

Report

Performance test on characterised control valves

Final Report 18391/1
September 2004

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SUMMARY

Performance tests were carried out on two types of water control valves from Belimo to verify their flow control characteristics.

The types tested were Characterised Control Valves (CCV) and Pressure Independent Characterised Control Valves (PICCV).

The tests were carried out on the using the Belimo test facilities in Danbury, Connecticut, USA, and the instrumentation provided.

The tests showed the valve control characteristics for the CCV were within $\pm 5\%$ for flow and C_v at full open conditions.

The PICCV valves tested exhibited characteristics of maintaining flow rate within $\pm 5\%$ of the mean value over a pressure range of 10-43lb/in².

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1 INTRODUCTION

Flow performance tests were carried out on two types of water flow control valve to verify the manufacturer's claims. The work was requested by Belimo Automation UK and was carried out at Belimo Aircontrols (USA) Inc, 43 Old Ridgebury Road, Danbury, CT 06810 during the period 17 to 19 March 2004.

2 OBJECTIVE

To verify the flow characteristics of the valves supplied for test.

3 ITEMS SUPPLIED

The two types of valve supplied consisted of:

Characterised Control Valve (CCV). This consisted of a ball valve having a characterising disc within the valve body shaped to give an equal percentage valve characteristic.

Pressure Independent Characterised Control Valve (PICCV). This used a ball valve and disc as in the CCV, but with the addition of a pressure reducing valve within the body designed to give a constant pressure across the flow control section.

4 TEST FACILITIES

The test facilities used were two permanently installed rigs that were normally used to carry out production control checks on the valves. The following standards were used in carrying out those checks:

ANSI/ISA-75.19-1995: Hydrostatic testing of control valves.

ISA 575.11-1985 (Revised 1997): Inherent flow characteristic and rangeability of control valves.

ISA 575.05-1983: Control valve terminology.

ANSI/ISA-75.02-1996: Control valve capacity test procedures.

The CCV rig consisted of a straight length of full bore pipework with the test valve installed. The standard minimum straight lengths of pipe were twenty diameters upstream and seven diameters downstream. Actual test lengths were longer. Flow rate was determined by ultrasonic meter attached to the pipework. Pressure drop was determined by transducers placed two diameters upstream and six diameters downstream of the test valve on piezometric rings.

A 0-100 lb/in² gauge was installed upstream of the valve to monitor the supply pressure.

½ inch and ¾ inch valves were tested.

Plate 1 General View of CCV test rig**Plate 2** 1/2 inch CCV valve under test. Flow from right to left

The PICCV rig consisted of straight lengths of pipework at one size larger than the valve, with the test valve installed. Two sizes of valve were tested, $\frac{1}{2}$ inch and $\frac{3}{4}$ inch. The standard minimum straight lengths of pipe were twenty diameters upstream and seven diameters downstream. Actual test lengths were longer. Flowrate was determined by ultrasonic meter attached to the pipework. Pressure difference and supply static was determined by static gauges placed two diameters upstream and six diameters downstream of the test valves.

Plate 3 General view of PICCV test rig



Plate 4 ½ inch valve under test

5 INSTRUMENTATION

CCV rig

Type	Serial	Calibration/specification
Omega differential pressure transducer	99234061	* $\pm 0.25\%$
Controlotron 1010 uniflow ultrasonic flow meter c/w: Sensor 1012TP	U11881 1188B & 215000A	09/07/04 + 20/07/04
Ashcroft gauge 0-100lb/in ²	NSN	* $\pm 2\%$ fsd

PICCV rig

Type	Serial	Calibration
Controlotron 1010 uniflow ultrasonic flow meter c/w: Sensor 1012TP	U12369 5364A & 5364B (used for $\frac{3}{4}$ valve tests) 21500B & 22211B (used for $\frac{1}{2}$ valve tests)	20/08/04 09/07/04
Shortridge Hydrodata multimeter HDM-150	W93671	14/09/98
Ashcroft gauges 0-60lb/in ²	NSN	* $\pm 2\%$ fsd

*Manufacturers specification.

6 TEST METHOD

6.1 CCV Rig

A Belimo actuator (type LR24SR2) was used to position the valve at various openings. Flow rate and pressure differential were measured and the results plotted.

