A GUIDE TO TESTING STAIRWELL AND PASSAGE PRESSURISATION SYSTEMS TO AS/NZS 1668 PT-1 1998.

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This paper has been prepared to use as a quick reference guide and should be used in conjunction with AS/NZS 1668 (The use of ventilation and air conditioning in buildings) Pt-1 1998 (Fire and smoke control in multi-compartment buildings).

It is not intented that this paper overrule any of the guidelines set by the standard, but simply assist persons using the standard find information in relation to commissioning stairwell and passage pressurisation systems.

References: AS/NZS 1668 Pt-1 1998 sections 4, 6, 7, 8, 9 + appendix "F".

AREAS COVERED

- TYPES OF FIRE ISOLATED EXIT PRESSURISATION SYSTEMS
- SYSTEM ARRANGEMENTS FOR SMOKE CONTROL
- REQUIRED TESTING FOR FIRE ISOLATED EXIT SYSTEMS
- TEST EQUIPMENT AND MATERIAL REQUIRED
- PROCEDURES FOR CONDUCTING THE TEST
- MAINTENANCE PERIODS

TYPES OF FIRE ISOLATED EXIT PRESSURISATION SYSTEMS

Vertical (Fire isolated stairwells).

1. Fire isolated exit system and ventilation system shut down.
2. Fire isolated exit system and purge smoke ventilation system (purge system).
3. Fire isolated exit system and zone ventilation system (zone pressurisation system).

Horizontal (Fire isolated passageways).

1. Fire isolated exit system and ventilation system shut down.
2. Fire isolated exit system and purge smoke ventilation system (purge system).
3. Fire isolated exit system and zone ventilation system (zone pressurisation system).

SYSTEM ARRANGEMENTS FOR SMOKE CONTROL

For guidelines to the operation and design requirements of the various types of ventilation systems see the appropriate section of the AS/NZS 1668 Pt-1 1998.

1. System **shutdown** (see section 6).
2. **Purge** system (see section 7).
3. **Zone** system (see section 8).

It is important to be able to identify and understand, the type of building smoke control system that has been adopted, so as to test the stairwell system correctly.

Combination Systems section 9.4.2.

For a building which is arranged as a zone pressurisation system with compartments supplied by two or more fans, having individual air intakes, and complies with section (9.4.2 a), or if a common outside air intake plenum is used and complies with section (9.4.2 b), air leakage from the pressurized compartments may be utilised to provide fire isolated exit pressurisation, without the need for a separate system for each stairwell.

Combinations of the above and separate stair pressurisation can also be adopted.

REQUIRED TESTING FOR FIRE ISOLATED EXIT SYSTEMS.

A. Inspection of the system and compliance with the standards.
B. Stairwell doors close and latch correctly.
C. Minimum pressure differential, doors closed.
D. Maximum pressure differential, doors closed.
E. Maximum opening door force.
F. Differential pressure recovery time, doors open to doors closed.
G. Minimum velocity selected doors open. (Vertical & Horizontal)
H. Noise levels.
I. Manual and automatic control start / stop.
J. Indication lights, fault, run, ready and display time.
K. Fan shut down on smoke intake and auto restart.
L. Documentation and sign off.

A. Inspection of the System and Compliance with the Standards.

The recommended procedure for commissioning stairwell systems prescribed in appendix "F" does not include an inspection, to verify the installation complies with the standards, it is of importance that the system is inspected and any non-conforming components are reported to the installing contractor or the engineer in charge of the

installation. It is assumed that the engineer in charge of the installation will conduct his own inspection for compliance. However, if in the process of testing the system the commissioning engineer finds the installation failing to comply, then these items should be reflected in the commissioning report, unless they are rectified before the completion of testing. Appendix "F" F-3 note; 2 gives guidelines as to the test reporting required.

The commissioning engineer should make himself familiar with the requirements of the standards so as to ensure the system's maximum reliability is achieved in the event of a fire. (See appendix "D").

Some common problems to be aware of are listed below.

- Be sure that all overloads, thermistor relays and any other device which would normally operate to protect the motor, be overridden on any fan required to run as part of the smoke control system. (See section 4.12.1 and commentary C4.12.1 and appendix "D" item (e)).
- The standard suggests that the use of speed drives is inappropriate, as the safety devices designed to protect the unit cannot be completely overridden. Some reference is made to the use of speed drives on stairwell fans in section 4.12.1.
- In a situation where all speed drive safeties cannot be overridden it is recommended that the automatic restart facility be set to provide the maximum number of restarts and that all other safety devices are set to their limit for maximum reliability. In my opinion the use of an automatic resetting overload may be more reliable than a simple fuse or circuit breaker protection. I suggest this as I have witnessed motor failure within ten seconds of start up due to momentary phase loss.

