**Construction**

The motorized fire-smoke damper shall be constructed as follows.

1. **Damper Frame** – The damper frame shall be made of 200 x 38 x 15mm x 2.0 mm thick hot-dipped galvanized steel C channel with a 38mm wide flange pre-punched with round holes for M6 bolts and nuts. The frame shall be fully welded at each corner joint.
2. **Damper Blade** – The damper shall be furnished with 1.2 mm thick double-skin airfoil shape galvanized steel blades equipped with SUS 301 stainless steel blade edge seal and 12.7 x 12.7 mm plated steel square stub shaft. The blade shall pivot on the damper frame with a 2-part bearing on each end consisting a bronze housing with brass insert. Round stub shaft shall not be allowed.
3. **Interconnecting blade linkages** – shall be located outside the air stream and pivot on stainless steel pin to prevent seizure
4. **Jamb Seal** – The vertical dampers frame shall be fitted with SUS301 jamb seal to minimize air leakage.
5. **Electric Actuator** – The electric actuator shall be on/off type complete with spring return function. It shall be single-phase, 24VAC, and shall be supplied and installed by the damper manufacturer to ensure proper selection to match the damper torque and interfacing between actuator and damper. The damper actuator stroke time shall not exceed 20 sec for 90-degree rotation at 50Hz. The actuator shall be capable of operating the damper to the fail-safe close position within 20 sec in the event of loss of power. The electric actuator shall be firmly coupled to a square damper drive shaft to prevent slipping. Two limit switches shall be provided on each actuator for remote monitoring of the damper positions. The actuator selected shall have sufficient torque to match the damper operating torque plus a minimum 20% safety factor.
6. **Heat Resistance Enclosure** – The heat resistance enclosure shall be made of hot-dipped galvanized steel internally insulated to protect the actuator from exposure to 250°C for a minimum of 2 hours. The enclosure shall be designed for easy access to the actuator with four draw-latches for maintenance. Sufficient space shall be allowed for removal of the heat resistance enclosure for maintenance
7. **Support Bracket** – Each damper shall be supported on two support brackets made of 2.5 mm thick hot-dipped galvanized steel. The damper support bracket shall be supplied by the manufacturer and securely anchored to the shaft enclosure wall by the installer.

**Modular Arrangement For large damper**

The Subcontractor shall ensure that large dampers can be brought to the designated location in the building site. All wirings used shall be of 2 hours fire rating. Fire-smoke damper shall be wired to a local damper control panel connected to the emergency power supply.

The Subcontractor shall supply full details of the damper modular arrangement, calculated torque with the specified safety factor, actuator selection, and the number of actuators used for approval before ordering.

**Mode of Operation**

Where the fire-smoke damper is installed in the duct penetration of a shaft enclosure, the damper shall be set to a normally failed-closed position. Upon activation, the damper on the fire floor shall energize to open position within 20 sec to extract smoke. The dampers on the non-fire floor shall remain closed to prevent any infiltration of smoke and fire. The whole ventilation system shall be fully operational within 60 sec.

**Damper Performance**

1. The fire–smoke damper and its actuator shall have the following performance requirements.
2. Fire resistance of 2 or 4 (choose the fire rating) hours according to the fire compartment rating.
3. Temperature rating of 250°C for 2 hours
4. Air Leakage through the closed damper shall not exceed 40.8 l/s/m2 or 0.041 m3/s/m2 at 1000 Pascal pressure differential.
5. The damper actuator shall have the required torque to drive the damper to the fully open and close positions under conditions of 10 m/s face velocity and 1000 Pascal pressure differential within 20 sec.
6. The damper pressure loss in the opened position shall not exceed 40 Pa at 10 m/s face velocity.

**Damper Testing**

A representative sample of the largest module, including all its operational components, shall have been subjected to the following sequence test procedures following the latest Singapore Standard for fire damper SS 333.

1. **Cycling Test** – The fire-smoke damper with an electric actuator shall undergo 20,000 successive cycling test at ambient temperature following the latest Singapore Standard for fire damper SS 333 Clause 6.5.2. Each cycle shall consist of one closing and one reopening of damper blades with the specified damper actuator while operating without duct system pressure. The closing time shall not exceed 20 sec, nor the reopening time exceeds 20 sec. The damper shall be cycled while position as intended for installation and function as intended after the 20,000 full-stroke.
2. **Temperature Degradation Test** – The same fire-smoke damper with all its components that completed the 20,000 cycling test shall be subjected to heating conditions of 250⁰C for 2 hours according to the latest Singapore Standard for fire damper SS 333 Clause 6.8. After 2 hours at 250⁰C and while still under the same heating condition, the damper with its actuator shall be operated through three complete cycles and shall function as intended. The closing time shall not exceed 20 sec, nor the reopening time exceeds 20 sec.
3. **Operation Test** – The same fire-smoke damper with all its components that completed the elevated temperature test shall be subjected to an operation test according to the latest Singapore Standard for fire damper SS 333 Clause 6.7.1 to 6.7.6. The damper shall operate normally under 1.0 kPa pressure and 10 m/s face velocity for three complete cycles and shall function as intended. The closing time shall not exceed 20 sec, nor the reopening time exceeds 20 sec.
4. **Air Leakage Test** – The same fire-smoke damper with all its components that completed the operation test shall be subjected to an air leakage test according to the latest Singapore Standard for fire damper SS 333 Clause 6.4.2. The damper shall meet the leakage requirement not exceeding 0.041 m3/s/m2 under 1000 Pa pressure differential across the closed damper.
5. In addition to the sequence testing, a specimen of the fire-smoke damper shall be tested for pressure loss according to AMCA Standard 500D. Pressure loss through the open damper shall not exceed 40 pascals at a face velocity of 10 m/s.
6. The fire-smoke damper shall be subjected to a fire-resistant test according to the latest Singapore Standard for fire damper SS 333 Clause 6.31 to 6.3.2. The fire-smoke damper shall be tested on a full-scale size furnace of 3000 x 3000 mm, and the damper tested shall be the largest that the furnace can test. Testing carried out on a single module damper shall not be used for performance assessment of a large multiple-module damper.

Test reports from recognized testing laboratories shall be submitted for approval.

**Damper Installation**

Single module damper shall be supplied with a separate sleeve for easy installation. The sleeve shall be installed first within the wall while unobstructed by damper blades. Without the damper, the sleeve can be easily installed on the wall opening with the retaining angles. They shall be supplied in separate modules with necessary hardware for assembly on-site by the installers for larger dampers. For larger dampers, Subcontractor shall submit installation details for approval.

The manufacturer shall provide installation and troubleshooting instructions and training to the damper installer before delivering the damper to the building site. Evidence of training shall be provided after training has been completed.