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LABORATORY TESTING AND RATING WEATHER LOUVRES WHEN SUBJECTED TO SIMULATED RAIN

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FOREWORD

The first edition of EUROVENT 2/5 was published in 1985. Since that time the work has been carried out in the CEN/TC 156 in order to prepare a new European Standard needed to support essential requirement of EC Directives.

The present edition, approved by the EUROVENT WG 2, is conform to the projected European Standard.

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1.0 SCOPE

This EUROVENT Document specifies a method for measuring the water rejection performance of louvres subject to simulated rain and wind pressures, both with and without air flow through the louvre under test. For the purpose of this test, a 1000 mm x 1000 mm section of weather louvre or the nearest possible blade increment, is to be tested.

Weather Louvres are designed to restrict the passage of water during rainfall while allowing the passage of air into or from an air distribution system or part of a building. They are used in a wide range of applications, there can be differences in wind speed and direction, levels of local turbulence, rate and droplet size distribution of rainfall and surface water flow from the surrounding structure. It is impractical to consider a standard test procedure simulating the whole range of likely conditions, but this standard provides heavy rainfall directed on to the louvre surface, with simulated wind pressures. This will provide a common basis on which to compare the water rejection performance of weather louvres of different designs.

The tests incorporated in this document are :

1.1 Weather Tests

These establish the weather louvre effectiveness when subjected to wind pressure at various air flow rates.

1.2 Discharge Loss Coefficient/Pressure Requirement

This establishes the air pressure loss through the weather louvre at various air flow rates and by calculation the Discharge Loss Coefficient.

2.0 SYMBOLS AND SUFFIXES

2.1 Symbols

Symbol	Quantity	Unit
A	Louvre core area/area of the hole in calibration plate	m^2
C_D	Discharge Loss Coefficient	
C_E	Entry Loss Coefficient	
p	Absolute static pressure	Pa
p_a	Atmospheric pressure	Pa
p_d	Velocity pressure $^1/_2\,\rho\,v^2$	Pa
p_r	Stagnation or absolute total pressure	Pa
p_s	Static gauge pressure $(p - p_a)$	Pa
p_t	Total pressure $(p_r - p_a)$	Pa
Δp	Flow meter pressure difference	Pa
Δp_t	Conventional total pressure differential for an air density of 1.2 $kg.m^{-3}$ at the inlet to the louvre or valve under test	Pa
q_v	Volume rate of air flow at the flow meter	$m^3.s^{-1}$
q_s	water supply rate to the nozzles	$l.h^{-1}$
q_u	water rejection rate collected upstream of the test louvre	$l.h^{-1}$
q_d	water penetration rate collected downstream of the test louvre	$l.h^{-1}$
ρ	Air density	$kg.m^{-3}$
θ	Temperature	^0C

Symbol	Quantity	Unit
E	*effectiveness*	%
v_w	wind velocity	$m.s^{-1}$
v_c	core velocity	$m.s^{-1}$

2.2 Suffixes

1 is the outlet of the weather louvre under test

m is the measuring point at the air flow meter

n is the value at selected point of air flow rate/static pressure curve

o *measured value with calibration plate*

cor

(used to show correct values against references values)

nom

3.0 DEFINITIONS

The definitions of terms used in this document are in accordance with ISO 3258, and as follows :

Weather Louvre

Weather Louvres - are devices intended to allow the passage of intake or exhaust air while minimising the ingress of rain.

Louvres can have either fixed or adjustable blades

Insertion loss

The insertion loss of a weather louvre is the difference in simulated rain penetration between the test specimen and the calibration plate at the same test conditions.

Weather louvre core area

The product of the minimum height H and minimum width W of the front opening in the weather louvre assembly with the louvre blades removed (see fig 5)

Louvre calibration plate

The louvre calibration plate is a plate having an opening of the same geometric shape and dimensions as the core area of the test specimen.

Discharge or entry loss coefficient of a louvre

The discharge or entry loss coefficient of a weather louvre is equal to the actual air flow rate divided by the theoretical air flow rate at a given pressure difference across the louvre. For louvres tested with air flow in the reverse direction then the coefficient of discharge becomes the coefficient of entry.

The theoretical air flow

The theoretical air flow rate is the product of the louvre core area and the air velocity calculated using the pressure difference across the louvre as the velocity pressure, assuming C_D or C_E = 1.

Weather louvre effectiveness

The effectiveness of a weather louvre at any air velocity through the louvre is the insertion loss of the louvre assembly divided by the water penetration of the calibration plate at that velocity.

4.0 INSTRUMENTATION

4.1 Air flow Rate Measurement

The air flow rate shall be measured using instruments in accordance with ISO 5221.

4.1.1 Air flow meters shall have the following ranges and accuracies:-

Table 4.1

Range $m^3.s^{-1}$	Accuracy of Measurement %
from 0,07 to 7 from 0,007 to 0,07	± 2,5 ± 5

Flow meters may be calibrated *in situ* by means of pitot static tube traverse techniques described in ISO 3966.

4.1.2. Flow meters shall be checked at intervals as appropriate but not exceeding 12 months. This check may take the form of one of the following :-

a) a dimensional check for all flow meters not requiring calibration.

b) a check calibration over their full range using the original method employed for initial calibration or meters calibrated in situ;

c) a check against a flow meter which meets the flow meter specification ISO 5221.

4.2 Pressure Measurement

4.2.1 Pressure in the duct shall be measured by means of a liquid-filled calibrated manometer, or any other device complying with section 4.2.2.

4.2.2. The maximum scale interval shall not be greater than the characteristics listed for the accompanying range of manometers.

Table 4.2

Range Pa	Max. scale interval Pa
≤ 25	1,0
> 25 ≤250	2,5
>250 ≤500	5,0
> 500	25,0

4.2.3 For air flow measurements, the minimum pressure differential shall be:

a) 25 Pa with an inclined tube manometer or micro-manometer;

b) 500 Pa with a vertical tube manometer.

4.2.4 Calibration standards shall be:

a) for instruments with the range $\leq$25 Pa, a micro-manometer accurate to $\pm$ 0,5 Pa;

b) for instruments with the range >25 $\leq$500 Pa, a manometer accurate to $\pm$ 2,5 Pa (hook gauge or micro-manometer);

c) for instruments with the range >500 Pa, a manometer accurate to $\pm$ 25 Pa (vertical manometer).

4.3 Temperature Measurement

4.3.1 Measurement of temperature shall be by means of mercury-in-glass thermometers, resistance thermometers or thermo-couples. Instruments shall be graduated to give readings in intervals not greater than 0,5K and calibrated to an accuracy of 0,25K.