This was carried out for two valve sizes. The flow coefficient (C_v) was then calculated and performance compared with the manufacturer's stated values.

6.2 PICCV Rig

A Belimo actuator (type LR24SR2) was used to position the valve at various openings. The differential pressure was varied and the flow rates recorded, the aim being to see the flow rate maintained within $\pm 5\%$ over the operating pressure range.

This was carried out on a $\frac{1}{2}$ inch and $\frac{3}{4}$ inch valve. In addition, a characteristic curve was plotted for the $\frac{3}{4}$ inch valve, using a constant differential pressure and varying the valve opening to observe the disc behaviour.

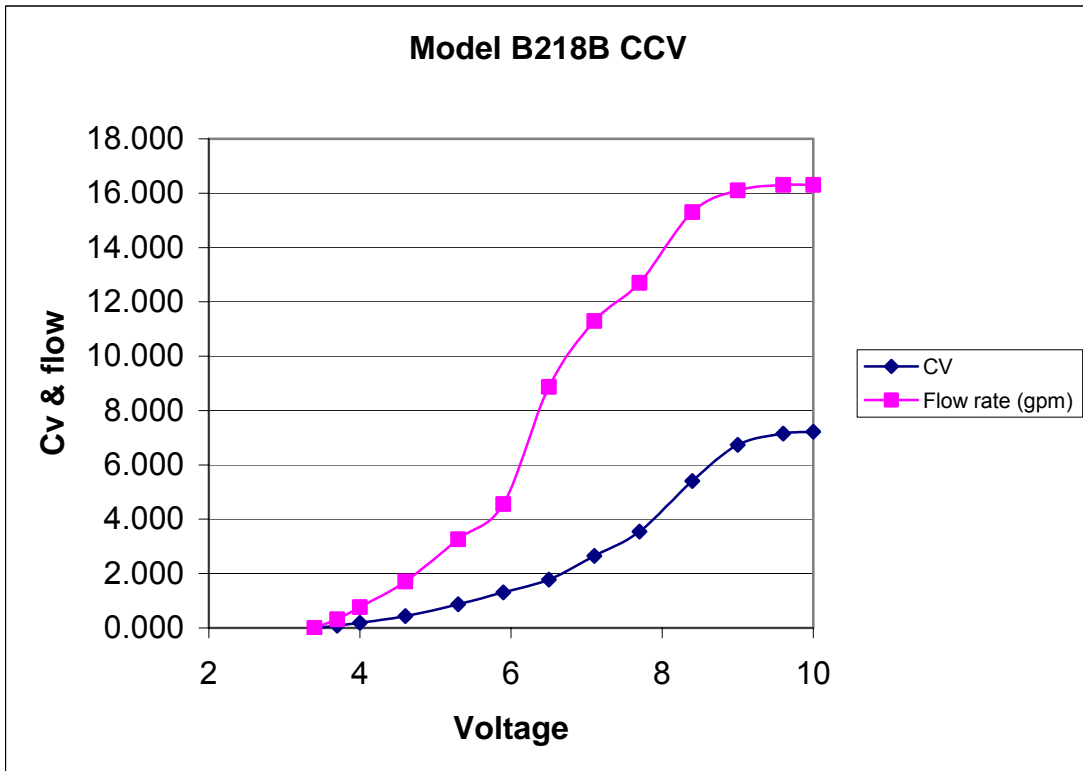
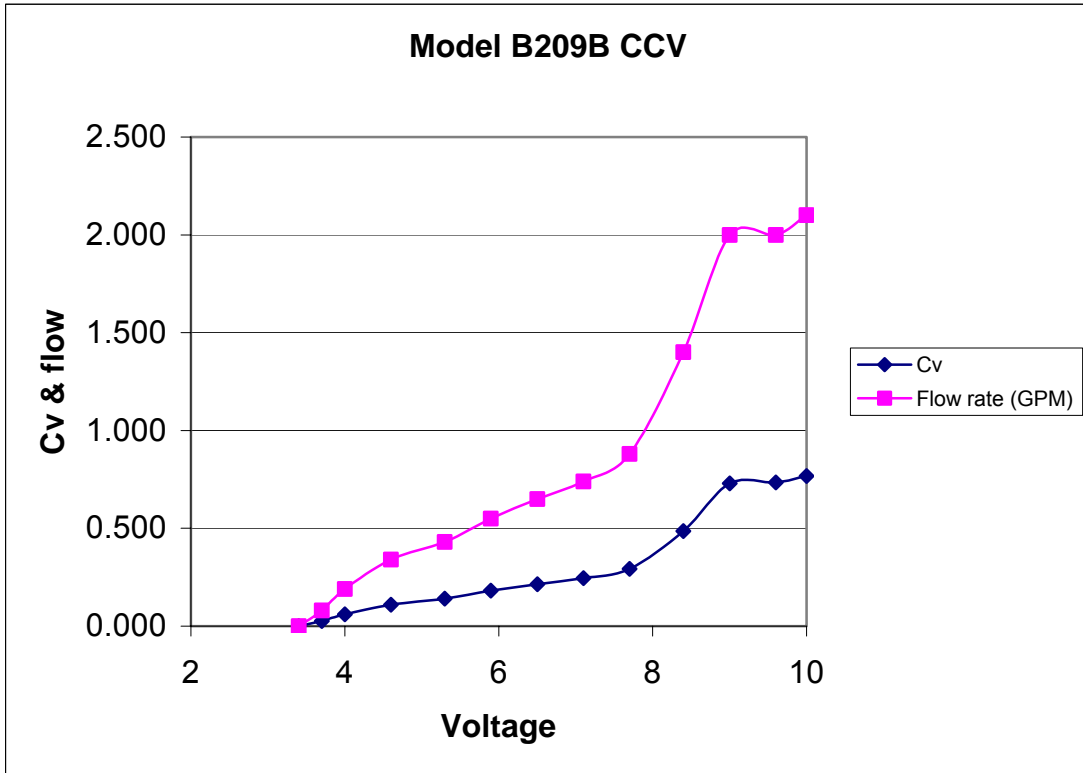
7 RESULTS

