

WATER MIST SYSTEM DESIGN AND REVIEW – THE MATRIX FROM IWMA

AN INSTRUMENT TO ASSIST FIRE ENGINEERS IN SELECTING THE SUITABLE SYSTEMS AND THE AUTHORITY HAVING JURISDICTION IN REVIEWING THEM FOR APPROVAL.

Luciano Nigro, Jensen Hughes Italy – Member of the Board of IWMA – luciano.nigro@jensenuhughes.com

Preface

The water mist technology can now be considered a mature fire suppression technology as it entered the third decade of installation both in marine and in land-based applications. Initiated more than 30 years ago to support the Halon replacement on board of ships, the technology grew very rapidly achieving almost 100% of the marine fire protection market on board of the passenger ships, protecting all the hazards from the machinery spaces to the accommodation and public spaces.

By the end of millennium many applications to land based occupancies were developed, based on several fire test protocols that were published by international organizations including Factory Mutual Approvals, UL, VdS, LPCB and others. Nevertheless, in the land based market the technology has not yet achieved the diffusion that could reach, for various reasons one of which, it is the opinion of the writer, remains the difficulties that fire engineers, designing and/or reviewing water mist system for acceptance, find in the process of selecting the system appropriate for each application and in verifying the adequacy of the design parameters that have been used per each system.

To support the fire engineers in this commitment, the IWMA (International Water Mist Association) has developed, in the past years, a descriptive document, the “Project Water Mist – an Alternate Solution to Sprinkler Protection in Building Fire Protection” published in 2014 and a “working tool” – THE MATRIX – available on the IWMA website (www.iwma.net), that is the subject of the present paper.

Documents available from the IWMA website

The first document, referred as “the Project”, also available from the association website, is a complete list of all the fire test protocols available on the market at the date of its publication with the description of the occupancies to which they apply and the indication of the organizations that developed and published them. As such, the Project already represents a valuable instrument for the fire engineer dealing with water mist systems. However, it still is a publication requiring a significant knowledge of the water mist technology to be used in practice.

The MATRIX was then studied and developed by the IWMA Scientific Council, with the advices from the Members, to be a real working tool for the fire engineers, having a structure more keen to the design and review activity a fire engineer usually does and being updated on a constant basis to be representative of the “state of the art” that is a key point when designing and installing an advanced technology fire suppression system.

A partial view of the summary of the MATRIX outcome for the Land Based Applications is summarized by the table here below; it is included just for completion of the paper but the best

way to consult it is to go to the IWMA website and see it in the complete format. The MATRIX is published both for Marine and Land Based applications. Here is the link to the land-based version for your convenience: <https://iwma.net/the-matrix/land-based-applications>.