4.4 Water Flow Meters

4.4.1 Water flow meters shall have an accuracy of measurement within 0,5% of the indicated flow rate.

4.4.2 Water flow meters shall be calculated against a known weight of water flowing for a measurement time period as specified in ISO 4185.

4.5 Timers

4.5.1. Timers for determining water flow rates shall have a minimum accuracy of 0,2 seconds.

4.6 Rain Gauge

4.6.1 Rain gauge shall have an accuracy of $\pm$ 2% of reading, this may be achieved using rain gauge MK 11 conforming to British Met Office Specifications.

5.0 TEST APPARATUS

The overall assembly is shown in figure 1.

The various elements are described as follows :

5.1 Wind Simulation Equipment

5.1.1 An external fan for directing the air perpendicular to the weather louvre test plane, as illustrated in figure 2.

5.1.2 The air outlet of the fan and any silencing or straightening section shall not be less than 1 m diameter.

5.1.3. The fan shall be capable of producing an air velocity of 13 $m.s^{-1}$ at 1 m in front of the test plane of the weather louvre.

5.1.4. An air straightener section shall be assembled to the outlet of the fan to avoid swirling air currents.

A suitable air straightener is illustrated in figure 2. Other air straighteners (such as described in ISO 5801 tests) may also be used.

5.2 Weather Section

5.2.1 The weather louvre or calibration plate, to be tested, shall be mounted and fixed in the centre of a 3 m x 3 m square wall at the rear of the weather section (see figure 2)

5.2.2. The weather louvre or the calibration plate as appropriate shall be tightly sealed to the wall, as recommended by the manufacturer and the test house.

5.2.3. The outside face of the weather louvre shall be facing the wind and rain simulation equipment.

5.3 Rain Simulation Equipment

5.3.1 The simulated rain shall be produced by at least 4 nozzles in an array close to the discharge of the wind effect fan to suit the spread of rain required. A suitable spray can be achieved by using the nozzles and control system as shown in figures 2 and 4 and Appendix A1.

5.3.2 The rain simulation equipment shall satisfy the following:-

With the calibration plate mounted in the test opening.

a) Capable of producing a simulated rain penetration through the calibration plate of 75 $l.h^{-1}$ (+ 10% - 0%) per square metre of opening.

b) The simulated rainfall rate measured using the rain gauge in the positions shown in figure 5 must not deviate from the mean value by more than 15%.

c) The water penetration through the calibration plate measured in the collection section shall be at least 80% of the water supply rate from the nozzles.

5.4 Collection Duct

5.4.1. The collection duct (see figure 3) shall be sealed against the back of the weather section.

5.4.2. The collection duct shall have a water droplet elimination section at the downstream end to prevent carry over of airborne water droplets from the collection duct. See Appendix A2 for details.

5.4.3. The collection duct shall have an airtight connection to the air flow *measuring plenum.*

5.5 Water Collection

5.5.1. a) <u>At the collection duct</u>

Water shall be collected at the drain from the collection duct so that the penetration for the test period can be measured.

5.5.2 b) <u>In front of the louvre</u>

Water shall be collected in the weather section at the base in front of the weather louvre or calibration plate so that the water rejection during the period of the test can be measured.

5.6 Aerodynamic Measurement Section

Typically illustrated in figure 6

5.6.1 Air Flow Rate Measurement

The air flow rate shall be measured by means of a conical inlet positioned at 600 mm from the discharge end of the section. To achieve a uniform flow approaching the conical inlet, resistance screens should be fitted.

The required uniformity is considered to be achieved if the maximum air velocity in plane A nowhere exceeds 1,25 times the average velocity in plane A.

Three uniform wire mesh or perforated plate screens adequately supported and sealed to the chamber spaced 100 mm apart and with 60%, 50% and 45% free area successively in the direction of flow may be expected to secure the required flow uniformity.

Other air flow rate meters complying with 4.1 may be used.

5.6.2. The pressure loss across the weather louvre shall be measured using static pressure measurement points positioned 100 mm behind the weather louvre on the sides of the aerodynamic test section (note, there shall be no obstructions within 2 m of the face of the louvre).

5.7 Mechanical Ventilation Section

5.7.1 The mechanical ventilation section shall consist of a ventilation fan that shall be capable of producing an air flow rate through the weather louvre under test over the range of 0,5 $m^3.s^{-1}$ to 3,5 $m^3.s^{-1}$ (see figure 6).

5.8 Test Specimen and Calibration Plate

5.8.1. The louvre to be tested shall be as near to but not exceeding the nominal dimensions of 1000 x 1000 mm as possible using standard blade pitches and without the use of cover plate or infills.

5.8.2. If the manufacturers range does not extend up to 1000 mm x 1000 mm then the maximum size unit shall be tested.

5.8.3. For the purpose of calibration tests a calibration plate shall be fabricated which will fit over the test plane and have an opening of the same dimensions as the core area of the weather louvre to be tested.

This plate is used in the determination of the rain penetration insertion loss of the louvre.

6.0 TEST METHODS

6.1 Water Penetration Test

6.1.1. The weather louvre to be tested shall be as detailed in 5.8 and shall be mounted and sealed to the 3 m x 3 m wall at the rear of the weather section as recommended by the manufacturer, to prevent any ingress of water other than through the weather louvre blades.

6.1.2 The weather louvre shall be tested at a minimum of 8 different core velocities ranging from 0 to 3,5 $m.s^{-1}$ in increments of 0,5 $m.s^{-1}$. The set values shall not deviate from the nominal values by more than ± 0,1 $m.s^{-1}$. All tests shall be at a constant simulated heavy rainfall rate of 75 $l.h^{-1}.m^{-2}$ (75 $mm.h^{-1}$). All tests shall be carried out at a simulated wind speed of 13 $m.s^{-1}$ measured by means of a velocity meter (ie, vane anemometer or pitot tube) on the centre line of the fan and 1 m in front of the face of the louvre.The velocity meter shall beremoved before the rain simulation nozzles are turned on.

The water flow rates shall be measured with a flow meter and set to the desired rates for each test. Water shall be collected from in front and behind the weather louvre.

6.1.3. For any of the series of tests the following shall be held at a constant within the tolerances given below.

Water supply rate (see fig 4)	± 2%
Water collection rate	± 10%
Ventilation air flow rate	± 5%
Wind velocity	± 10%

6.1.4. Test values shall be noted at not more than 10 minute intervals and the test period shall be complete when a minimum of four consecutive readings of values within the steady state tolerance have been noted. Minimum test period is 30 minutes.