  The standard recommends the elimination of as many safety devices as possible to ensure reliable operation. (See Appendix "D").
- Ensure that normal operating or maintenance personnel cannot inadvertently deactivate each component. (See appendix "D").
- Be aware of the electrical standards as laid out in section 4.12; pay particular attention to 4.12.4 the requirement for lockable isolators and warning labels, as these are commonly forgotten.
- Check that the control and indication is compliant with section 4.13. Be sure that fan indication switches operate reliably and that the response times are adequate. Note fans with speed controllers should be tested to ensure proving switches operate reliably at their lowest speed.
- Tubing for indication or the operation of dampers shall maintain integrity for not less than two hours. (See section 4.14).
- The manual control switches at the fire control panel should be operable at all times, independent of the fire alarm signal. (See section 4.13.2).
- Indication lights at the fire control panel should also be operable at all times, independent of the fire alarm signal. (See section 4.13.3).

B. Stairwell Doors Close and Latch Correctly.

Prior to the commencement of activating the exit pressurisation system it is important to walk through the stairwell or passage way and confirm that all door hardware has been fitted. Test each door in sequence that it closes and latches correctly. Use a spring balance to measure the force generated by the door closer itself. This force should be lower than 60 Newtons or 6 kg. although no guidelines are given, nor is there any requirement to record the results of this test. Experience has proven that if the static door force exceeds the values nominated, it will be extremely difficult to keep the maximum door force below the required 110 Newtons when the system is operating. See section 4.7b and C 4.7.

C. Minimum Pressure Differential.

No direct reference is made to the requirements of a minimum differential pressure between the stairwell and the fire effected compartment. A minimum differential pressure of 20Pa should be adopted to reduce the transfer of smoke. (See section 8.3 and commentary C8.3).

The upper limit will be governed by the maximum door force requirements of 110 Newtons. (See section 4.7, commentary C4.7 and C5.4.7).

For **zone** systems, preliminary tests should confirm that the exit doors on the non-fire-effected compartments are able to close and latch against the positive pressure developed by the supply air system. (See sections C8.5.1.3 and 4.7b).

The above condition is unlikely to occur on zone systems incorporating a separate fire isolated exit system. This is due to the exit system developing a pressure differential greater or equal to the non-fire affected floors therefore causing the doors to close.

D. Maximum Pressure Differential.

The system should be set so the maximum pressure differential between the stairwell and the fire-affected floor doesn't cause the maximum door force to exceed 110 Newtons. For ease of set up the pressure should be set as low as possible. 10 to 20 Pa above the minimum required differential pressure is a good starting point. Set the differential pressure for 30 to 40 Pa.

E. Maximum Opening Door Force.

The door force test should be conducted with the exit pressurisation systems operating and all doors leading to and from the stairway closed. This method should be adopted for any type of system be it zone, purge or system shutdown. The fire control system should be operating in its automatic

mode and the fire-affected floor should be selected to perform the test. The door force should meet the requirements of section 4.7. The combined force of pressure differential across the door and the door closing mechanism should not exceed 110 Newtons.

The automatic door closing mechanism should meet the requirements set out by AS 1905-1.

AS 1905-1 recommends that the maximum force for the door closer to be no greater than 70 Newtons when the door is in still air and no greater than 110 Newtons when subject to draught.

F. Differential Pressure Recovery Time, Doors Open To Doors Closed.

The recovery time is the time taken for the velocity at the door or the pressure differential in the stairwell to recover after the opening and closing of doors. The best way to test the recovery time is to monitor the stairwell pressure using a magnahelic gauge with all doors closed. Then by, opening the fire affected floor door fully, allow the exit pressurisation system to settle. Close the door quickly and watch the magnahelic gauge. The pressure will rise suddenly then begin to drop. Record the time taken for the pressure differential to recover back to its set value. The time taken should be less than 10 seconds. (See section 9.3.1c).

The thought here is that if an exit door is approached and the pressure differential is well above its normal operating pressure, the door may appear jammed. For an unsuspecting occupant attempting to escape the fire affected floor, the next reflex action for the occupant would be to retry the exit door. It is intended that the pressure differential be restored before panic sets in.

Note: the requirement here has changed dramatically since the introduction of the 1991 standard. Prior to this the 1979 standard nominated a time of 15 seconds as a preferable requirement and provided a maximum time not to exceed 60 seconds. It would therefore be suggested that for systems constructed before 1991 the system should be tested in accordance with its relevant standard.

