CASKADE
HYDRA

UKAS

UNITED KINGDOM ACCREDITATION SERVICE

Negative Pressure Test
UKAS Calibration Test

EUREMICA® GROUP

JULY 2006

CASKADE 1500 GUTTER SECTION
EVENWOOD, CO. DURHAM

1 Report

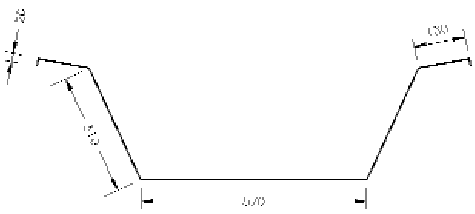
The negative pressure tests were performed to test the Caskade gutter section as a standard manufactured module, the actual module tested would be utilised in operation within the roof structures. The module replicates an actual 1500mm girth Caskade gutter, 7.5 metres in length, with two sizes of cavity tray, one being the largest section having the greatest cross section and surface area, the second section being the smallest. The gutter sections were connected by means of normal site butt strap membrane welded joints.

Gutter profile specification

1500girth: 1.5mm Steel substrate to Z35

Coating: 1.2mm PVC bonded to substrate

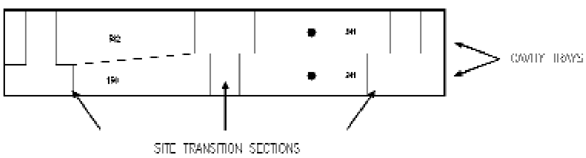
Composition: 2 x 3000mm gutter sections & 2 x 750mm gutter end sections



1.5mm Thick, 1500mm Girth Gutter

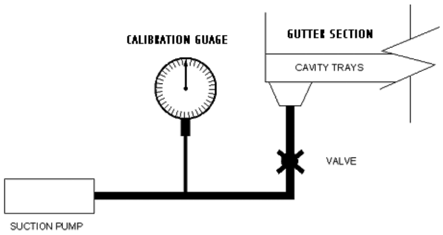
Cavity Trays

150mm section increasing by slow taper to 341mm section



The cavity trays were fitted and welded in factory-controlled conditions and the butt strap membrane joints and transition sections were site fixed.

Outlet pipework



The outlet pipes were connected to the negative pressure test apparatus.

Euremica Ltd undertook the test independently and Euremica calibrated all equipment to UKAS standards.

The tests reduced the pressure within the sealed Caskade cavity trays gradually up to a negative pressure of –0.6 bars. This was held for a two-minute period. The objective was to test the tensile strength of the substrate Z28, the factory jointing process and the membrane site welded joints.

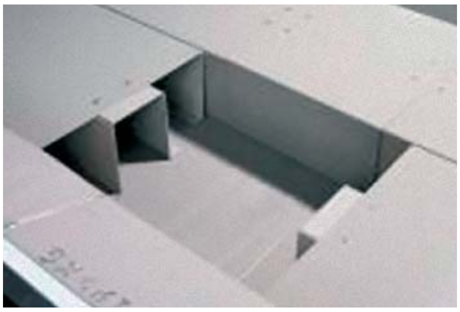
2 Test Charts

Observations				
Pressure	**Time**	**Structures**	**Joints**	**Comments**
-0.1 bar	Periodic	No Abnormalities	No Abnormalities	At each stage no abnormalities in the structure were observed up to and inclusive of –0.6 bar, which was stabilised and held for a two minute duration
-0.2 bar	"	"	"	
-0.3bar	"	"	"	
-0.4 bar	"	"	"	
-0.5 bar	"	"	"	
-0.6 bar	2 min duration	"	"	


Sealing Caskade gutter sole joint


Primary Chamber Installed


Secondary Chamber installed


First Transition piece installed


Second Transition piece installed

Negative pressure test suction unit


Test guage connected to test piece outlet


Connection arrangement


Final guage reading -0.75 bar

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TEST CERTIFICATE

CASKADE HYDRA

Instrument House
Morgan Drive
Guisborough
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Certificate of Test

ITEM UNDER TEST: CASKADE 1500 GUTTER

CUSTOMER: CA GROUP

METHOD No.: 095

TEST No.: P362

CALIBRATED BY: J BOOTH

PRESSURE	INTERVAL	STRUCTURAL MOVEMENT
-0.1 BAR	EQUAL	NONE
-0.2 BAR	EQUAL	NONE
-0.3 BAR	EQUAL	NONE
-0.4 BAR	EQUAL	NONE
-0.5 BAR	EQUAL	NONE
-0.6 BAR	HELD FOR 2 MINS	NONE

The Above results were obtained by connecting an Edwards Vacuum Pump to the test piece, with a 10″ Standard Test Gauge in the line, to measure the Negative pressures as they were achieved, the equipment used is traceable to UKAS through Cert No . HM12591.