Note: Wind speed will only be tested before and after testing.

6.1.5 Calibration plate tests

a) Mount the calibration plate in the test position.

b) Mount the spray nozzles as illustrated on figure 2.

c) Adjust the ventilation air flow rate q_v to zero and set the wind velocity at 13 $m.s^{-1}$.

d) Set up the rain pattern as described in section (5.3)

e) Adjust the water supply rate q_s so that the penetration rate q_{do} lies between 75 $l.h^{-1}$ per m^2 (+ 10% - 0%) of the calibration plate.

f) For the test period the following values shall be measured and recorded:-

1. the water supply rate .... q_{so} ($l.h^{-1}$)

2. the water rejection rate.................................. q_{uo} ($1.h^{-1}$)

3. the water penetration rate.............................. q_{do} ($l.h^{-1}$)

4. air flow rate through plate.............................. q_{vo} ($m^3.s^{-1}$)
(except for no air flow test)

5. wind velocity .... v_w ($m.s^{-1}$)
(at the start and end of test period)

g) Adjust the air flow q_v through the plate to the next value in the test schedule as in 6.1.2 and repeat e) to f).

h) When tests have been made at all of the values of q_{vo} the test results shall be summarised and the penetration rate corrected by calculation if the water supply rate has varied from the nominal value of q_{so}.

The nominal water supply rate $q_{s\ nom}$ is the supply rate to the nozzles that will produce a penetration of 75 $l.h^{-1}.m^{-2}$ through the calibration plate at the test air flow rate.

$$q_{s\ nom} = 75.\ q_{so}.q_{do}^{-1}.A$$

6.1.6 Weather Louvre test

a) Install the weather louvre in the test opening.

b) Install the spray nozzles as illustrated on figure 2.

c) Adjust the flow rate q_{vo} to zero and the wind speed to 13 $m.s^{-1}$.

d) The rain pattern shall be as established during the testing of the calibration plate.

e) Adjust the water supply rate as close as possible to $q_{s\ nom}$ as established during the testing of the calibration plate.

f) During the test period the following values shall be measured and recorded:-

1. the water supply rate .... q_s ($l.h^{-1}$)

2. the water rejection rate .... q_u ($l.h^{-1}$)

3. the water penetration rate .... q_d ($l.h^{-1}$)

4. air flow rate through weather louvre .... q_v ($m^3.s^{-1}$)
(except for no air flow test)

g) Adjust the air flow rate q_V through the weather louvre to the next value in the test schedule and repeat e) to f).

Note: Air flow rates should be as established during calibration plate test $\pm$ 5%.

h) When tests have been made at all of the values of q_V the test results shall be summarised and the penetration rate corrected by calculation if the water supply rate has varied from the nominal value of $q_{s\ nom}$.

The corrected water penetration rate $q_{d\ corr}$ is the water penetration rate that would be achieved if the water supply rate were to be equal to the nominal water supply rate $q_{s\ nom}$ at the test ventilation air flow rate.

$$q_{d\ corr} = q_{s\ nom} \cdot q_d \cdot q_s^{-1}$$

6.1.7. <u>Test Reporting</u>

i) Prepare a graph of the test results of the rain penetration through the calibration plate by plotting:

$q_{s\ nom}$ (vs) v_c and

q_{do} (vs) v_c

ii) Prepare a graph of the test results of the rain penetration through the weather louvre by plotting:

$q_{s\ nom}$ (vs) v_c and

$q_{d\ corr}$ (vs) v_c

iii) Prepare a graph of the effectiveness of the weather louvre at different velocities by plotting the velocity calculated from $q_V.A^{-1}$ against the effectiveness E calculated from.

$$E = [75.A - q_{d\ corr}].100\ [75.A]^{-1}$$

at each of the test air flow rates

Note:- a) louvre effectiveness is defined in paragraph 3.

b) 75.A is the product of the required calibration plate water penetration rate (75 l/hr/m^2) and the area of the calibration plate hole A.

6.2. Discharge And Entry Loss Coefficient/Pressure Loss

6.2.1 To derive the pressure loss and discharge or entry loss coefficient of the weather louvre, five different air flow rates q_V shall be measured at the air flow rate meter. The lowest flow rate in the range shall be such that it produces a pressure difference greater than 10 Pa and the highest shall be 3,5 $m^3.s^{-1}$.

6.2.2. If there are significant differences in the air temperature and static pressure between the flow meter and the weather louvre under test so that the air density ratio:

$\rho_m.\rho_1^{-1}$ is less than 0,98 or greater than 1,02, then the following correction should be applied:-

$$q_{v1} = q_v . \rho_m . \rho_1^{-1}$$

where

$$\rho_m = 3,47 . 10^{-3} \quad \{(p_{su} + p_a).(\theta_u + 273)^{-1}\}$$

and

$$\rho_1. = 3,47 . 10^{-3} \quad \{(p_{s1} + p_a).(\theta_1 + 273)^{-1}\}$$

Otherwise q_{v1} may be taken as equal to q_v

6.2.3. Having measured values of p_{s1} and also determined corresponding values of q_{v1} in accordance with 6.2.2, the following functions shall be plotted on linear graph paper:

p_{s1} vs $(q_{v1})^2$

6.2.3.1 By graphical or calculation methods the best straight line through the plotted points and passing through zero should be determined (see figure 7a). If isolated points fall outside the 5% differential pressure band about the best mean line, repeat the tests at the relevant flow rates to check validity of test data.

6.2.3.2 If groups of points fall outside the $\pm$ 5% band indicating the test results do not follow a linear relationship between q_{v1} and p_{s1} instead draw the best line (curve) through the points and zero (see figure 7b). If the p_{s1} points fall within $\pm$ 5% of the line (curve) then the curve can be used for calculation in 6.2.4. If outside $\pm$ 5% of the curve then only individual test points for p_{s1} can be used in 6.2.4 and the situation made clear in reporting the test results.

6.2.4. The discharge loss coefficient C_D shall be calculated for each ventilation air flow rate used in the test. This may also apply to the entry loss coefficient C_E.

$$C_D = \frac{\text{Actual Flow}}{\text{Theoretical Flow*}}$$

$$= q_{vn}.\{A\,(2.p_{sn}\,.\rho_{1n}^{-1})^{1/2}\}^{-1}$$

where ρ_{1n} = 1,2 or corrected density in accordance with 6.2.2.

