TEST RESULT SUMMARY

FCC PART 15 SUBPART C
Section 15.231(e)

MANUFACTURER'S NAME	EcoWater Systems Inc
NAME OF EQUIPMENT	Transmitter for Water Softener System
MODEL NUMBER	**7213206 - Rev. A**
MANUFACTURER'S ADDRESS	1890 Woodlane Drive Woodbury MN 55125
TEST REPORT NUMBER	W9552
TEST DATE	04 November 1999

According to testing performed at TÜV Product Service Inc, the above-mentioned unit is in compliance with the electromagnetic compatibility requirements defined in FCC Part 15.

It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical characteristics. Any modifications necessary for compliance made during testing on the above mentioned date(s) must be implemented in all production units for compliance to be maintained.

TÜV Product Service Inc, as an independent testing laboratory, declares that the equipment tested as specified above conforms to the requirements of FCC Part 15.

Date: 17 December 1999

Location: Taylors Falls MN
USA

G. S. Jakubowski
Test Engineer

J. T. Schneider
Lead Engineer

Not Transferable

EMC EMISSION - T E S T R E P O R T

Test Report File No.	:	**WC1G955201**	Date of issue:	17 December 1999

Model / Serial No.	:	**7213206 - Rev. A /**
Product Type	:	Transmitter for Water Softener System
Applicant	:	EcoWater Systems Inc
Manufacturer	:	EcoWater Systems Inc
License holder	:	EcoWater Systems Inc
Address	:	1890 Woodlane Drive
	:	Woodbury MN 55125
Test Result	:	■ **Positive** ☐ **Negative**
Test Project Number Reference(s)	:	**W9552**
Total pages including Appendices		32

TÜV Product Service Inc is a subcontractor to TÜV Product Service, GmbH according to the principles outlined in ISO/IEC Guide 25 and EN 45001.

TÜV Product Service Inc reports apply only to the specific samples tested under stated test conditions. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. TÜV Product Service Inc shall have no liability for any deductions, inferences or generalizations drawn by the client or others from TÜV Product Service Inc issued reports.

This report is the confidential property of the client. As a mutual protection to our clients, the public and ourselves, extracts from the test report shall not be reproduced except in full without our written approval. This report shall not be used by the client to claim product endorsement by NVLAP or any agency of the US government.

TÜV Product Service Inc and its professional staff hold government and professional organization certifications and are members of AAMI, ACIL, AEA, ANSI, IEEE, NVLAP, and VCCI

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

D I R E C T O R Y - EMISSIONS

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

EMISSIONS TEST REGULATIONS :

The emissions tests were performed according to following regulations:

☐ - EN 50081-1 / 1991		
☐ - EN 55011 / 1991	☐ - Group 1	☐ - Group 2
	☐ - Class A	☐ - Class B
☐ - EN 55013 / 1990		
☐ - EN 55014 / 1987	☐ - Household appliances and similar	
	☐ - Portable tools	
	☐ - Semiconductor devices	
☐ - EN 55014 / A2:1990		
☐ - EN 55014 / 1993	☐ - Household appliances and similar	
	☐ - Portable tools	
	☐ - Semiconductor devices	
☐ - EN 55015 / 1987		
☐ - EN 55015 / A1:1990		
☐ - EN 55015 / 1993		
☐ - EN 55022 / 1987	☐ - Class A	☐ - Class B
☐ - EN 55022 / 1994	☐ - Class A	☐ - Class B
☐ - BS		
☐ - VCCI	☐ - Class A	☐ - Class B
■ - FCC Part 15 Subpart C Section 15.231(e)		
☐ - AS 3548 (1992)	☐ - Class A	☐ - Class B
☐ - CISPR 11 (1990)	☐ - Group 1	☐ - Group 2
	☐ - Class A	☐ - Class B
☐ - CISPR 22 (1993)	☐ - Class A	☐ - Class B

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Environmental conditions in the lab:

	Actual
Temperature	: 24 °C
Relative Humidity	: 26 %
Atmospheric pressure	: 99.4 kPa
Power supply system	: 120 VAC to 24 VAC for microcontroller to 5 VDC to turn transmitter on/off

Sign Explanations:

☐ - not applicable
■ - applicable

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Emissions Test Conditions: CONDUCTED EMISSIONS (Interference Voltage)

