SPECIFICATIONS

1	Commercial Specification	Requirement Specification	Reasons/ arguments/ explanations
	To ensure the highest quality and performance, the pressure cylinder must be manufactured using a deep drawing process from a single piece of metal. This method guarantees maximum structural integrity and eliminates any potential weaknesses.	The pressure cylinder must be manufactured using a deep drawing process from a single piece of metal to ensure maximum structural integrity and eliminate weaknesses.	**Higher Structural Integrity** • No weld seams, eliminating weak points that could lead to stress cracks or leaks. • Welded seams are the weakest points in pressure vessels and prone to failure under high loads. **Improved Safety & Durability** • Uniform wall thickness ensures predictable pressure distribution and reduces the risk of localized weaknesses. • Lower risk of material fatigue, as no joints create stress concentrations. **Greater Corrosion Resistance** • Weld seams are vulnerable to corrosion, especially in harsh environments or high-moisture conditions. • Deep-drawn vessels have a more homogeneous surface, offering better corrosion protection. **Better Performance Under Cyclic Loads** • Pressure vessels often face fluctuating pressures, which can cause material fatigue. • Deep-drawn vessels handle cyclic loads better than welded ones, which are more prone to crack formation. **Better Performance Under Cyclic Loads** • Pressure vessels often face fluctuating pressures, which can cause material fatigue. • Deep-drawn vessels handle cyclic loads better than welded ones, which are more prone to crack formation. **Enhanced Quality Control & Lower Inspection Costs** • Welded vessels require ultrasonic and X-ray inspections, increasing production costs and potential failure risks. • Deep-drawn vessels require fewer inspections, reducing long-term manufacturing costs. **Lighter Weight & Higher Efficiency** • Can be manufactured with less material since no extra thickness is needed for weld reinforcements. • Reduced weight improves transport efficiency and lowers operational costs. **This point is mainly to compete with Chinese cylinders**

SPECIFICATIONS

2	Commercial Specification	Requirement Specification	Reasons/ arguments/ explanations
	To ensure superior protection and longevity, the pressure cylinder must feature a double coating. This advanced coating system provides enhanced resistance against corrosion, wear, and environmental factors, ensuring the cylinder's durability and reliability in demanding conditions.	The pressure cylinder must have double coating	**Corrosion Protection** • Pressure vessels are often exposed to harsh environments, including moisture, chemicals, and varying temperatures, which can accelerate corrosion. • A double coating system significantly improves corrosion resistance by creating an extra barrier against oxidation and chemical reactions. **Mechanical Durability** • Single-layer coatings are more susceptible to mechanical damage such as scratches, impacts, and abrasions, which can compromise the protective layer. • A second coat enhances the overall durability, ensuring that minor damages to the outer layer do not expose the metal to potential degradation. **Extended Service Life** • By applying a second coating, the lifespan of the pressure vessels is increased, reducing the frequency of maintenance and replacement costs. • Long-term investment in double coating minimizes operational downtime due to coating failures. **Improved Adhesion and Aesthetic Quality** • The first layer (primer) ensures proper adhesion of the paint to the surface, while the second layer provides a smooth and even finish, improving both functionality and appearance. • Enhanced surface uniformity reduces the risk of weak spots or uneven coating thickness, which can lead to localized corrosion.

SPECIFICATIONS

3	Commercial Specification	Requirement Specification	Reasons/ arguments/ explanations
	To ensure compliance with industry standards and guarantee the highest level of safety and reliability, the calculation software to be used must be approved by both FM (Factory Mutual) and UL (Underwriters Laboratories). This dual approval ensures that the software meets rigorous testing and certification requirements, providing confidence in its accuracy and performance.	The calculation software to be used must be FM (Factory Mutual) and UL (Underwriters Laboratories) approved.	**Safety and Compliance:** • FM Approval: Ensures that the software meets rigorous safety standards and is reliable in preventing fire hazards and other risks associated with industrial applications. • UL Certification: Guarantees that the software complies with industry standards for safety and performance, providing assurance that it has been tested and evaluated for potential risks. **Quality Assurance:** • FM and UL approvals are recognized globally as benchmarks for quality and safety. Using software with these certifications ensures that the product is of high quality and meets international standards. **Regulatory Requirements:** • Many industries and regulatory bodies require the use of FM and UL approved software to comply with local and international regulations. This helps in avoiding legal issues and ensures that the software is accepted by regulatory authorities. **Risk Management:** • Utilizing FM and UL approved software minimizes the risk of software failure, which can lead to significant financial losses and safety hazards. It ensures that the software has undergone thorough testing and validation. **Market Acceptance:** • FM and UL certifications enhance the credibility and market acceptance of the software. Clients and stakeholders are more likely to trust and adopt software that meets these stringent standards.