Gauge information: Budenberg 10″ stg serial No. 12962684, EH 6161

We Hereby certify that the test figures were correct as stated at the time of test.

EUROMICA® GROUP

UKAS UNITED KINGDOM ACCREDITATION SERVICE

CERTIFICATE OF CALIBRATION

ISSUED BY DH Budenberg Ltd.

DATE OF ISSUE 20 AUGUST 2003 CERTIFICATE NUMBER **03059**

UKAS CALIBRATION
0138

DH·Budenberg

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APPROVED SIGNATORY

M. PARKINSON/J. HACKNEY/
S. WALLACE

Customer	: EUREMICA LIMITED,
Address	: Guisborough.
Customer Ref.	: 109711
Laboratory Ref.	: RR1924
Calibration date	: 19-20 August 2003

Area & Mass Certificate

Description

An oil operated Dead-Weight Tester.

Manufacturer	: Budenberg
Model number	: 480VHXA
Piston-cylinder Unit Serial No.	: 083G
Calibrated range	: 6 to 60 bar 60 to 1400 bar
Weight Set Nos.	: A5936 and 2131
Units	: bar

Tested as received.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Measurements

Piston-cylinder Unit

The effective areas (see note 1) were determined by directly balancing the assembly against piston-cylinder assemblies whose effective area have been determined by the National Physical Laboratory, N.P.L.

The floating elements were cleaned and weighed. The assembly was levelled using a spirit level mounted on top of the weight table. Measurements were made at several pressures within the assembly's working range using Shell Tellus T37 oil. The piston was balanced midway between the upper and lower limits of its travel rotating freely in a clockwise direction at approximately ½ to 1½ Hz. As far as possible, oil escaping past the piston was mopped away.

The temperature at the time of the measurements was 20°C ± 3°C.

Weight Set

After cleaning, the piston unit and weights have been weighed in air on balances calibrated using standard weights traceable to British National Standards (see note 4).

Units

The SI unit of pressure is the pascal. To convert from pascal to bar, multiply by 1×10^{-5} (for lb/in^2 multiply by $1.450\,377 \times 10^{-4}$).

Results

Piston-Cylinder No.083G (Low Range)

In the pressure range 6 to 60 bar
the effective area Ap at 20°C and applied pressure p, was found to be expressible in the form:

$$A_p = A_o (1 + ap)$$

where $A_o = (8.064\,00 \pm 0.000\,40) \times 10^{-5}$ m^2
and $a = (6.3 \pm 0.8) \times 10^{-12}$ / pascal
Mass value of piston assembly : 0.568 134 4 ± 0.000 005 kg
Buoyancy & Fluid Head correction (V) : $-1.318\,7 \times 10^{-6}$ m^3
(see note 1)
Surface Tension Correction (C) : 9.9×10^{-4} N

Piston-Cylinder No. 083G (High Range)

In the pressure range 60 to 1400 bar
the effective area Ap at 20°C and applied pressure p, was found to be expressible in the form:

$A_p = A_o (1 + ap)$

where $A_o = (4.031\ 91 \pm 0.000\ 22) \times 10^{-6}\ m^2$

and $a = (1.0 \pm 0.3) \times 10^{-12}$ / pascal

Mass value of piston assembly : 0.567 012 2 ± 0.000 005 kg

Buoyancy & Fluid Head correction (V) : -3.409 x $10^{-9}\ m^3$
(see note 1)

Surface Tension Correction (C) : 9.9 x 10^{-4} N
(see note 3)

Weight Set Numbers A5936 and 2131

Weight Marked		Measured Mass m'	Uncertainty of Measurement
Pressure in bar	No.	(kg)	(±mg)
1.0/20 *	A5936 A	0.255 408 1	5
9/180	A5936 B	7.402 364	30
10/200	A5936 C	8.224 555	30
10/200	A5936 D	8.224 782	30
10/200	A5936 E	8.224 714	30
10/200	A5936 F	8.224 700	30
10/200	A5936 G	8.224 684	30
5/100	A5936 H	4.112 433	16
2/40	A5936 J	1.644 930	15
2/40	A5936 K	1.644 975	15
1.0/20	A5936 L	0.822 473 4	5
0.5/10	A5936 M	0.411 225 4	5
0.2/4.0	2131 N	0.164 473 1	5
0.2/4.0	2131 P	0.164 451 8	5
0.1/2.0	2131 R	0.082 256 8	2
0.05/1.0	2131 S	0.041 124 1	2
0.02/0.4	2131 T	0.016 444 5	2
0.02/0.4	2131 U	0.016 460 3	2
0.01/0.2	2131 V	0.008 230 2	2

**Make up weight.*

Calculation of Applied Pressure

For details concerning the operation of pressure balances and the calculations involved reference should be made to the NPL publication "The Pressure Balance - A Practical Guide to its use", second edition.