The *CONDUCTED EMISSIONS (INTERFERENCE VOLTAGE)* measurements were performed at the following test location:

☐ **- Test not applicable**

☐ - Wild River Lab Large Test Site (Open Area Test Site)
☐ - Wild River Lab Small Test Site (Open Area Test Site)
☐ - Oakwood Lab (Open Area Test Site)
■ - Wild River Lab Screen Room
☐ - New Brighton Lab Shielded Room

Test equipment used :

	Model Number	Manufacturer	Description	Serial Number	Cal Date
■ -	3825/2	EMCO	50 Ω LISN	1329	5-99
■ -	ESHS-20	Rohde-Schwarz	EMI Receiver	837055/003	3-99

Use of the calibrated equipment on this list ensures traceability to national and international standards.

Emissions Test Conditions: RADIATED EMISSIONS (Magnetic Field)

The *RADIATED EMISSIONS (MAGNETIC FIELD)* measurements were performed at the following test location:

☐ - Wild River Lab Large Test Site (Open Area Test Site)
☐ - Wild River Lab Small Test Site (Open Area Test Site)
☐ - Oakwood Lab (Open Area Test Site)

at a test distance of :

☐ - 3 meters
☐ - 30 meters

■ **- Test not applicable**

Test equipment used :

	Model Number	Manufacturer	Description	Serial Number	Cal Date

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Emissions Test Conditions: RADIATED EMISSIONS (Electric Field)

The *RADIATED EMISSIONS (ELECTRIC FIELD)* measurements, in the frequency range of 30 MHz-1000 MHz, were tested in a horizontal and vertical polarization at the following test location :

☐ - Test not applicable

■ - Wild River Lab Large Test Site (Open Area Test Site)
☐ - Wild River Lab Small Test Site (Open Area Test Site)
☐ - Oakwood Lab (Open Area Test Site)

at a test distance of :

■ - 3 meters
☐ - 10 meters
☐ - 30 meters

Test equipment used :

	Model Number	Manufacturer	Description	Serial Number	Cal Date
■ -	EM-6917B	Electro-Metrics	Biconicalog Antenna	101	9-99
■ -	8566B	Hewlett-Packard	Spectrum Analyzer	2221A01596	4-99
■ -	85662A	Hewlett-Packard	Analyzer Display	2152A03640	4-99
■ -	85650A	Hewlett-Packard	Quasi-Peak Adapter	2811A01127	4-99
■ -	ZHL-1042J	Mini-Circuits	Preamplifier	H072294-11	3-99

Use of the calibrated equipment on this list ensures traceability to national and international standards.

Emissions Test Conditions: INTERFERENCE POWER

The *INTERFERENCE POWER* measurements were performed by using the absorbing clamp on the mains and interface cables in the frequency range 30 MHz - 300 MHz at the following test location :

■ - Test not applicable

☐ - Wild River Lab Large Test Site (Open Area Test Site)
☐ - Wild River Lab Small Test Site (Open Area Test Site)
☐ - Oakwood Lab (Open Area Test Site)
☐ - Wild River Lab Screen Room
☐ - New Brighton Lab Shielded Room

Test equipment used :

Model Number	Manufacturer	Description	Serial Number	Cal Date

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Emissions Test Conditions: RADIATED EMISSIONS (Electric Field)

The *EQUIVALENT RADIATED EMISSIONS* measurements in the frequency range 1 GHz - 4.2 GHz were performed in a horizontal and vertical polarization at the following test location :

■ - Wild River Lab Large Test Site (Open Area Test Site)
☐ - Wild River Lab Small Test Site (Open Area Test Site)
☐ - Oakwood Lab (Open Area Test Site)
☐ - Wild River Lab Screen Room

at a test distance of:

☐ - 1 meters
■ - 3 meters
☐ - 10 meters

☐ - Test not applicable

Test equipment used :

	Model Number	Manufacturer	Description	Serial Number	Cal Date
■ -	3115	EMCO	Horn Antenna	9001-3275	9-99
■ -	8566B	Hewlett-Packard	Spectrum Analyzer	2221A01596	4-99
■ -	85662A	Hewlett-Packard	Analyzer Display	2152A03640	4-99
■ -	85650A	Hewlett-Packard	Quasi-Peak Adapter	2811A01127	4-99
■ -	ZHL-1042J	Mini-Circuits	Preamplifier	H072294-11	3-99
■ -	AFT-8434	Avantek	Preamplifier	9112 Z221	3-99

Use of the calibrated equipment on this list ensures traceability to national and international standards.