G. Minimum Velocity, Selected Doors Open (Vertical & Horizontal).

Velocity Test (vertical).

1. Shutdown systems require the same test procedures to be adopted as purge systems, without the need for the ventilation systems to be operating.
2. Purge systems require all fire isolated exit systems serving the fire affected floor to be tested simultaneously. Each fire isolated exit system is to have the exit door from the compartment to the stairwell fully open, the adjacent door above or below fully open and the main discharge door from the stairwell to outside fully open. (Three doors for each stairwell). See section 9.3.1(a)-1.
3. Zone systems require all fire isolated exit systems serving the fire affected floor to be tested at the same time. Each fire isolated exit system is to have the exit door from the compartment to the stairwell fully open and the main discharge door from the stairwell to outside fully open. (Two doors for each stairwell). (See section 9.3.1(a)-2).

Velocity Test (horizontal).
A horizontal fire isolated exit system test would normally be conducted the same as purge or system shutdown. However, the number of doors that should be fully open is dependent on the size of the largest compartment protected by the system. This is based on the presumption that the largest compartment area will have the most number of exit doors served by the system and possibly the longest estimated evacuation time, causing it to be a more critical area. (See section 9.3.2).

If more than one fire isolated exit system serves a compartment, then it would be necessary to test both systems simultaneously and confirm that the relief from the compartment is adequate to maintain the required door velocity with all doors fully open.

The standard also suggests that only the exit doors from the largest compartment need be tested for air velocity. Needless to say, the number of doors required to be fully open could be more than two adjacent doors and the exit door to outside. All doors served by the fire isolated exit system should be tested for door opening forces.

Notes on the methods of velocity testing.

1. It is important to understand the intent of the design for horizontal fire isolated exit systems as they can vary considerably. The number of doors required to be open during the velocity tests is dependent on the building layout and the evacuation procedures.
2. The commentary C9.3.1b suggests that three doors should be open during the testing of any stairwell system. However, this appears to contradict the testing procedure for vertical **zone** pressurisation systems as specified in 9.3.1a.2. The paragraph nominates testing the system with the fire effected compartment door/s fully open. The inference of 9.3.1a-2 is that the adjacent door above or below is not required to be open during the test, as this floor would be pressurized and therefore obtaining the required door velocity would not be possible. It is also possible that opening the adjacent door may improve the velocity through the door of the fire-affected floor. Test as per 9.3.1 a-2 with the fire-affected floor and the exit door to outside fully open. (Two doors fully open for each stairwell).
3. If two or more systems and their associated stairwells serve a compartment, then all exits from this compartment should be opened simultaneously during the testing of the door velocity. (See section 9.3.1a).

4. For **purge** and system **shutdown** this would also require the doors of the adjacent compartment to be fully open.
5. For all systems when testing the door velocity it is important to remember: we are not only testing the fire exit pressurisation system's ability to deliver the desired make up air, we are also testing the fire-affected floor's (and adjacent floor for **purge** or system **shutdown**) ability to relieve the supplied air from all compartments' exits doors via the smoke relief system. (See section 9.6-air relief).
6. There is no requirement for providing 1.0m/s at the exit door to outside. However recording the velocity at this door can prove useful in determining if the supply to the stairwell is sufficient.
7. There is also no requirement to provide 1.0m/s at the adjacent exit door/s of the selected adjacent floor. It is assumed however that for systems tested as **purge** or system **shutdown**, the adjacent door/s shall comply with the velocity requirements (not less than 1.0 m/s). This is due to the possibility of the selected fire-affected compartment door, becoming the adjacent door of the next compartment to be tested. (See section 9.3.1a and appendix "F" 6.2.2).

H. Noise Levels.

With the system operating in fire mode each exit should be tested to ensure the minimum noise levels are maintained. The noise level in the stairwell at each exit should be tested with the stairwell door open and is required to be less than 80 dB(A) on the overall spectrum scale. The noise level at each exit inside the occupied space should be tested with the stairwell door closed and is required to be less than 65 dB (A) or 5 dB (A) above the normal background level to a maximum of 80 dB (A). (See appendix "F" 8.1 and sections 4.17 and 4.6).

I. Manual and Automatic Control Start / Stop.

The control of the exit pressurisation system should be controlled in accordance with table 9.1 section 9. This table provides the designer with the conditions, which should automatically start and stop the stairwell system.