The results are detailed for CCV and PICCV tests. Note that recorded data is in imperial units of US gallons/minute for flow and lb/in² for pressure.

7.1 CCV

CCV		Characteristic		B209B ½	Cv=0.8
Control range 2-10 volt					
Voltage	ΔP (lb)	Flow (gpm)	Cv		Var %
3.4	9.9	0.00	0.000		
3.7	9.8	0.08	0.026		
4.0	9.6	0.19	0.061		
4.6	9.5	0.34	0.110		
5.3	9.3	0.43	0.141		
5.9	9.2	0.55	0.181		
6.5	9.2	0.65	0.214		
7.1	9.1	0.74	0.245		
7.7	9.0	0.88	0.293		
8.4	8.3	1.40	0.486		
9.0	7.5	2.00	0.730		
9.6	7.4	2.00	0.735		
10.0	7.5	2.10	0.767		-4.15

CCV		Characteristic		B218B ¾	Cv=7.4
Control range 2-10 volt					
Voltage	ΔP (lb)	Flow (gpm)	CV		Var %
3.4	17.8	0.00	0.000		
3.7	17.4	0.32	0.077		
4.0	17	0.76	0.184		
4.6	15.6	1.71	0.433		
5.3	14.1	3.26	0.868		
5.9	12.2	4.56	1.306		
6.5	24.9	8.87	1.778		
7.1	18.1	11.30	2.656		
7.7	12.8	12.70	3.550		
8.4	8	15.30	5.409		
9.0	5.7	16.10	6.744		
9.6	5.2	16.30	7.148		
10.0	5.1	16.30	7.218		-2.46