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Equipment Under Test (EUT) Test Operation Mode - Emission tests :

The device under test was operated under the following conditions during emissions testing:

☐ - Standby

☐ - Test program (H - Pattern)

☐ - Test program (color bar)

☐ - Test program (customer specific)

☐ - Practice operation

☐ - Normal Operating Mode

■ - Transmitter on.

Configuration of the device under test:

■ - See Constructional Data Form in Appendix B - Page B2

☐ - See Product Information Form in Appendix B - beginning on Page B3

The following peripheral devices and interface cables were connected during the measurement:

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

■ - unshielded power cable

☐ - unshielded cables

☐ - shielded cables MPS.No.: _____

☐ - customer specific cables

☐ - _____

☐ - _____

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Emission Test Results:

Conducted emissions 10/150 kHz - 30 MHz

The requirements are ■ - MET ☐ - NOT MET

Minimum limit margin 14 dB at 29.8 MHz

Maximum limit exceeding _____ dB at _____ MHz

Remarks: _____

Radiated emissions (magnetic field) 10 kHz - 30 MHz

The requirements are ☐ - MET ☐ - NOT MET

Minimum limit margin _____ dB at _____ MHz

Maximum limit exceeding _____ dB at _____ MHz

Remarks: _____

Radiated emissions (electric field) 30 MHz - 1000 MHz

The requirements are ■ - MET ☐ - NOT MET

Minimum limit margin for fundamental 5 dB at 418.0 MHz

Minimum limit margin for spurious 11 dB at 836.1 MHz

Remarks: The fundamental was measured to be 86.8 dBuV/m in peak mode, minus 20 dB (based on 10% duty cycle) to get average measurement, or 66.8 dBuV/m (2187 uV/m) compared to a limit of 72.3 dBuV/m (4133 uV/m). The second harmonic was measured to be 61.3 dBuV/m in peak mode, minus 20 dB (based on 10% duty cycle) to get average measurement, or 41.3 dBuV/m (116.1 uV/m) compared to an average limit of 52.3 dBuV/m (413.3 uV/m).

Interference Power at the mains and interface cables 30 MHz - 300 MHz

The requirements are ☐ - MET ☐ - NOT MET

Minimum limit margin _____ dB at _____ MHz

Maximum limit exceeding _____ dB at _____ MHz

Remarks: _____

Equivalent Radiated emissions 1 GHz - 4.2 GHz

The requirements are ■ - MET ☐ - NOT MET

Minimum limit margin 11 dB at 3344.5 MHz

Maximum limit exceeding _____ dB at _____ MHz

Remarks: Peak analyzer reading of 63.6 dBuV/m, minus 20 dB (based on 10% duty cycle) to get average measurement, or 43.6 dBuV/m (151.3 uV/m), compared to an average limit of 54 dBuV/m (500 uV/m).

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DEVIATIONS FROM STANDARD:

None.

GENERAL REMARKS:

The bandwidth of the fundamental must be less than 0.25% of the center frequency, or 1.045 MHz. Page A6 of A9 shows the bandwidth to be less than 170 kHz. The transmitter operates on a 10% duty cycle, so a duty cycle relaxation factor of 20 log 10/100, or 20 dB is used to convert peak readings to average readings. Pages A7 and A8 of A9 show the on/off times.

SUMMARY:

The requirements according to the technical regulations are

■ - met

☐ - **not** met.

The device under test does

■ - fulfill the general approval requirements mentioned on page 3.

☐ - **not** fulfill the general approval requirements mentioned on page 3.