The manual override switches shall be installed and function in accordance with 4.13.1 and 4.13.2. The FFCP (fire fighters control panel) shall incorporate an ON.AUTO.OFF override switch for each stairwell fan. The switch is required to be operable at all times independent of a fire initiation. (See section 4.13.2). The switch in the "ON" position should override all automatic control functions of the fan in a fire situation. In the instance of an exit pressurisation fan the requirement is for the "ON" position to override the necessity of the fire signal to start the fan. The "ON" position is also required to override the smoke detector, which may have stopped the fan due to malfunction. (See section 4.13.1 and C4.13.1c).

In addition to the fire override control on the FFCP, each fan generally has a MANUAL, OFF, AUTO switch located at the mechanical switchboard. The control wiring should be designed such that if this switch were to be left in the OFF OR MANUAL positions the FFCP can override the selection or the MANUAL, OFF, AUTO switch shall be lockable and fitted with a prominent warning label as described. (See section 4.12.4). For maintenance or repair purposes the local isolator can isolate the fan and the standard recognises this requirement. (See section 4.13.2 and NOTE).

Indication Lights, Fault, Run, Ready and Display Time.

Each fan shall be provided with a positive proving switch, which shall be arranged to sense airflow.
(See section 4.13.3).

In the case of stairwell fans, it is possible at times the airflow could be going in the reverse direction of its normal operation if the fan is fitted with a speed drive. This occurs when the pressure in the stairwell exceeds the set point and the fan slows to reduce the pressure. However, the pressure on the discharge side will still be higher than the suction side. Therefore a pressure switch piped across the fan will still remain made. For speed driven fans it is imperative to set a minimum speed in the drive so that the proving switch remains made through all its normal operating conditions. A minimum speed of 15 Hz is usually adequate to provide positive proving through the fans operating range and still provide good pressure control. The minimum speed setting should be selected before the final testing of the maximum door force and the recovery time.

To check the indication under its worst condition stop the fan and manually run the fan at its minimum speed and ensure the run status is able to make.

It is envisioned that some delay in display times will be inherent in the system for reliable operation. No guidelines are given for the maximum time of display but it is recommended that display times be minimised. (See section 9.4.5. Table 9.1 Notes).

K. Fan Shut Down on Smoke Intake and Auto Reset.

During the testing of the fan control under automatic operation, the smoke detector located in the supply air stream should be tested for correct operation. Introducing smoke into the fan intake, until the fan shuts down via the supply air smoke detector, can easily do this. The operation of the manual override control can then be tested to check that the "ON" position overrides the smoke detector shutdown. After running the fan for a short time the override control can be set back to the automatic position. The fan should continue to run, as the smoke detector should have reset provided the smoke has cleared sufficiently.

The smoke detector in the fan supply air stream is not required to initiate a fire alarm signal; its purpose is

specifically to provide protection against introducing smoke-laden air from outside. Section 4.10.5b gives guidelines for the required operation.

Section 4.10 provides guidelines to the types and sensitivity requirements of smoke detectors. Supply air detectors shall comply with section 4.10.2.1b.

L. Documentation and Sign Off.

The test documentation for each stairwell pressurisation system should be layed out in a similar format as shown in the standard. (See appendix "F", F-3 and figures F4 to F6).

The pressurisation fans themselves should also be tested to "NEBB" procedural standards or some other testing authority to ensure the correct operation of the fan. The running current, voltage, direction of rotation, class of motor and nameplate details should be recorded.

TEST EQUIPMENT AND MATERIAL REQUIRED.

- Copy of the standard AS/NZS 1668 Pt-1 1998.
- Duct tape or credit card.
- Spring balance new or calibrated 0 to 12 kg.
- Timed anemometer, hot wire anemometer or some other type of instrument capable of measuring 0.8 m/s and above with +/- 3% accuracy by manufactures data.
- Manometer or magnahelic gauge (0 to 60Pa).
- Stop watch.
- Sound level meter.

PROCEDURES FOR CONDUCTING THE TESTS.

The procedures for conducting the test are explained in appendix "F".

Conduct the tests as listed in appendix "F" being methodical in approach. Note that all building ventilation and air conditioning systems should be first fully commissioned in the normal operation mode. (See F.4 appendix "F"). In particular where a system or part of a system is utilized for smoke control.

This guide has been written in chronological order so as to assist the commissioning engineer to perform and document the test results.

MAINTENANCE PERIODS

Maintenance on the system should be carried out within the periods as specified by (AS 1851 Pt-6 1983) and BCA requirements. (See appendix "B" 13).

- Level 1 (Monthly). Simulated start and sensory test.
- Level 2 (Annually). Started from building sprinkler system or by any zone smoke detector or thermal.
- Level 3 (Biannually). Full test of system.