		Standard		
LAND		GENERAL DESIGN & INSTALLATION		
		EN14972-3: 2020	Fixed firefighting systems - Water mist systems Design and installation	
		VdS 3188: 2019	Water Mist Sprinkler Systems and Water Mist Extinguishing Systems (High Pressure Systems) - Planning and Installation	
		BS 8489-1: 2016	Fixed fire protection systems – Industrial and commercial watermist systems Part 1: Code of practice for design and installation	
		NFPA 750: 2023	Standard on Water Mist Fire Protection Systems	
		FM Global Loss Prevention Data Sheet 4-2: 2022	Water mist systems	
Business Segment	Application	FIRE TEST PROTOCOLS		Type approvals
Residential	Residential occupancies	prEN 14972-17	Test protocol for residential occupancies for automatic nozzle systems	
		BS 8458: 2015	Fixed fire protection systems – Residential and domestic watermist systems – Code of practice for design and installation	LPCB
		UL 2167: 2021	Water Mist Nozzles for Fire Protection Service Ch.44 - Residential area fire tests	UL
Commercial buildings	Offices, schools, hotels, recreational areas, etc (EUR OH1, FM HC-1, NFPA LH)	EN14972-3: 2021	Test protocol for office, school class rooms and hotel for automatic nozzle systems	
		prEN 14972-4 (no published document available yet)	Test protocol for non-storage occupancies for automatic nozzle systems	
		prEN 14972-7	Test protocol for commercial low hazard occupancies for automatic nozzle systems	
		VdS 3883-1en: 2020	Fire Test Protocol for Water Mist Systems, Part 1: Protection of office spaces and accommodation areas	VdS
		BS 8489-7: 2016	Fixed fire protection systems – Industrial and commercial watermist systems Part 7: Fire performance tests and requirements for watermist systems for the protection of low hazard occupancies	
		FM 5560: 2021	Approval Standard for Water Mist Systems, APPENDIX G: Fire tests for water mist systems for the protection of non-storage occupancies, Hazard Category 1 (HC-1) [formerly Light Hazard occupancies]	FM Approvals
		UL 2167: 2021	Water Mist Nozzles for Fire Protection Service Ch.43 - Shipboard public space fire tests & Ch.45 - Light Hazard area fire tests	
	Sidewall sprinklers	FM 5560: 2021	Approval Standard for Water Mist Systems, APPENDIX G: Fire tests for water mist systems for the protection of non-storage occupancies, Hazard Category 1 (HC-1) [formerly Light Hazard occupancies]	FM Approvals
		VdS 3883-2en: 2020	Protection of Office Spaces and Accommodation Areas with Water Mist Sidewall Sprinklers	VdS
	False floors and false ceilings	FprEN 14972-6	Test protocol for false floors and false ceilings for automatic nozzle systems	
		VdS 3883-3en: 2020	Fire Test Protocol for Water Mist Systems, Part 3: Protection of False Ceilings and False Floor of OH Group 1	VdS
	Atrium	EN 14972-10: 2022	Test protocol for atrium protection with sidewall nozzles for open nozzle systems	
	Car garages / Parking garages NFPA OH1, FM HC-2/HC-3	prEN 14972-5 (no published document available yet)	Test protocol for car garages for automatic nozzle systems	
		VdS 3883-4en: 2020	Fire Test Protocol for Water Mist Systems, Part 4: Protection of car garages	VdS
		FM 5560: 2021	Approval Standard for Water Mist Systems, APPENDIX P: Fire tests for water mist systems for the protection of non-storage occupancies, Hazard Category 2 (HC-2) and Hazard Category 3 (HC-3)	FM Approvals
		UL 2167: 2021	Water Mist Nozzles for Fire Protection Service Ch.46 - Ordinary Hazard Group 1 fire tests	UL
	Sales, storage & shopping areas NFPA OH2, FM HC-3	prEN 14972-2 (no published document available yet)	Test protocol for shopping areas for automatic nozzle systems	
		VdS 3883-5en: 2020	Fire Test Protocol for Water Mist Systems, Part 5: Protection of selected sales and storage areas and mechanical floors	VdS
		FM 5560: 2021	Approval Standard for Water Mist Systems, APPENDIX P: Fire tests for water mist systems for the protection of non-storage occupancies, Hazard Category 2 (HC-2) and Hazard Category 3 (HC-3)	FM Approvals
		UL 2167: 2021	Water Mist Nozzles for Fire Protection Service Ch.47 - Ordinary Hazard Group 2 fire tests	
Data halls	FM 5560: 2021	Approval Standard for Water Mist Systems, APPENDIX M: Fire tests for water mist systems for the protection of data processing equipment rooms/halls - above raised floor	FM Approvals	
	FM 5560: 2021	Approval Standard for Water Mist Systems, APPENDIX N: Fire tests for water mist systems for the protection of data processing equipment rooms/halls - below raised floor	FM Approvals	
Mechanical escalators	VdS-Rolltreppen/escalator _en_V1(Draft)-20.08.09	Test Setup and Requirements - Protection of mechanical escalator	VdS	

The MATRIX

The first column is very simple to interpret; it is just referred to the business segment of the case under consideration, divided into Residential, Commercial and Industrial. There is nothing to add to this very simple differentiation.