Testing Start Date: 04 November 1999

Testing End Date: 04 November 1999

- TÜV PRODUCT SERVICE INC -

J. T. Schneider
Lead Engineer

Tested By:
G. S. Jakubowski

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

Test-setup photo(s):
Conducted emission 10/150 kHz - 30 MHz

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Test-setup photo(s):
Radiated emission 30 MHz - 4.2 GHz

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Appendix A

Test Data Sheets

and

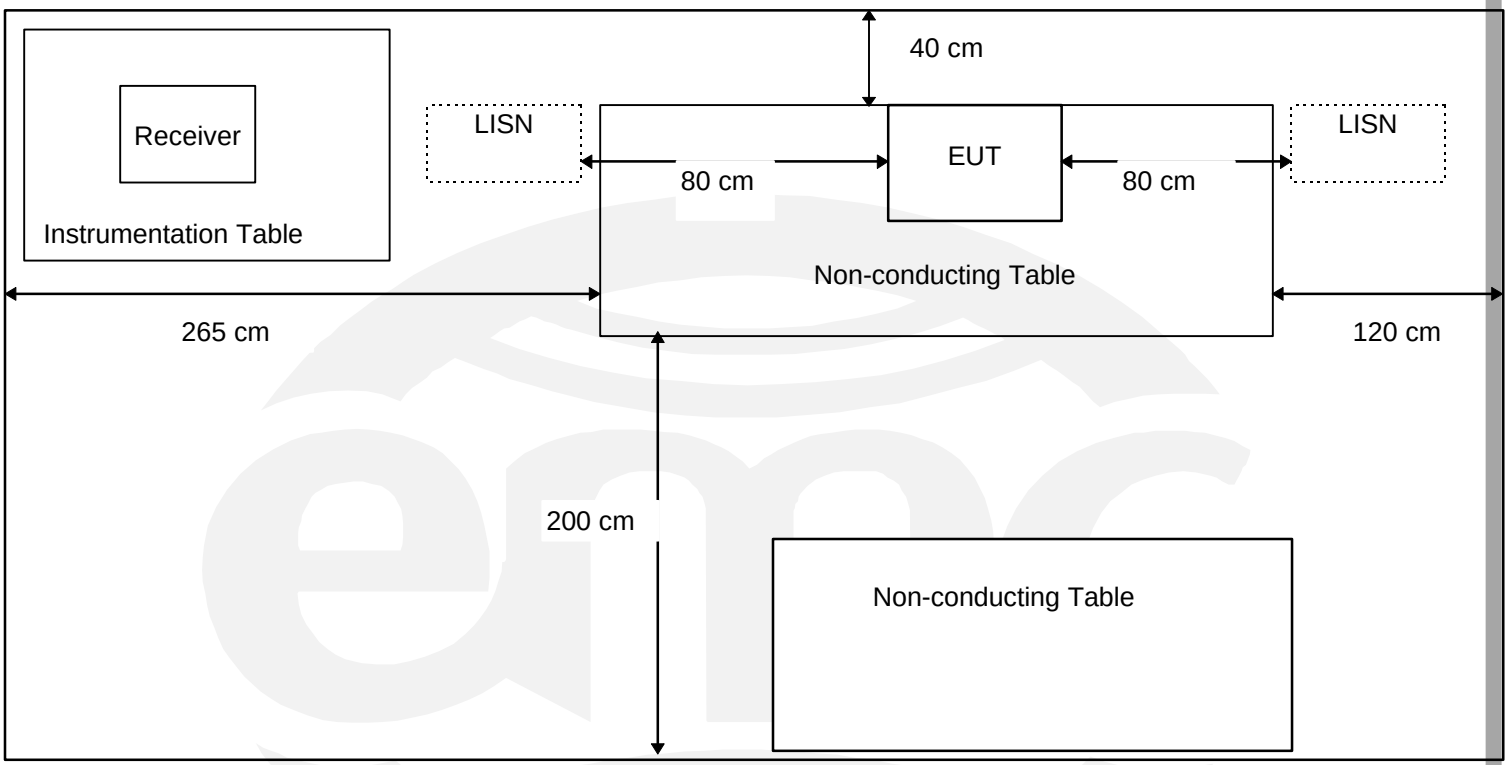
Test Setup Drawing(s)