* Theoretical flow is defined as the flow with a loss coefficient ζ = 1

7.0 Classification Of Weather Louvres

Weather louvres shall be classified by their ability to reject simulated rain.

7.1 Penetration Classification

Table 1 shows different classifications based on the maximum simulated rain penetration per square metre of louvre. The effectiveness is determined in accordance with section 6.1.7. iii.

Water penetration rating at a given louvre face velocity is determined by the water penetration while the louvre is subjected to a 13 $m.s^{-1}$ simulated wind velocity and a simulated rain fall at the nominal rate.

Class	Effectiveness	Maximum allowed penetration of simulated rain $l.h^{-1}.m^{-2}$
A	1 to 0,99	0,75
B	0,989 to 0,95	3,75
C	0,949 to 0,80	15,0
D	Below 0,8	Greater than 15,0

TABLE 1 - PENETRATION CLASSIFICATION

These classifications apply at various core velocities.

7.2 Discharge Loss Coefficient

The discharge loss coefficient given in Table 2, shall be determined in accordance with section 6.2.4.

Class	Discharge Loss Coefficient
1	0,4 and above
2	0,3 to 0,399
3	0,2 to 0,299
4	0,199 and below

TABLE 2 - DISCHARGE LOSS COEFFICIENT CLASSIFICATION
(Note: The above also applies to entry loss coefficient)

The water penetration class letter should precede the co-efficient of discharge class letter followed by the limiting core velocity such as:

A	2	up to	1 $m.s^{-1}$
B	2	up to	2 $m.s^{-1}$
C	2	up to	3 $m.s^{-1}$

The classification applies to a specific weather louvre design irrespective of size.

APPENDIX A1

SIMULATED RAIN SPRAY NOZZLES

A 1.1 simulated rain spray nozzles

The general arrangement for the simulated rain spray nozzles shall be as indicated in Figures 2 and 4.

The overall required effect is to cover the area of the louvre and calibration plate in a uniform manner.

In order to achieve a satisfactory trajectory, water flow rate and droplet size from the nozzles it is necessary to spray water from the nozzles in short bursts with only one of the 4 nozzles spraying at any instant.

This is achieved by connecting each nozzle array to an electrically or mechanically operated timer valve as shown in Figure 4.

The total flow rate to the nozzle array shall be maintained constant and the water flow sufficient to ensure that the droplet size is significant.

The nozzles used shall be of the wide spray type featuring a solid cone-shaped spray pattern with a square impact area, and a spray angle of 93^0 to 115^0 with a capacity of 3.7 litres per minutes at 0.3 Bar pressure.

APPENDIX A2

WATER ELIMINATOR PERFORMANCE TEST

A 2.1 Water eliminator performance test

The following installation and procedures shall be used to check the effectiveness of the water eliminators in the water collection duct as shown in Figures 1 and 3.

The test shall be carried out for the extremes of the louvre test conditions ie,

simulated wind = 13 $m.s^{-1}$ ventilation rate = 3,5 $m^3.s^{-1}$
simulated wind = 13 $m.s^{-1}$ no ventilation rate

A 2.2 Installation

The nozzles shall be supplied with water by means of a pump drawing water from a small sump tank, the sump tank shall have a sight glass for gauging the water content. The drain from the collection duct shall feed to the sump tank.

A 2.3 Procedure

a) *install the array of spray nozzles in the collection duct.*

b) fill the sump tank with water and, start the pump and set the water flow rate to 75 $l.h^{-1}$ (+10%-0%)

c) allow sufficient time for the surfaces of the collection tank to become wetted (approximately one hour).

d) after the surfaces of the collection duct have been wetted, the sump tank shall be filled to a mark on the sight glass.

e) as the water level in the sump drops due to water loss, refill the tank with measured amounts.

f) continue the test for a period of two hours.

g) calculate the total amount of water used to refill the tank.

The rate of water loss (amount of water used to refill the tank), shall be less than 3% of the hourly water flow rate through the nozzle.

APPENDIX A3

TYPICAL TEST RESULTS AND CALCULATION EXAMPLES

TYPICAL EXAMPLE CALCULATIONS

Tables 1 and 2 show in tabulation form typical test results and data derived from these results for a louvre having a core area of 0,893 m^2.

AIR FLOW RATE $m^3.s^{-1}$	CORE VELOCITY $m..s^{-1}$	WATER SUPPLY RATE $l.h^{-1}$	WATER PENETRATIO N RATE $l.h^{-1}$	NOMINAL WATER SUPPLY RATE $l.h^{-1}$
q_v	$v_c = q_vA^{-1}$	q_{so}	q_{do}	$q_{s\,nom}$
0,00	0,00	74,00	67,15	73,81
0,45	0,50	74,00	68,84	71,99
0,89	1,00	74,00	70,66	70,14
1,38	1,55	74,00	70,96	69,84
1,79	2,00	74,00	71,78	69,05
2,26	2,53	74,00	71,97	68,86
2,68	3,00	74,00	72,35	68,51
3,08	3,45	74,00	72,43	68,42

TABLE 1 - CALIBRATION PLATE TEST RESULTS

AIR FLOW RATE $m^3.s^{-1}$	CORE VELOCITY $m.s^{-1}$	WATER SUPPLY RATE $l.h^{-1}$	$l.h^{-1}$	WATER PENETRATION RATE $l.h^{-1}$	$l.h^{-1}$	LOUVRE EFFECTIVENESS E
q_v	q_vA^{-1}	q_s	$q_{s\,nom}$	q_d	$q_{d\,corr}$	%
0,00	0,00	74,00	73,83	0,30	0,30	99,6
0,45	0,50	74,00	71,83	0,59	0,57	99,1
0,89	1,00	74,00	70,48	0,91	0,86	98,7
1,43	1,60	74,00	69,49	0,99	0,93	98,6
1,79	2,00	74,00	69,12	1,89	1,76	97,4
2,21	2,47	74,00	68,84	2,10	1,95	97,1
2,68	3,00	74,00	68,62	19,76	18,33	72,6
3,17	3,55	74,00	68,30	36,78	33,94	49,3

TABLE 2 - WEATHER LOUVRE PERFORMANCE DATA
Core Area 0.893 m^{-2}

LOUVRE PRESSURE LOSS Pa	AIR FLOW RATE $m^3.s^{-1}$	AIR FLOW RATE $(m^3.s^{-1})^2$	point C_D	variance from mean C_D%
p_s	q_v	q_v^2		
10	1,065	1.134	0,293	0,6
16	1,304	1,700	0,284	-2.6
25	1,688	2,849	0,294	0,9
36	2,000	4,000	0,290	-0,4
46	2,268	5,144	0,291	-0,1
56	2,507	6,285	0,292	0,1
67	2,726	7,431	0,290	-0,5
76	2,928	5,573	0,292	0,4
83	3,099	9,604	0,295	1,6

MEAN C_D = 0,291

TABLE 3 - AIR FLOW TEST RESULTS AND DERIVED DATA

Typical example of test results showing the progression from tables to graphs as described in 6.1.7.