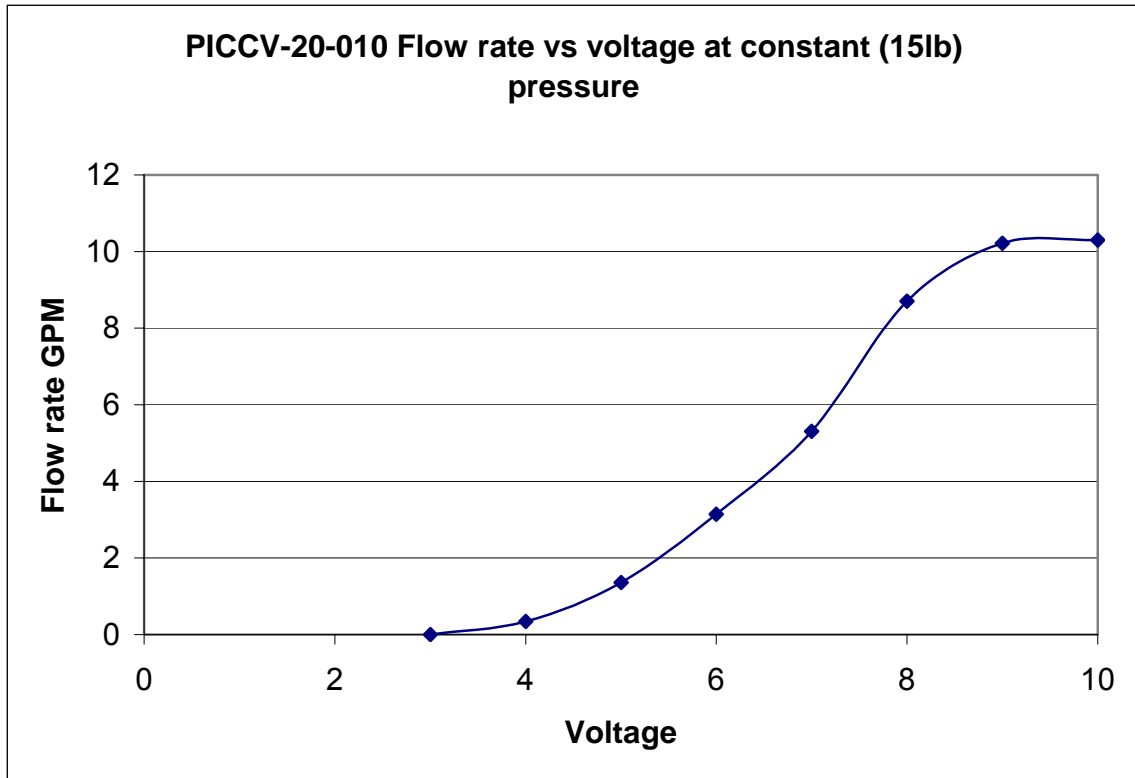
7.2 PICCV

PICCV		Characteristic		PICCV-20-010		Control range 2-10V 3/4 6-10 GPM					
Voltage	DP (lb)	Flow (gpm)	Var%	Voltage	DP (lb)	Flow (gpm)	Var %	Voltage	DP (lb)	Flow (gpm)	Var %
8	5	6.07	-15.8	6	5	2.78	-13.6	8.75	5	9.41	-9.0
	7	6.55	-9.2		7	2.93	-8.9		7	9.84	-4.8
	10	6.93	-3.9		10	3.07	-4.6		10	10.05	-2.8
	12	6.97	-3.3		12	3.11	-3.3		12	10.07	-2.6
	15	7.11	-1.4		15	3.16	-1.8		15	10.03	-3.0
	20	7.19	-0.3		20	3.16	-1.8		20	10.68	3.3
	25	7.28	1.0		25	3.21	-0.2		25	10.55	2.0
	30	7.31	1.4		30	3.23	0.4		30	10.44	1.0
	35.0	7.34	1.8		35.0	3.29	2.2		35.0	10.42	0.8
	40	7.40	2.6		40	3.34	3.8		40	10.40	0.6
	43	7.37	2.2		43	3.39	5.4		43	10.43	0.9
		Mean	7.21		Mean		3.22			Mean	10.34

Outlying flow rates at 5 and 7 lb not used in calculating the mean.