SPECIFICATIONS

4	Commercial Specification	Requirement Specification	Reasons/ arguments/ explanations
	To ensure the highest standards of safety and performance, all personnel involved in the design, installation, or service of fire suppression systems must be certified and have completed training provided or approved by the system manufacturer or supplier. This certification and training guarantee that all team members possess the necessary expertise and knowledge to handle the systems effectively and safely.	All personnel involved in the design, installation, or service of fire suppression systems must be certified and have completed training provided or approved by the system manufacturer or supplier.	**Personnel must undergo specific training provided or approved by the fire suppression system manufacturer or supplier.** **This training must ensure that personnel are familiar with the particular system they are working with, including:** • Product-specifik installation and configuration • Operational features and functionalities • Maintenance and troubleshooting guidelines • Safety measures and emergency procedures

SPECIFICATIONS

5	Commercial Specification	Requirement Specification	Reasons/ arguments/ explanations
	To ensure optimal performance and safety, the orifice size in the fire suppression system utilizing a 200 or 300-bar cylinder must not exceed 10 mm from the cylinder hand wheel valve all the way to the manifold inlet.	The orifice size in the fire suppression system utilizing an **200 or 300-bar cylinder must not exceed 10 mm from Cylinder hand wheel valve all the way to manifold inlet** to ensure: 1. System safety – Prevents dangerous pressure surges and uncontrolled decompression. 2. Controlled discharge – Ensures stable and effective release of the fire suppression agent. 3. Equipment protection – Reduces the risk of damage to pipes, valves, and system components.	**Prevention of pressure surges and pipe integrity risks:** • A larger orifice may cause dangerous pressure surges (water hammer effect), potentially damaging pipes and valves. **Controlled release of fire suppression agent:** • An oversized orifice may lead to uncontrolled discharge, posing risks to equipment and personnel. **System stability and operational efficiency:** • A smaller orifice ensures a controlled and consistent flow, which is critical for effective fire suppression. • Mitigation of uncontrolled decompression risks: • At 300 bar, an excessively large orifice could result in sudden pressure release, leading to system failure or unintended pressure fluctuations. **Compliance with safety standards:** • Industry regulations and best practices recommend limiting orifice size to ensure pressure system reliability and safety.

SPECIFICATIONS

6	Commercial Specification	Requirement Specification	Reasons/ arguments/ explanations
	To enhance safety and operational reliability, the fire suppression system must incorporate a separation between the handwheel valve and the discharge valve.	Separation of Handwheel Valve and Discharge Valve for safety.	**Purpose** **This requirement specification defines the necessary conditions for separating the handwheel valve and the discharge valve to enhance safety during installation, maintenance, and operation. The separation aims to:** • Prevent accidental discharge during installation and servicing. • Ensure leak-free operation by allowing controlled pressurization of a small chamber before full system activation. • Minimize the risk of human error by implementing a structured and secure installation process. **Functional Requirements** **Prevention of Accidental Discharge** • The system must be designed so that the handwheel valve remains closed during installation and servicing. • Gas flow into the discharge valve must only occur after a controlled integrity check. **Leak Testing and Verification** • The handwheel valve must be briefly opened to allow gas into a small chamber in the discharge valve for leak detection before full pressurization. • A mandatory six-hour pressure test must be conducted to ensure no leakage before system activation. • The test must detect any leakage without exposing the full gas volume to the system. **Secure Installation Process** • Full pressurization must not be applied until the installation is complete and successfully tested. • The installation process must ensure that human errors, such as premature pressurization, are prevented. **Compliance and Testing Requirements** • The system must comply with relevant gas containment and safety standards. • Certified leak detection methods must be used to verify system integrity. • A structured checklist must be followed to ensure that each step of the installation and verification process is properly executed.