TABLE 1 TO GRAPH (1)
TABLE 2 TO GRAPHS (2) AND (3)

A 3.1 Coefficient of discharge

Procedure using typical results given in Table 3
with test area A = 0,893 m^2 and ρ = 1,2 $kg.m^{-3}$

1. Determine the best straight line between q_{v1}^2 and p_{s1}.

2. At any actual air flow rate establish the corresponding differential pressure across the louvre p_s. (from graph - best fit line).

3. Using the formula detailed in 6.2.4;

$$C_D = \frac{\text{Actual flow}}{\text{Theoretical flow}}$$

$$= q_{vn}.\{(A\,(2.p_{sn}.\rho_{1n}^{-1})^{½}\}^{-1}$$

For example, at the maximum flow rate of 3,099 $m^3.s^{-1}$ and related pressure loss of 83 Pa from Table 3.

$$C_D = 3{,}099\{0{,}893\,(2.83.1{,}2^{-1})^{½}\}^{-1} = 3{,}099.10{,}5^{-1}$$
$$= 0{,}295$$

By repeating this calculation for each of the flow rates in Table 3, the mean value of 0,291 can be calculated and the variance from the mean C_D established (this variance should comply with the requirements of 6.2.3.2).

A 3.2 Louvre Effectiveness

AIR FLOW RATE $m^{-3}.s^{-1}$ q_v	CORE VELOCITY $q_v.A^{-1}$	TEST LOUVRE PENETRATION $l.h^{-1}$ $q_{d\,corr}$
1,79	2,0	1,76

Louvre effectiveness

$$= [75.A - q_{d\,corr}].100.[75.A]^{-1}$$

$$[75.0,893 - 1.76].100\ [75.0,893]^{-1}$$

$$= 97.4\%$$

A 3.3 Classifications

Water penetration classification	Coefficient of discharge classification	Up to core velocity of (m.s^{-1})
A	3	0,5
B	3	2,5
B	3	2,8
D	3	3,5