PICCV	Characteristic			PICCV-15-005	Control range 2-10V 1/2 0.5-5.0 GPM						
Voltage	DP (lb)	Flow (gpm)	Var%	Voltage	DP (lb)	Flow (gpm)	Var %	Voltage	DP (lb)	Flow (gpm)	Var %
7.8	5	4.56	-12.0	7	5	3.18	-14.5	6	5	1.53	-12.7
	7	4.85	-6.4		7	3.60	-3.3		7	1.65	-5.9
	10	5.15	-0.6		10	3.63	-2.4		10	1.71	-2.5
	12	5.25	1.4		12	3.66	-1.6		12	1.69	-3.6
	15	5.25	1.4		15	3.70	-0.6		15	1.72	-1.9
	20	5.17	-0.2		20	3.70	-0.6		20	1.72	-1.9
	25	5.20	0.4		25	3.70	-0.6		25	1.74	-0.8
	30	5.25	1.4		30	3.73	0.2		30	1.76	0.4
	35.0	5.16	-0.4		35.0	3.84	3.2		35.0	1.76	0.4
	40	5.11	-1.4		40	3.82	2.7		40	1.84	4.9
	43	5.08	-1.9		43	3.71	-0.3		43	1.84	4.9
		Mean	5.18		Mean		3.72			Mean	1.75

Outlying flow rates at 5 and 7 lb not used in calculating the mean.



8 CONCLUSIONS

The tests showed the valve control characteristics for the CCV were within $\pm 5\%$ for flow and Cv at full open conditions, using the instrumentation provided.

The PICCV valves tested exhibited characteristics of maintaining flow rate within $\pm 5\%$ of the mean value over a pressure range of 10-42lb/in². The flow at differential pressures below 7lb, and particularly around 5lb fell outside the 5% band. The best characteristic (most stable and smallest tolerance band) was achieved when these outlying results were not used in calculation of the mean flow rate, as shown in the results.

APPENDICES

APPENDIX: A CALIBRATION CERTIFICATES

CERT.# 1720

QUALITY CERTIFICATE
OF
INTRINSIC CALIBRATION

CUSTOMER: BELIMO TECHNOLOGY**CONTRACT #: PEMCO****WORK ORDER #: PEMCO**


IT IS HEREBY CERTIFIED THAT ALL MATERIAL HEREWITH FURNISHED WERE MANUFACTURED IN THE UNITED STATES OF AMERICA. ALL MEASURING AND TEST EQUIPMENT WHICH WERE USED TO INSPECT, TEST AND CALIBRATE THIS AND ALL OTHER EQUIPMENT MANUFACTURED BY **CONTROLTRON** ARE TRACEABLE TO THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY. TEST AND/OR INSPECTION REPORTS INDICATING CONFORMANCE ARE ON FILE.

ALL WORK HAS BEEN PERFORMED IN ACCORDANCE WITH OUR **ISO 9000 - ANSI/ASQC Q9000** CERTIFIED QUALITY SYSTEM AS DOCUMENTED IN **QAM 101**, REV. A.1, DATED 25 JUNE 1996.

THE EQUIPMENT LISTED BELOW MEETS THE REQUIREMENTS OF OUR PROCEDURES THAT ARE APPLICABLE TO IT, AND IS EXPECTED TO PERFORM WITHIN ITS SPECIFICATION WHEN INSTALLED IN ACCORDANCE WITH THE INSTRUCTIONS PROVIDED WITH THE EQUIPMENT.

PART NO.
1011PPS-B3

SERIAL NO.
5364 A/B


QUALITY ASSURANCE MANAGER

8/20/2004
DATE

ATTACHMENTS:

FORM CC204A-REV. 6

155 Plant Avenue, Hauppauge, NY 11788 • (631) 231-3600 • Fax: (631) 231-3334



CERT #: 1331

QUALITY CERTIFICATE
OF
COMPLIANCE, CALIBRATION AND CONFORMANCE

CUSTOMER: BELIMO**CONTRACT #:** PEM04081**WORK ORDER #:** C240458/C231188

IT IS HEREBY CERTIFIED THAT ALL MATERIAL AND SERVICES HERewith FURNISHED IN THE QUANTITIES AS CALLED FOR IN THE ABOVE CONTRACT MEET THE REQUIREMENTS, SPECIFICATIONS AND DRAWINGS APPLICABLE TO THAT CONTRACT AND WERE MANUFACTURED IN THE UNITED STATES OF AMERICA. ALL MEASURING AND TEST EQUIPMENT USED TO INSPECT, TEST AND CALIBRATE OUR PRODUCTS ARE TRACEABLE TO THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY. TEST AND/OR INSPECTION REPORTS ARE ON FILE AND ARE, AT LEAST, FOUR (4X) TIMES GREATER ACCURACY THAN THE EQUIPMENT BEING CALIBRATED. CERTAIN COMPUTER-CHIP DEVICES ARE STATE-OF-THE-ART COMPONENTS AND AS SUCH ARE VERIFIED BY THEIR OWN PROGRAMMING ON A ONE-TO-ONE BASIS.