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

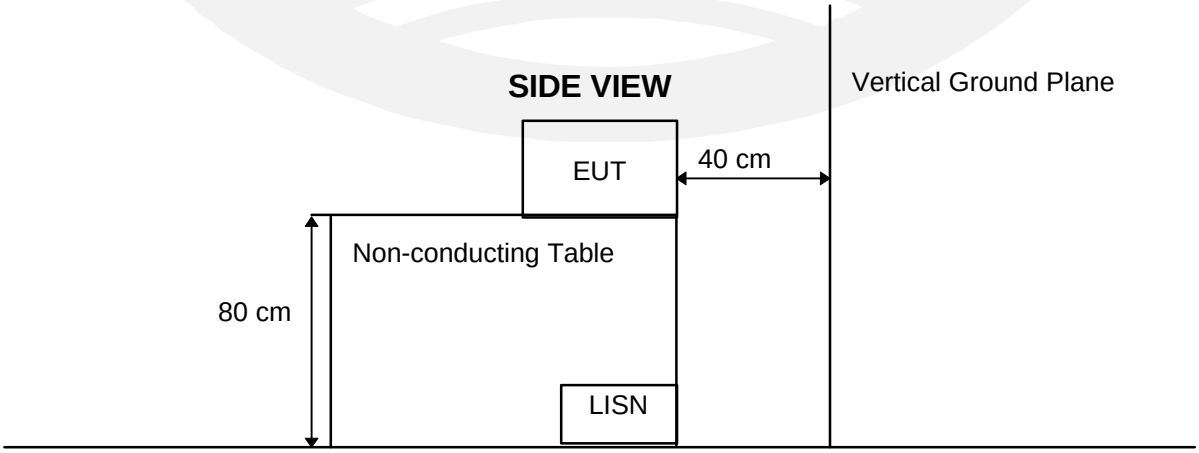
TEST SETUP FOR EMISSIONS TESTING

WILD RIVER LAB
Screen Room

TOP VIEW



SIDE VIEW



Other Measurements:
2 meters from top of EUT to ceiling
80 cm from closest part of EUT to the LISN

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TEST SETUP FOR EMISSIONS TESTING

WILD RIVER LAB
Large Test Site

Notes:

1. Items shown in dotted lines are located on the floor below the test area. It is 5 meters vertically from the ground floor to the test area.

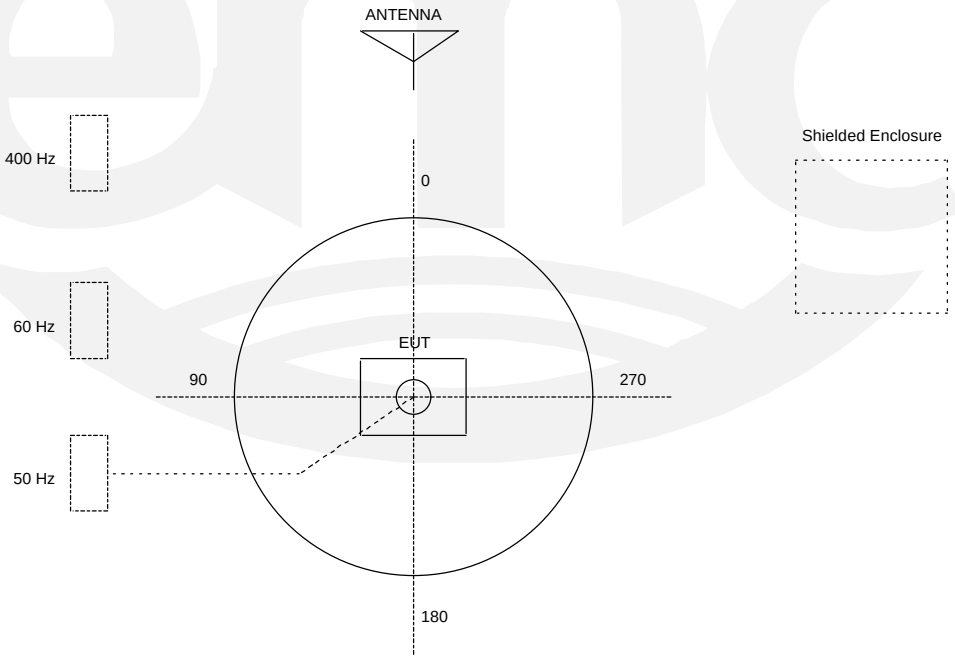
2. 50 Hz, 60 Hz, and 400 Hz are power panels for alternating current.