CLASSIFICATION EXAMPLES FROM TYPICAL RESULTS

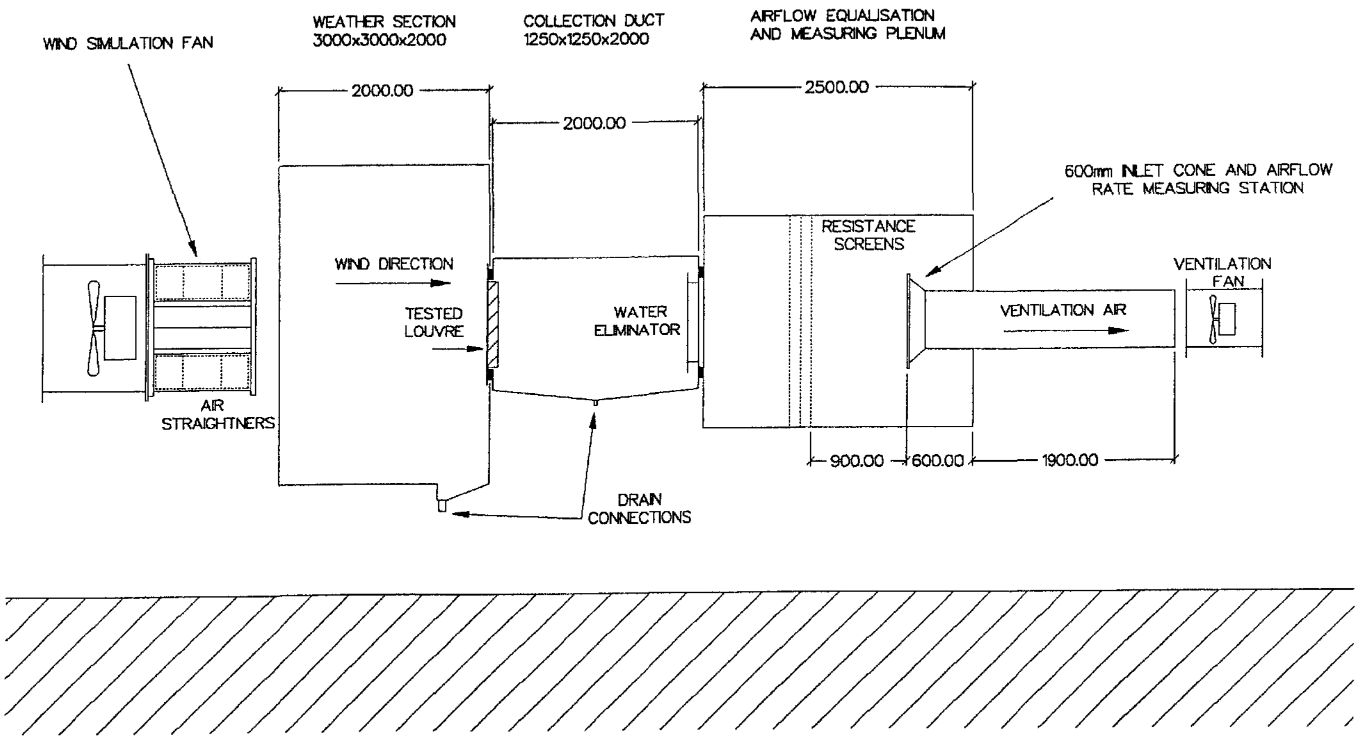


FIGURE 1 AERODYNAMIC WEATHER LOUVRE TEST FACILITY

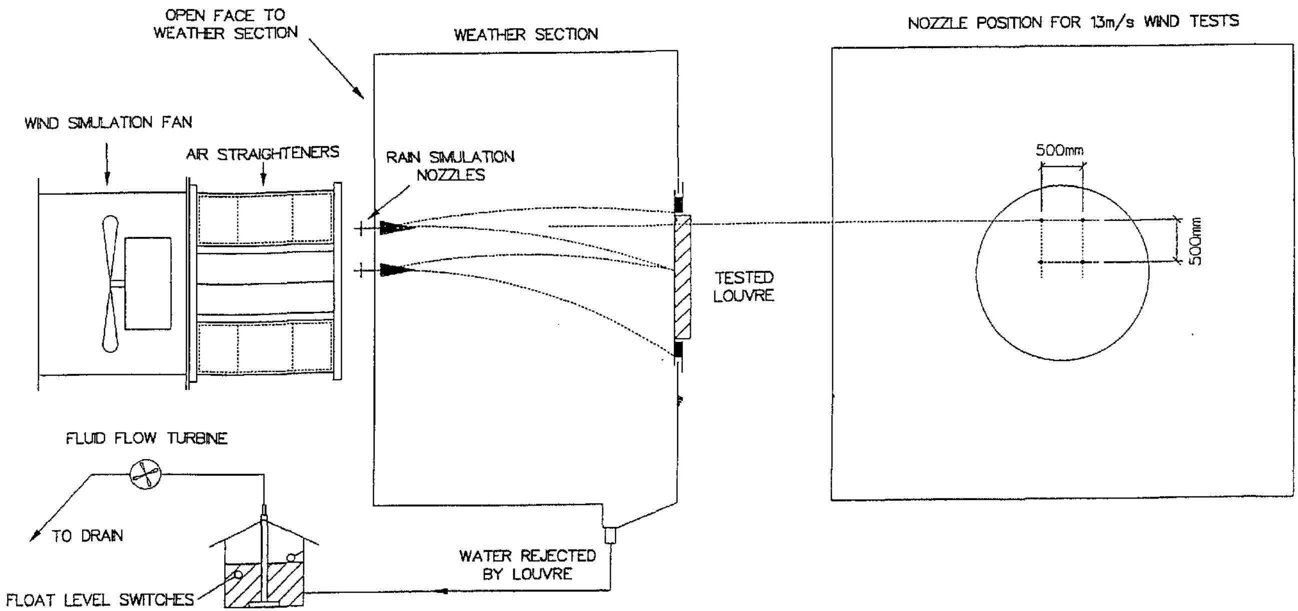


FIGURE 2 WEATHER SIMULATION SECTION OF BSRIA LOUVRE TEST FACILITY

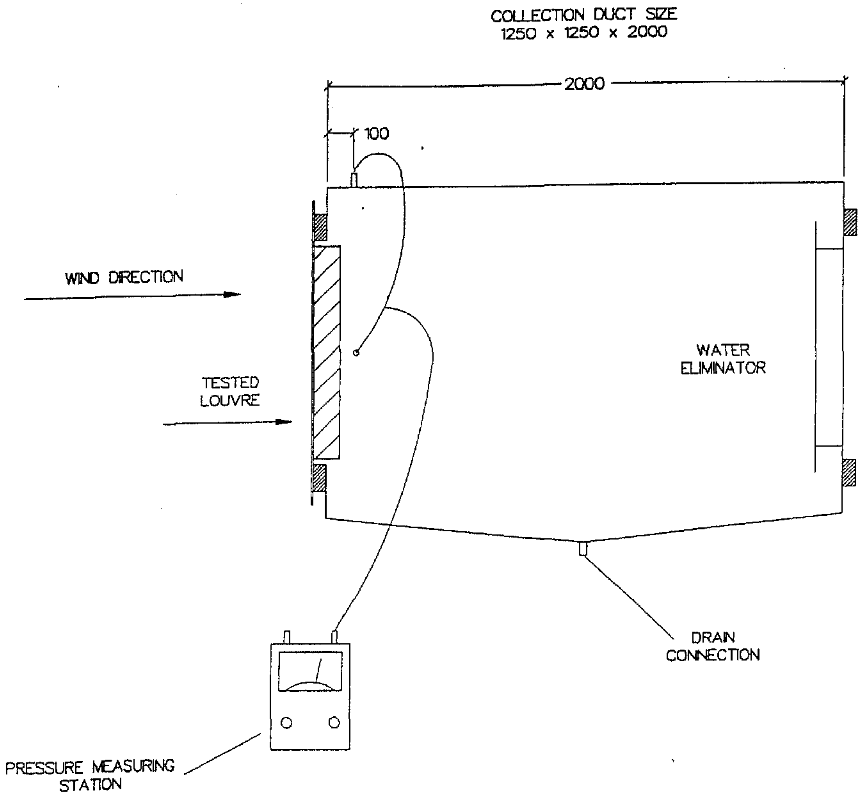


FIGURE 3 COLLECTION DUCT DETAIL

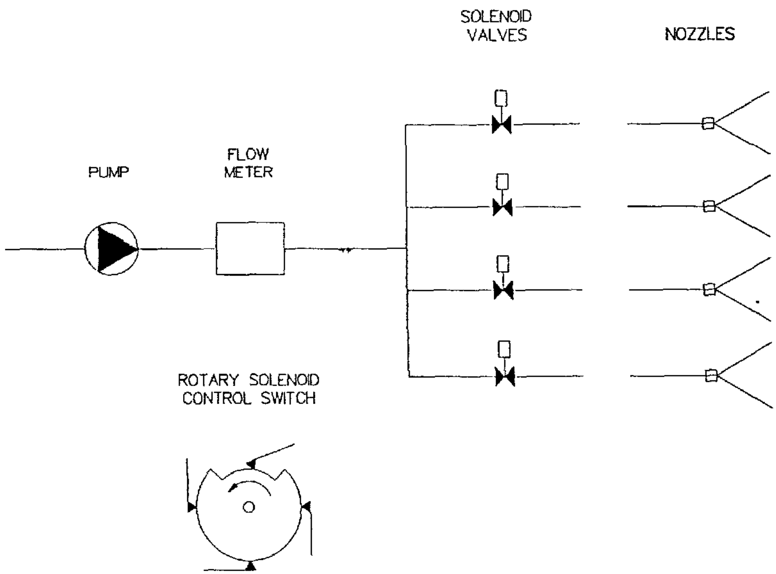