SPECIFICATIONS

6a	Commercial Specification	Requirement Specification	Reasons/ arguments/ explanations
	To enhance safety and operational reliability, the fire suppression system must incorporate a separation between the handwheel valve and the discharge valve.	Separation of Handwheel Valve and Discharge Valve for safety.	**(6 CONTINUED)** **Safety and Risk Mitigation** • The separation of the handwheel valve and discharge valve must eliminate the risk of immediate gas exposure during installation. • The design must ensure that operators can verify system integrity without endangering personnel or equipment. **Conclusion** The separation of the handwheel valve and discharge valve is a critical safety measure that prevents accidental discharge, ensures thorough leak testing, and guarantees a safe installation process. These requirements must be adhered to in order to achieve a secure and reliable system before full pressurization.

SPECIFICATIONS

7	Commercial Specification	Requirement Specification	Reasons/ arguments/ explanations
	To ensure the highest levels of safety, reliability, and compliance with industry standards, only manufacturer-approved manifolds must be used in fire suppression systems. This guarantees that all components are designed and tested to work seamlessly together	Use only manufacturer-approved manifolds are used in fire suppression systems to guarantee safety, reliability, and compliance with industry standards.	**Manufacturer Approval:** • The manifold must be supplied by the system manufacturer and approved for use in the fire suppression system. **Certifications:** • The manifold must be UL (Underwriters Laboratories) approved and FM (Factory Mutual) certified to ensure compliance with fire safety and performance standards. **Pressure Testing:** • The manifold must be pressure tested up to 600 bar to verify its strength and integrity under extreme conditions. **Third-Party Certification:** • The manifold must be officially certified by the manufacturer to ensure it meets all required safety and quality standards. **System Compatibility:** • The manifold must be fully compatible with the fire suppression system components to ensure proper function and prevent system failures. **Compliance and Verification** • The supplier must provide documentation and test reports verifying compliance with UL, FM, and pressure testing standards. • Only approved and certified manifolds may be used to maintain system integrity and ensure operational safety.

SPECIFICATIONS

8	Commercial Specification	Requirement Specification	Reasons/ arguments/ explanations
	To ensure the highest standards of safety and performance, all fire suppression systems must have a valid system approval. This guarantees that all components used are certified for compatibility with the specific extinguishing gas utilized in the system.	In order to ensure that all fire suppression systems have a valid system approval, guaranteeing that all components used are certified for compatibility with the specific extinguishing gas used in the system.	**Requirements** **System Approval:** • The fire suppression system must have a complete system approval from a recognized certification body (e.g., UL, FM, LPCB). • The approval must cover the system as a whole, ensuring safe and effective operation. **Component Certification:** • All components used within the system (e.g., cylinders, valves, manifolds, discharge nozzles, hoses) must be approved for use with the specific extinguishing gas. • Components must not be mixed with non-approved parts to ensure system integrity and performance. **Gas Compatibility:** • The approval must confirm that the entire system, including its components, is tested and certified for the specific extinguishing gas (e.g., Inergen, IG541). • No substitutions or modifications may be made without approval from the certification body. **Compliance and Documentation:** • The system approval and component certifications must be documented and available for verification during installation, maintenance, and inspection. • The manufacturer or supplier must provide official test reports and certification documents confirming compliance. **Compliance and Verification** • The fire suppression system must comply with all relevant national and international fire safety standards. • System approval documentation must be maintained and regularly reviewed to ensure ongoing compliance. • Any replacements or modifications must be approved to maintain certification validity. This specification ensures that only fully approved systems and components are used, reducing risks and ensuring reliability in fire suppression operations.

SPECIFICATIONS

9	Commercial Specification	Requirement Specification	Reasons/ arguments/ explanations
	To ensure the safety and well-being of individuals in areas where fire suppression systems are deployed, especially where people may be present or unable to evacuate, the systems must be designed to prevent harm by using safe extinguishing agents. In oxygen-reducing systems	Safe Fire Suppression for Occupied Areas to ensures that fire suppression systems used in areas where people may be present or unable to evacuate are designed to prevent harm by using safe extinguishing agents and, in oxygen-reducing systems, compensating for reduced oxygen levels with CO_2 to support respiration.	**Human-Safe Extinguishing Agent:** • The fire suppression system must use an extinguishing agent that does not pose health risks to occupants. • The agent must be free from toxic chemicals, harmful residues, or substances that could cause long-term health effects. • The system must comply with relevant safety standards for human exposure, such as NFPA 2001, ISO 14520, or equivalent. **Toxicity and Chemical Exposure Prevention:** • The extinguishing medium must not produce harmful by-products or chemical reactions that could endanger human health. • The system must ensure that occupants are not exposed to hazardous substances during or after discharge. **Oxygen Reduction System Compensation:** • In oxygen-reducing fire suppression systems, a controlled amount of CO_2 must be introduced to compensate for the reduced oxygen levels. • The CO_2 concentration must be optimized to support the human respiratory system and prevent asphyxiation. • The compensation levels must be based on scientific research and meet occupational safety guidelines for breathing support. **Conclusion** • This requirement ensures that fire suppression systems in occupied areas prioritize human safety by using non-toxic agents and, in oxygen-reducing systems, compensating with CO_2 to support respiration. These measures prevent harm and provide a safe environment for people during and after a fire suppression event.