The following formula can be used to calculate the applied pressure at the specified datum level.

$$P = \frac{[\Sigma m + V * (p_f - p_a)] * g + C}{A_o * (1 + a * P * [1 + \lambda * (t - 20)]}$$

Where Σm = mass of buoyancy corrected masses inc. piston (kg) (see note 4)

V = Buoyancy & Fluid Head Correction.(m^3)

p_a = Air density (kg/m^3)

p_f = Fluid Density (kg/m^3) see note 3

p= Applied pressure in pascal

g= Local acceleration due to gravity (m/sec^2)

C= Surface Tension Correction. (N)

A_o= Effective Area at zero pressure. (m^2)

a = Distortion Constant (per Pascal)

λ= Temperature Coefficient of Piston Cylinder Unit.

= 16.5×10^{-6} / °C

t= Temperature of Piston-cylinder Unit. (°C)

Uncertainty of Calculated Pressure

If the pressure is calculated from the above formula, the uncertainty in the calculated value (calculated from a combination of area & mass uncertainties) will be as follows:

Pressure Range	Uncertainty
6 to 1400 bar	< 0.0070 %

Additional uncertainties will arise depending on how well the gravity, g, is known at the site of use, and how accurately the temperature of the piston-cylinder assembly can be measured.

Notes

1) The term effective area is taken to be the quotient of the net downward force due to the loading weights plus the floating element, after allowing for fluid head, buoyancy and surface tension effects, and the applied pressure at the datum level when the system is in equilibrium. In the case of air operated piston-cylinder units any buoyancy & fluid head corrections have been incorporated into the effective area value.

The applied pressure is the amount by which the internal pressure at the datum level exceeds ambient atmospheric pressure at the same level. The datum level was taken to be the grooved ring on the outside of the piston-cylinder housing. When working at a different level fluid head corrections need to be made.

2) The Customers piston-cylinder assembly was not calibrated in its own base.

3) The Pressure fluid used in the calibration was Shell Tellus T37 which was taken to have the following properties:

Density	(ρ_f)	: 870 kg/m^3 at 20°C
Surface Tension	(σ)	: 31 mN/m
Kinematic Viscosity		: 87 centistokes at 20°C

4) Each mass value given for the weights and piston represents the conventional mass, which for a weight taken at 20°C is the mass of a reference weight of a density 8000 kg/m^3 which in air of density 1.2 kg/m^3 would balance the corresponding weight identified in the first column.

ie. $m = m' * [1 - \rho_a'/\rho_s] = m' * 0.99985$

where m = mass corrected for air buoyancy (kg)
m' = uncorrected mass (kg) - as reported
ρ_a' = assumed air density (1.2 kg/m^3)
ρ_s = assumed density of weights (8000 kg/m^3)

If the actual densities vary from 1.2 & 8000 kg/m^3 errors will be introduced. To a good approximation the true correction can be calculated using:

$$m = m' * 0.99985 * [1 - (1/\rho_m) * (\rho_a - 1.2)]$$

where ρ_m = Actual density of weight (kg/m^3)
ρ_a = Actual Air density (kg/m^3)

The density of the piston was taken to be 7 800 kg/m^3 and the density of the stainless steel weights was taken to be 7 800 kg/m^3.

For more detailed explanations on buoyancy corrections see section 3.2 & 3.3 of 'The Pressure Balance - A Practical Guide to its Use by S. Lewis & G. Peggs, National Physical Laboratory, second edition'.

5) The United Kingdom Accreditation Service (UKAS) is one of the signatories to the International Laboratory Accreditation Co-operation (ILAC) arrangement for the mutual recognition of Calibration Certificates. UKAS is also one of the signatories to the Multilateral Agreement of the European Co-operation for Accreditation (EA) for the mutual recognition of Calibration Certificates issued by accredited laboratories.

***** End of Certificate *****