FIGURE 4 SCHEMATIC DIAGRAM OF NOZZLE CONTROL SYSTEM

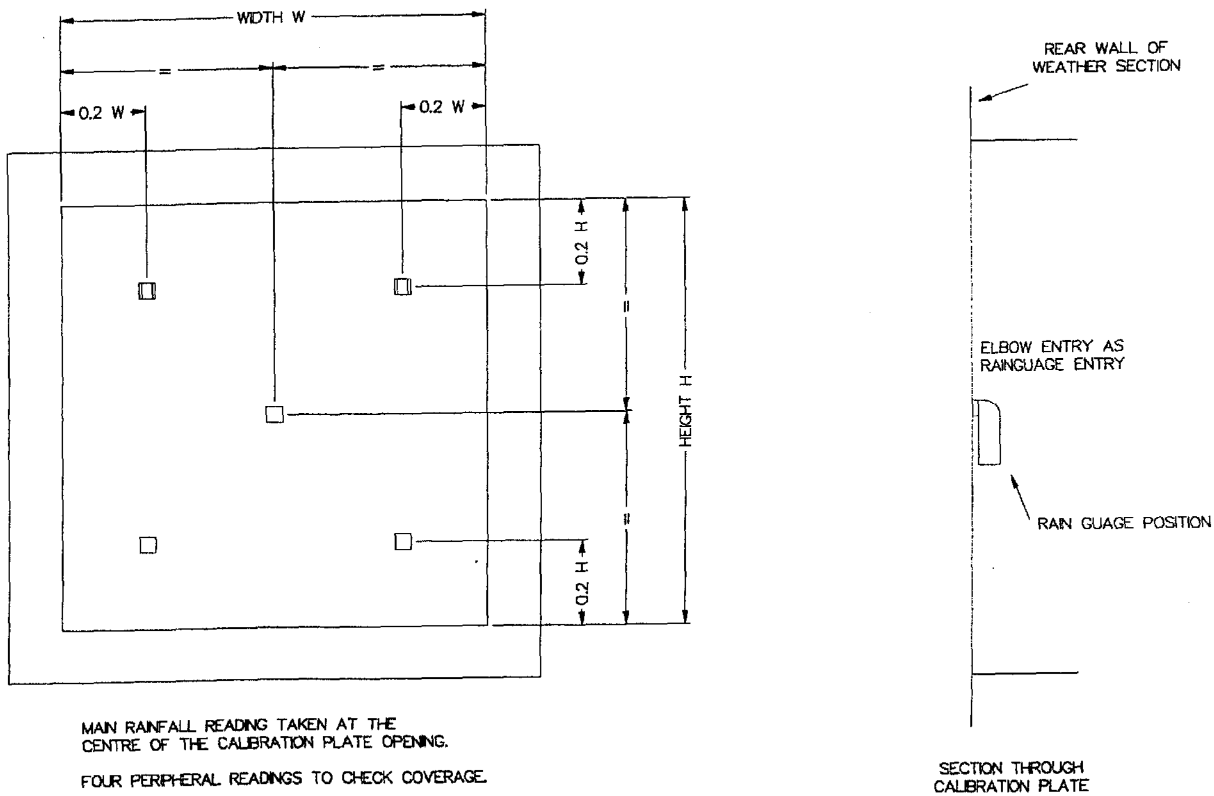


FIGURE 5 RAINFALL COVERAGE

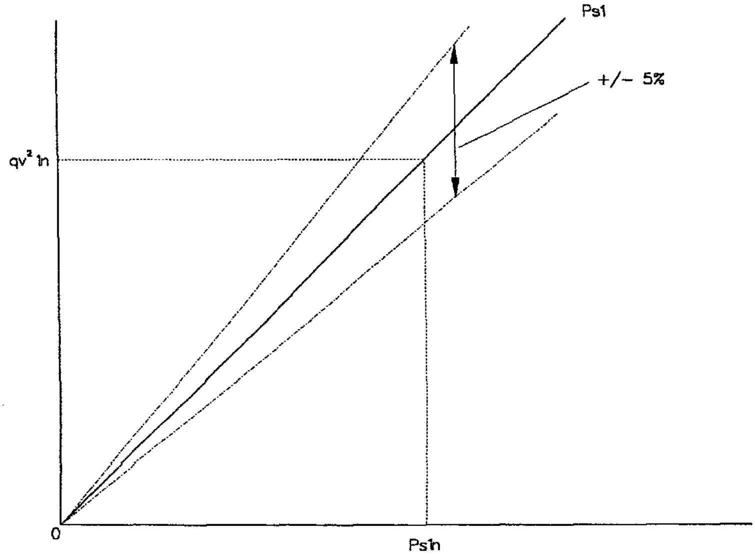


FIGURE 6 FLOW RATE/PRESSURE REQUIREMENT
STRAIGHT LINE CHARACTERISTIC FOR Ps1 vs qv^2 1

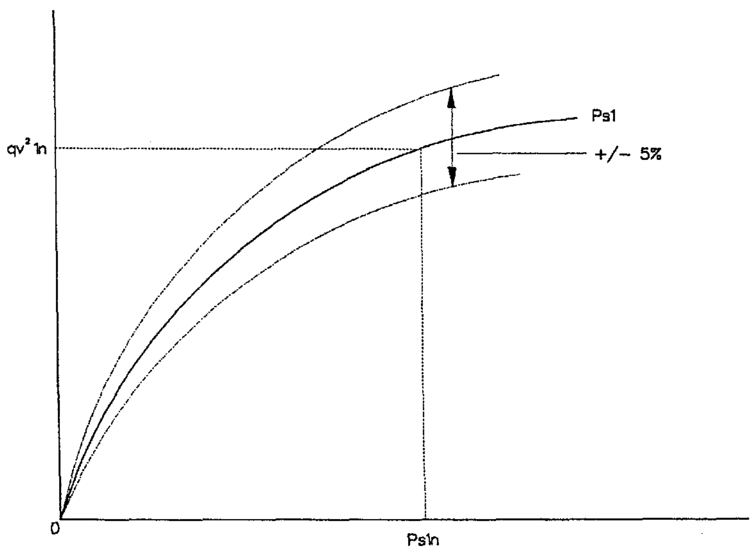
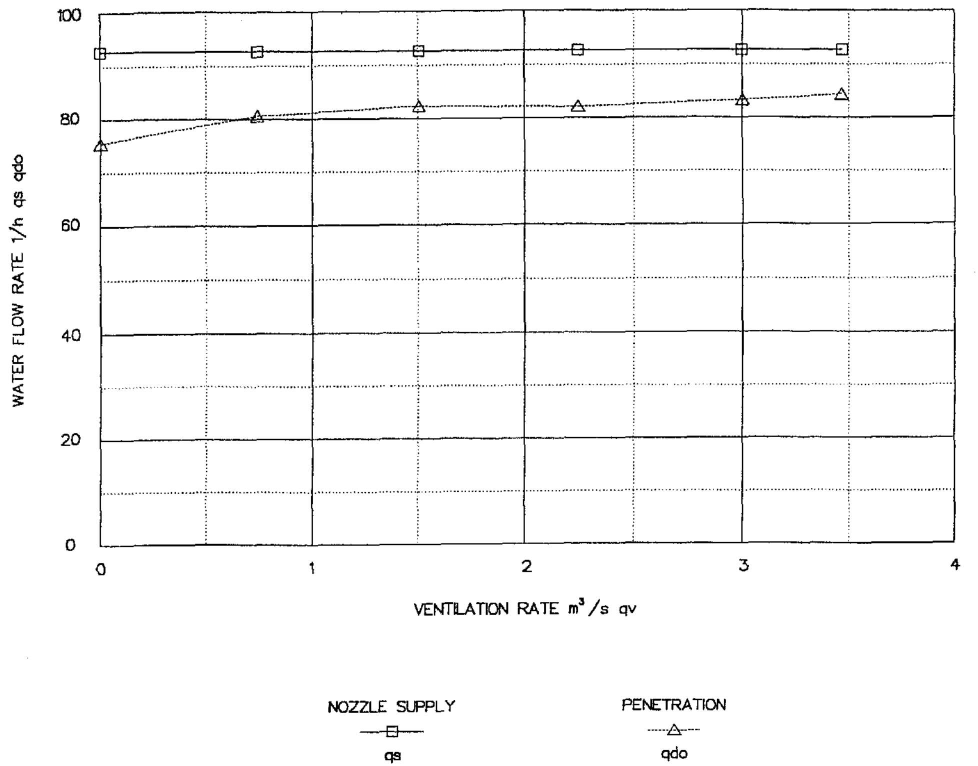
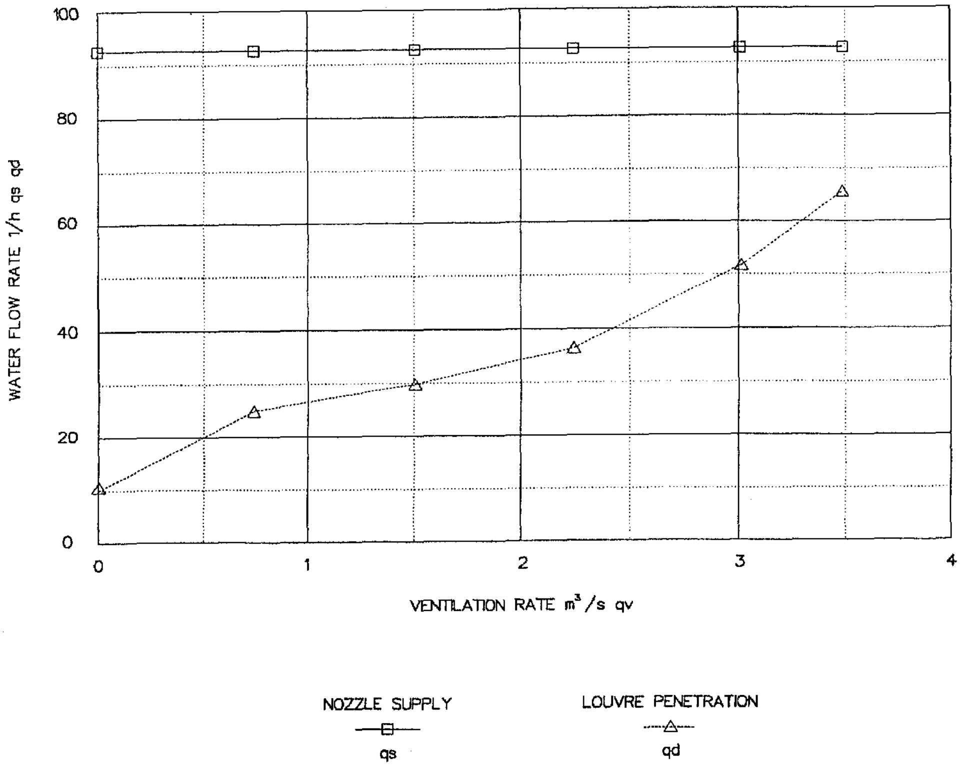