ALL WORK HAS BEEN PERFORMED IN ACCORDANCE WITH OUR ISO 9000 - ANSI/ASQC Q9000 CERTIFIED QUALITY SYSTEM AS DOCUMENTED IN QAM 101, REV. A.1, DATED 25 JUNE 1996.

THE EQUIPMENT LISTED BELOW IS EXPECTED TO PERFORM WITHIN ITS SPECIFICATION WHEN INSTALLED IN ACCORDANCE WITH THE INSTRUCTIONS PROVIDED WITH THE EQUIPMENT.

<u>PART NO.</u>	<u>SERIAL NO.</u>
1010P1	12369
	12368
1011PPS-B3	21500A/B
	21211A/B


QUALITY MANAGER

4/7/04
DATE

ENCLOSURE:
NONE

CC204 REV. 3

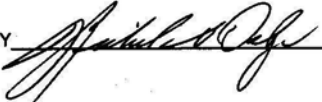
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CERTIFICATE OF CALIBRATION	
INSTRUMENT <u>HydroData Multimeter</u>	
MODEL <u>HDM-150</u>	SERIAL NO <u>W93071</u>
TEST BY <u>D. Lutz</u>	DATE <u>9-14-98</u>
This is to certify that this instrument has been calibrated using instrumentation which is traceable to masters at the National Institute of Standards and Technology.	
CERTIFIED BY 	



Shortridge Instruments, Inc.

7855 EAST REDFIELD ROAD / SCOTTSDALE, ARIZONA 85280-3430
TELEPHONE (602) 991-6744 / FAX (602) 443-1267

May 1, 1998

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PEMCO

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CERT #: 1343

QUALITY CERTIFICATE
OF
COMPLIANCE, CALIBRATION AND CONFORMANCE

CUSTOMER: Belimo Tech (USA) Inc.**CONTRACT #:** 86464**WORK ORDER #:** C230509

IT IS HEREBY CERTIFIED THAT ALL MATERIAL AND SERVICES HERewith FURNISHED IN THE QUANTITIES AS CALLED FOR IN THE ABOVE CONTRACT MEET THE REQUIREMENTS, SPECIFICATIONS AND DRAWINGS APPLICABLE TO THAT CONTRACT AND WERE MANUFACTURED IN THE UNITED STATES OF AMERICA. ALL MEASURING AND TEST EQUIPMENT USED TO INSPECT, TEST AND CALIBRATE OUR PRODUCTS ARE TRACEABLE TO THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY. TEST AND/OR INSPECTION REPORTS ARE ON FILE AND ARE, AT LEAST, FOUR (4X) TIMES GREATER ACCURACY THAN THE EQUIPMENT BEING CALIBRATED. CERTAIN COMPUTER-CHIP DEVICES ARE STATE-OF-THE-ART COMPONENTS AND AS SUCH ARE VERIFIED BY THEIR OWN PROGRAMMING ON A ONE-TO-ONE BASIS.

ALL WORK HAS BEEN PERFORMED IN ACCORDANCE WITH OUR ISO 9000 - ANSI/ASQC Q9000 CERTIFIED QUALITY SYSTEM AS DOCUMENTED IN QAM 101, REV. A.1, DATED 25 JUNE 1996.

THE EQUIPMENT LISTED BELOW IS EXPECTED TO PERFORM WITHIN ITS SPECIFICATION WHEN INSTALLED IN ACCORDANCE WITH THE INSTRUCTIONS PROVIDED WITH THE EQUIPMENT.

<u>PART NO.</u>	<u>SERIAL NO.</u>
1010P1	11881
1011PPS-B3	20274 A/B

QUALITY MANAGER

7/20/04
DATE

ENCLOSURE:

CC204 REV. 3

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