The second column is the most important for the fire engineer; it is the column dedicated to the Applications and it is the key point for the correct interpretation of the MATRIX. The selection of the application that more accurately represents the fire hazard related to the “formal” applications for which a test protocol exists, requires a considerable judgment from the fire engineer. In fact, it should be considered that to put the actual application in direct relationship with one of the test protocols shown in the list of the MATRIX provides the information to proceed with the design of the system but also, automatically, it implies that the captioned application can be protected with a water mist system.

In other words, the meaning of the Application column of the MATRIX is the key to the feasibility of a specific fire suppression system for a given application.

Of course, the real world is not so simple, because the applications listed in the “Application Column” of the MATRIX are not easily related to the actual application under consideration; paragraph 4.1.3.2 of the EN 14972-1 states: *“Test protocols: one of the greatest challenges to engineering of water mist fire suppression systems lies in determining whether the conditions of a particular and recognized test protocol are representative of the actual conditions in a given application based on an understanding of the dynamics of the interaction of water mist with fire.”* More in details there are applications very clear, for example the “car garages/parking garages” is straightforward identified as a place where automobiles are parked or “industrial oil cookers” are easily identified as the machines where food is deep fried. But there are also several applications that are not so well defined as for example “residential occupancies” or “data halls”. In all these cases some additional information is needed to relate the applications listed in the MATRIX and the real world. This matter will be considered later, in the comment section.

The third column of the MATRIX is the Test Protocol column; third and fourth columns fully identify the test protocol(s) existing for a given application. The list is updated regularly by the Association therefore it can be considered as the most updated list of water mist fire test protocols presently available worldwide.

As mentioned, there are many applications for which more than one protocol is available; how to select the protocol that best fit the actual application under consideration is again a matter related to the correlation between the formal test protocol defined in the test protocol document listed in the third and fourth columns and the actual application under consideration. And again, it is the main responsibility of the fire engineer in charge for the design or the review of the system to ascertain it.

The last column identifies the type approval that can be obtained by “positively passing” each test protocol mentioned in the previous columns. This is also a very important column to be considered because it distinguishes the test protocols in those that lead to a formal approval, and the organization granting the type approval is listed in column 5, from those protocols that do

not lead to a formal approval but are simply offered to the market as reference protocols to be used by the authorities having jurisdictions, the laboratories, the verification agencies, the manufacturers etc...

For those that are not so much familiar with the type approval process, it is possible to say that the fire test protocols are the procedures issued by the organizations involved in the water mist fire suppression technology to run each of the mentioned test. They list the materials to be used, the procedure to run the tests and the pass-fail criteria to determine the outcome of the tests. The delivery of the laboratory that performs the test is simply a fire test report describing all the steps followed to do the test and the results obtained. In some cases, also the interpretation of the results is left to somebody else who will use the test report for the design and installation of a water mist system.

To complete these considerations, it should be noticed that the organizations issuing fire test protocols for water mist applications are not so many and can be divided in two groups: the Approval Bodies and the Standardization Bodies.

Approval Bodies for water mist applications include FM Approvals¹, UL² and VdS³; the Standardization Bodies include the CEN⁴ committee on water mist system and the BS⁵. As it is possible to see in the MATRIX table the Approval Bodies always grant a type-approval for the system passing the test protocol for the specific application; the Standardization Bodies normally don't, except for the residential applications tested according to BS standard 8458 that are approved by the LPCB⁶.

The approval issued by an Approval Body is a very useful information document also for the above-mentioned matter concerning the correlation between the test protocol and the actual application under consideration; the Approval Body will certainly define in detail the applications that can be effectively protected by the approved systems. An example is the chapter 1.2 of the FM standard 5560⁷ where all the 16 applications for which FM Approvals has issued a test protocol are described in detail with all the applicable limitations and/or extensions.

