless steel tubing shall be HRB 90.

- D. Compression Fittings shall be Parker “Ermeto Original (EO or EO2)” progressive ring fittings, Series S (heavy) in metric tube sizes, or equivalent.
1. For tubing running to the exterior of or in the exterior the building, fittings and nuts shall be entirely stainless steel.
  2. Special fittings manufactured by the Vendor include stainless steel “distribution blocks”.
- E. Pipe and Tubing Supports
1. Comply with the requirements and as specified herein:
  2. Pipe supports for welded stainless steel piping shall conform to the hanging requirements of NFPA 13 and ASME B31.1. Construct stanchions, straddle supports, and trapeze supports based on hanger spacing, span and minimum load capacities in NFPA 13.
  3. Supports for stainless steel tubing shall comply with ASME B31.1 and the manufacturer’s recommendations with respect to spacing. The maximum spacing between tube supports and maximum distances from tube supports to bends or compression fittings shall comply with manufacturer’s recommendations.
  4. Where obstructions make it impossible to comply with spacing limits for tube supports, the distance between supports may be increased by 75 percent, provided that there are no fittings or changes in direction between the two supports.
  5. Tube clamps shall be non-combustible Ermeto Original series A components for normal mechanical stress, or equivalent. Utilize compatible mounting rail attachments with lock nut and locking plate where necessary.
  6. Utilize “uni-strut” metal mounting rails or equivalent as trapeze members where required to span between structural members or stanchion supports. Attach all support materials firmly to the building structure, using trapeze bars, back plates, angle brackets, welds, concrete inserts, U-bolts and floor anchors as required.

## 2.4 VALVES

- A. Valve type and size shall be in accordance with the design drawings.
- B. Drain valves are located at the base of each system riser and at the extreme end of each water mist piping system

- C. The discharge control valve shall be designed to fit directly to the outlet port of the nitrogen cylinder hand wheel valve (an adaptor may be required or used) and it shall be of the latching/self-resetting type.

## 2.5 SPRAY HEADS

- A. Spray Heads shall be listed or tested for the intended application, or Approved by the Authority Having Jurisdiction (AHJ).
- B. Provide and install Marioff HI-FOG stainless steel water mist spray heads with 9 single orifice nozzles with a nominal diameter not to exceed 0.7mm or equivalent. Other spray heads shall be permitted, provided that documentation is submitted to confirm equivalency with respect to fire test performance, K factor, spacing rules, distribution pattern, spray cone angle and temperature rating
- C. Each spray head shall be fitted with a screen to prevent particles from interfering with the normal operation of the spray head.
- D. The water mist spray heads shall produce a droplet size in the range of 100  $\mu\text{m}$  at the maximum operating pressure of 80 bar (spray head pressure) and a droplet size of approximately 50  $\mu\text{m}$  at the nominal operating pressure of 40 bar.

## 2.6 SUPERVISORY AND ALARM DEVICES

- A. The water mist system installer shall provide and install all monitoring, supervisory and alarm devices that attach to the MAU, control valves, or water mist piping system. The contractor responsible for work shall connect the devices to the fire alarm system.
- B. Monitoring supervisory and alarm devices include the following:
  - 1. Tamper Switches. Mount tamper switches on all valves as required by code, so that correct, reliable operation is assured.
  - 2. Pressure Switches. Provide and install pressure switches on the MAU and on system piping as indicated on the Drawings.
    - a. Pressure and level switches intended to function as supervisory devices shall be compatible with the electrical requirements of the Fire Alarm and Control Panel. They shall be wired into the Fire Alarm Panel by the contractor responsible for work.
    - b. Install isolating valves so that pressure switches can be isolated for removal or replacement without shutting down the system.