SPECIFICATIONS

10	Commercial Specification	Requirement Specification	Reasons/ arguments/ explanations
	To ensure comprehensive and effective fire suppression, the extinguishing agent used in the system must have a density as close to air as possible. This optimized density achieves an optimal three-dimensional (3D) distribution, preventing the agent from either sinking to the ground or rising too quickly.	Fire Suppression System with Optimized Agent Density for 3D Effect this is to ensure that the extinguishing agent used in a fire suppression system has a **density as close to air as possible** to achieve an optimal **three-dimensional (3D)** distribution. This prevents the agent from either sinking to the ground or rising too quickly, ensuring effective fire suppression throughout the protected area.	**Density Optimization:** • The extinguishing agent must have a density close to that of air (~1.2 kg/m^3 at 20°C) to ensure uniform dispersion. • he agent must not be significantly heavier than air (to avoid settling at ground level) or lighter than air (to prevent it from accumulating at ceiling level). **Three-Dimensional Fire Suppression:** • The extinguishing agent must distribute evenly in all directions to ensure complete fire coverage. • The system must be designed to prevent stratification, ensuring that the agent effectively fills the entire protected volume. **Testing and Performance Validation:** • The system must be tested in real-world conditions to verify the 3D distribution effect. • Fire suppression effectiveness must be validated according to recognized industry standards (e.g., NFPA 2001, ISO 14520, EN 15004).

SPECIFICATIONS

11	Commercial Specification	Requirement Specification	Reasons/ arguments/ explanations
	To guarantee the highest levels of reliability and system integrity, every discharge valve in the fire suppression system must undergo rigorous testing. This includes functional activation testing and a minimum of 20 hours of leakage testing.	Activation and Leakage Testing of Discharge Valves in Fire Suppression Systems that ensures that every **discharge valve** in a fire suppression system is functionally tested for activation and has undergone a **leakage test for a minimum of 20 hours** to guarantee reliability and system integrity.	**Activation Testing:** • Each discharge valve must be individually tested to verify correct activation before installation. • The activation test must ensure that the valve opens and closes properly under system conditions. **Leakage Testing:** • Every discharge valve must undergo a continuous leakage test for at least 20 hours to confirm a leak-free seal. • The test must be conducted under the same pressure conditions as the operational environment. **Conclusion** This requirement ensures that each discharge valve is tested for proper activation and leak-tightness over a 20-hour period before installation. This guarantees system reliability, prevents gas loss, and enhances overall fire suppression system performance.

SPECIFICATIONS

12	Commercial Specification	Requirement Specification	Reasons/ arguments/ explanations
	To ensure optimal performance and reliability, fire suppression systems must undergo annual testing. This includes verifying the activation of the master valve and the functionality of all moving components, without any loss of gas or the need for gas replacement	Annual Testing of Master Valve and Moving Components in Fire Suppression Systems to ensure that fire suppression systems undergo **annual testing** to verify the **activation of the master valve** and the functionality of all **moving components, without loss of gas or new gas replacement necessary .** This guarantees that the system will operate correctly in the event of a fire.	**Annual Master Valve Activation Test:** • The master valve must be tested at least once per year to confirm that it can be properly activated. • The activation must be measurable and documented, ensuring that the valve opens and closes as required. • The test must be performed under safe conditions without compromising system integrity. **Testing of All Moving Components:** • All mechanical parts of the fire suppression system (e.g., valves, actuators, nonreturn valves, Bleed fittings) must be functionally tested annually. • The test must confirm that all moving components operate smoothly and without obstruction. • Any worn or malfunctioning parts must be replaced or repaired immediately. **System Reliability Verification:** • The annual test must ensure that the entire system is operational, with no sticking, blockages, or mechanical failures. **Conclusion** This requirement ensures that the master valve and all moving components are tested annually, confirming system functionality and reliability. Regular testing prevents failures and guarantees that the fire suppression system will function as expected in an emergency.