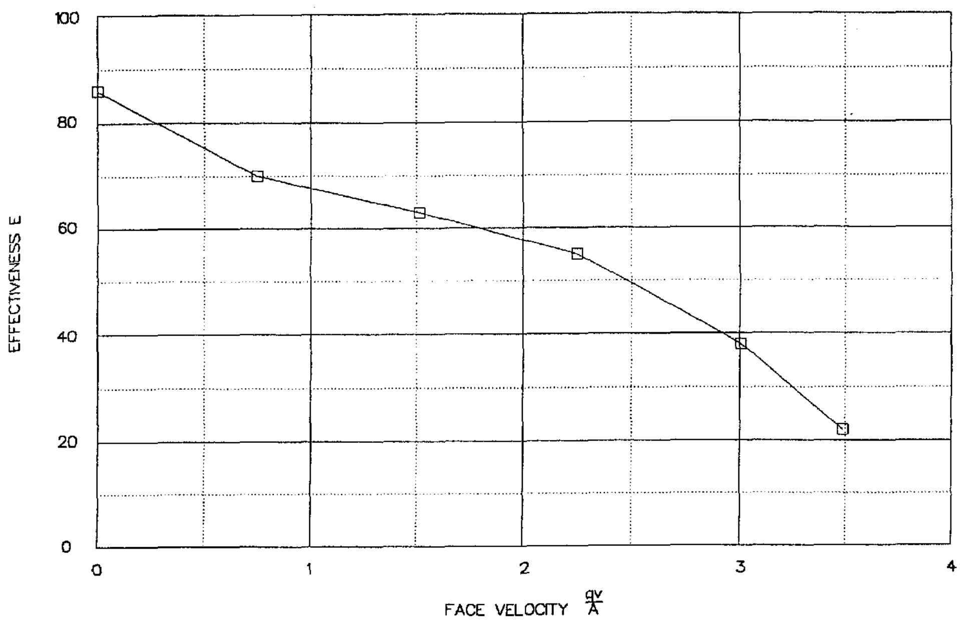
FIGURE 7 FLOW RATE/PRESSURE REQUIREMENT
BEST LINE (CURVE) CHARACTERISTIC FOR Ps1 vs qv^2 1



GRAPH (1). RAIN PENETRATION OF CALIBRATION PLATE WITH 13m/s WIND EFFECT



GRAPH (2). RAIN PENETRATION OF LOUVRE WITH 13m/s WIND EFFECT



GRAPH (3). EFFECTIVENESS OF LOUVRE WITH 13m/s WIND

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