## 2.7 STRAINERS AND FILTERS

- A. Comply with the requirements in NFPA 750 for filters and strainers on the water supply connection.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Stainless Steel Tubing
  1. Protect stored stainless steel tubing against entry of debris and mechanical damage.
  2. Follow the manufacturer's recommendations for best practice in cutting, cleaning and bending stainless steel tubing. Best practices shall include:
    - a. Use of wheel-type tube cutters is prohibited.
    - b. All tube cuts shall be made by saw in a tube cutting vice.
    - c. Use de-burring and reaming tool on every tube end.
    - d. Use 90 degree or 45 degree bends at changes in direction wherever possible, rather than elbows.
    - e. Employ tube bend prior to connection to every nozzle adapter fitting, as shown in the Drawings. Do not connect into adapter fitting at 90 degree angle.
    - f. Reject all bends with visible signs of tube flattening.
    - g. Before assembly, remove scale and foreign material from inside and outside of pipe or tube. Use pneumatic "Jet-Cleaner" tool or equivalent to push a cleaning plug properly sized for the tube inside diameter through every section of tubing after preparation and before installation. Cleaning procedures will be inspected for adequacy prior to commencing work, and installed tubing that has not been cleaned shall be removed, cleaned and re-installed
    - h. Collect cleaning plugs in a waste receptacle after use. Do not re-use cleaning plugs.
  3. Compression Fittings
    - a. Follow the compression fitting manufacturer's recommendations of good practice for setting ferrules and tightening fittings.

- b. Follow the compression fitting manufacturer's recommendations of good practice for clamp and support details to minimize stress on fittings.
- c. Use hydraulic ferrule-setting machine with correct dies for all progressive-ring ferrules on tubing larger than 16-mm.
- d. Use hand-held hardened pre-assembly tool for setting progressive-ring ferrules in 16-mm and 12-mm tubing. Do not set ferrules by tightening in the fitting.

## 3.2 INSTALLATION

### A. General

1. Coordinate installation of the water mist system equipment, piping, and alarm devices with other work.

### B. Piping and Tubing

1. All system tubing shall be 16 mm tubing from the outlet to the first tee. All individual branch tubing to spray heads shall be 12 mm.
2. The maximum length of 16 mm tubing is 10 m and the maximum length of 12 mm tubing is 20 m.

### C. Pipe Hangers and Supports

1. Pipe clamps or U-bolts shall be used to anchor pipe to stanchions or any other type of support. Clamps shall prevent vertical or lateral movement, but permit longitudinal expansion of the pipe or tube.
2. Trapeze Hangers shall comply with NFPA 13 for span and structural dimensions. Attachment of hangers or clamps to the trapeze shall be made with rigid vertical members, to provide horizontal rigidity to the supported pipe. Use of long all-thread rods and clevis-type hangers without bracing to prevent horizontal pipe movement shall not be permitted.
3. Tube hangers (clamps) shall be spaced in accordance with NFPA 750 or Manufacturer's recommendations.

### D. Valves

1. Provide clearance around lever handled ball valves sufficient to permit full unobstructed movement of the lever handle.
2. Provide clearance around the Sectional Control Valves to permit access to connections and attached instrumentation.

## **PART 4 INSPECTION AND TESTING**

### **4.1 GENERAL**

- A. System acceptance tests shall comply with NFPA 750, NFPA 25, manufacturer's acceptance test recommendations and the requirements of this section.
- B. The test procedures may include the following (as applicable):
  - 1. Visual quality check of installation of nozzles, pipes, tubing and hangers,
  - 2. Pneumatic and Hydrostatic Tests,
  - 3. Review of Mechanical Components,
  - 4. Review of Electrical Components,
  - 5. Preliminary Functional Tests, and
  - 6. System Operational (Discharge) Tests.

### **4.2 TUBING and SUPPORTS**

- A. Visual Inspection
  - 1. Hanger details including support fastening to walls, ceilings, ceiling structure, tube clamp spacing and nozzle supports shall be inspected for conformance to recommended practice and the details of this specification.
  - 2. Repair or replace all hangers and tube supports that do not meet the requirements of this specification.
- B. Hydrostatic Testing
  - 1. Test all piping and tubing hydrostatically in accordance with the requirements of NFPA 750.
  - 2. Vent air from the system piping and tubing as it is filling with water.
  - 3. Repair all leaks revealed through the hydrostatic test and retest until the test pressure remains stable for the duration of the test.

### **4.3 SYSTEM COMMISSIONING**

- A. A representative of the self-contained system manufacturer or trained authorized Distributor shall be present for the commissioning of the system. The commissioning of the system shall be coordinated with the contractor responsible for the work and the AHJ.

1. Commissioning shall be performed in accordance with a written procedure which has been reviewed and approved by the system manufacturer.

## **PART 5 SYSTEM MAINTENANCE**

### **5.1. MAINTENANCE SCHEDULE**

- A. Prepare a maintenance schedule complying with the manufacturer's recommendations and the requirements of NFPA 750 and NFPA 25.
- B. Include maintenance actions for weekly, monthly, bi-annual and annual frequencies.