The same does not apply to the test protocols issued by the Standardization Bodies that also include a paragraph per each protocol describing the scenarios to which the protocol can be applied, but this information is "embedded" in the test protocol text and is not easily available to the fire engineer. Again, see the comment paragraph for more info on this matter.

The above is a complete description of the MATRIX content; it is important to notice that there is a considerable effort behind the simple table summarizing all the results (see the original in the IWMA website, the picture shown before is just a portion of it), because all the information included in the table is carefully verified and checked by the IWMA Scientific Council that includes some of the most relevant professionals dealing with water mist technology in the world.

However, there are some comments and some actions to take into consideration to make it better and even more useful to the fire engineer mentioned in the beginning.

Comments

As mentioned in the text, the correlation between the fire test protocol and the actual application under consideration is not easy for the fire engineer; it is possible, when talking about test protocols issued by Approval Bodies, that are liable for what they indicate and shall give all the information necessary for the correct use of the protocols; it is less straightforward for the Standardization Body protocols.

The second and most important comment is related to the real availability of the system on the market; with the MATRIX it is only possible to say that, for a given application, one or more test protocols exist and whether they lead to a type approval or not but no information is given about the availability of one or more manufacturers that can provide a water mist system designed and installed in accordance to the test protocol under consideration. This second issue has been discussed many times among the Association members but the commercial implications that are related to the mentioning of one or more manufacturers would lead to problems that are outside of the scope of the Association. The identification of the manufacturer(s) holding an approval or having carried out a fire test according to one of the test procedures issued by the Standardization bodies remains a responsibility of the fire engineer in charge for the design of the system.

Future Steps

The maintenance of the MATRIX, to be always updated, is of utmost importance for the tool and for the Association, in order to provide a concrete help to the fire engineers involved in the design, installation or verification of a water mist system in land-based applications.

The addition of a column to the current ones with a description in details of the application to which the protocol is applicable, or the implementation of a “second page” in the summary with each line of the protocols completed with the description of the applicable scenarios given in the protocol itself could be of help in finding correct protocol to use for a given application.

Finally, the availability of water mist systems on the market: this issue cannot be included in the MATRIX but can be solved by checking the appropriate sources of information; considering that the number of organizations issuing protocols is minimal it is easy to check with each one of them which manufacturers have been tested per each protocol. To help the fire engineers to search for it, a list of the approval guides giving details of the approved manufacturers is given in the bibliography.

More difficult will be to find the manufacturers that have systems successfully tested according to the fire test protocols issued by one of the Standardization Bodies because in these cases, there is no specific entity that will list the performed tests and the unique source of information will be the Manufacturers themselves that shall be asked to provide all the information and possibly test report. This is essential to document that their systems have successfully passed the necessary fire test protocols because, as stated in the last sentence of the introduction to EN 14972-1: *Water mist is a specific application solution which needs to be proven for each individual application and/or occupancy.*

Bibliography

- General Bibliography:
SFPE Handbook of Fire Protection Engineering – Chapter 46 – Water Mist Fire Suppression Systems.
- Specific Bibliography:
 - (1) FM Approvals - <https://www.approvalguide.com/search?searchParams=groupid=ODU=>
 - (2) UL - <https://www.ul.com/services/water-mist-system-equipment-component-testing>
 - (3) VdS.- <https://vds.de/en/certification/companies-and-specialist-professionals/fire-protection/installer-company-for-fire-extinguishing-systems>
 - (4) CEN – CEN/TC191/WG10 – Water Mist Fire Fighting Systems – EN 14972 series
 - (5) BS - <https://www.bsigroup.com/en-GB/search-results/?q=Water%20Mist%20Systems&Page=1&tab=Standards>
 - (6) LPCB - <https://www.redbooklive.com/pdfdocs/redbook-vol1part3.pdf?rn=47100>
 - (7) FM Class Number 5560 – Examination Standard for Water Mist Systems – January 2021 edition