3. The antenna may be positioned horizontally 3, 10 or 30 meters from the center of the turntable.

4. The circle is a 6.7 meter diameter turntable.

5. A ground plane is in the plane of this sheet.

6. The test sample is shown in the azimuthal position representing zero degrees.



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T U V P R O D U C T S E R V I C E

RADIATED EMISSIONS

Large Test Site — Report W9552 Run 1
3 Meter Antenna Distance — Date 11-04-99 Page 1
Equipment Under Test: — Engineer _____
ECO WATER SYSTEMS — Tech: GSJ_____
WATER SOFTENER CONTROLLER — Requester_____
Notes: P/N 7209875 - TRANSMIT MODE

Frequency MHz	Level dBuV	Factor dB	Cable dB	Peak dBuV/m	Ave dBuV/m	Polar\ Height		15.231 Limit dBuV/m
0 DEGREES AZIMUTH = RIGHT SIDE								
EUT LAYING FLAT, NORMAL POSITION								
FUNDAMENTAL MAXED AT 265 DEG, HORIZONTAL, 1.66 METERS HIGH								
(20 DB PEAK-AVERAGE DUTY CYCLE CORRECTION)								
418.07	66.58	16.2	1.9	84.7	64.7	H	--	72.3
EUT ON ITS RIGHT SIDE								
MAXED AT 273 DEG, VERT, 1.14 M								
418.07	68.7	16.2	1.9	86.8	66.8	V	--	72.3
EUT ON ITS BACK								
MAXED AT 344 DEG, HORIZ, 1.6 M								
418.06	66.9	16.2	1.9	85	65	H	--	72.3
EUT ON ITS RIGHT SIDE (WORST CASE)								
2ND HARMONIC MAXED AT 284 DEG, HORZ, 1 M								
836.13	35.92	21.7	2.8	60.5	40.5	H	--	52.3
3RD HARMONIC MAXED AT 229 DEG, HORZ, 1.2 M								
1254.2	32.96	24.5	3.6	61	41	H	--	54
4TH HARMONIC MAXED AT 103 DEG, HORZ, 1.68 M								
1672.2	30.06	27.4	4.2	61.7	41.7	H	--	54
5TH HARMONIC MAXED AT 316 DEG, HORZ, 1.76 M								
2090.3	24.98	29.3	4.8	59	39	H	--	54
6TH MAXED AT 230 DEG, HORZ, 1.68 M								
2508.4	8.24	31.4	5.3	44.9	24.9	H	--	54
7TH MAXED AT 150 DEG, HORIZ, 1.1 M								
2926.4	21.32	32.3	5.8	59.4	39.4	H	--	54
8TH MAXED AT 330 DEG, HORZ, 1 M								
3344.5	24.76	32.6	6.2	63.6	43.6	H	--	54
9TH MAXED AT 170 DEG, HORZ, 1 M								
3762.6	17.88	33.4	6.7	57.9	37.9	H	--	54
10TH MAXED AT 307 DEG, HORZ, 1 M								
4180.7	7.88	34	7.1	49	29	H	--	54

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T U V P R O D U C T S E R V I C E

RADIATED EMISSIONS

Large Test Site — Figure____ — Report W9552 Run 1
3 Meter Antenna Distance — Date 11-04-99 Page 2
Equipment Under Test: — Engineer _____
ECO WATER SYSTEMS — Tech: GSJ_____
WATER SOFTENER CONTROLLER — Requester_____
Notes: P/N 7209875 - TRANSMIT MODE

Measurement Summary

Frequency MHz	Final dBuV/m	Final uV/m	Azimuth deg	Polar\ Height		Delta 15.231(e)	Delta
418.07	66.8	2187.7	--	H	--	-5.5	
836.13	40.5	105.92	--	H	--	-11.8	
1254.2	41	112.20	--	H	--	-13	
1672.2	41.7	121.61	--	H	--	-12.3	
2090.3	39	89.125	--	H	--	-15	
2508.4	24.9	17.579	--	H	--	-29.1	
2926.4	39.4	93.325	--	H	--	-14.6	
3344.5	43.6	151.35	--	H	--	-10.4	
3762.6	37.9	78.523	--	H	--	-16.1	
4180.7	29	28.183	--	H	--	-25	

File W9552 Run 1

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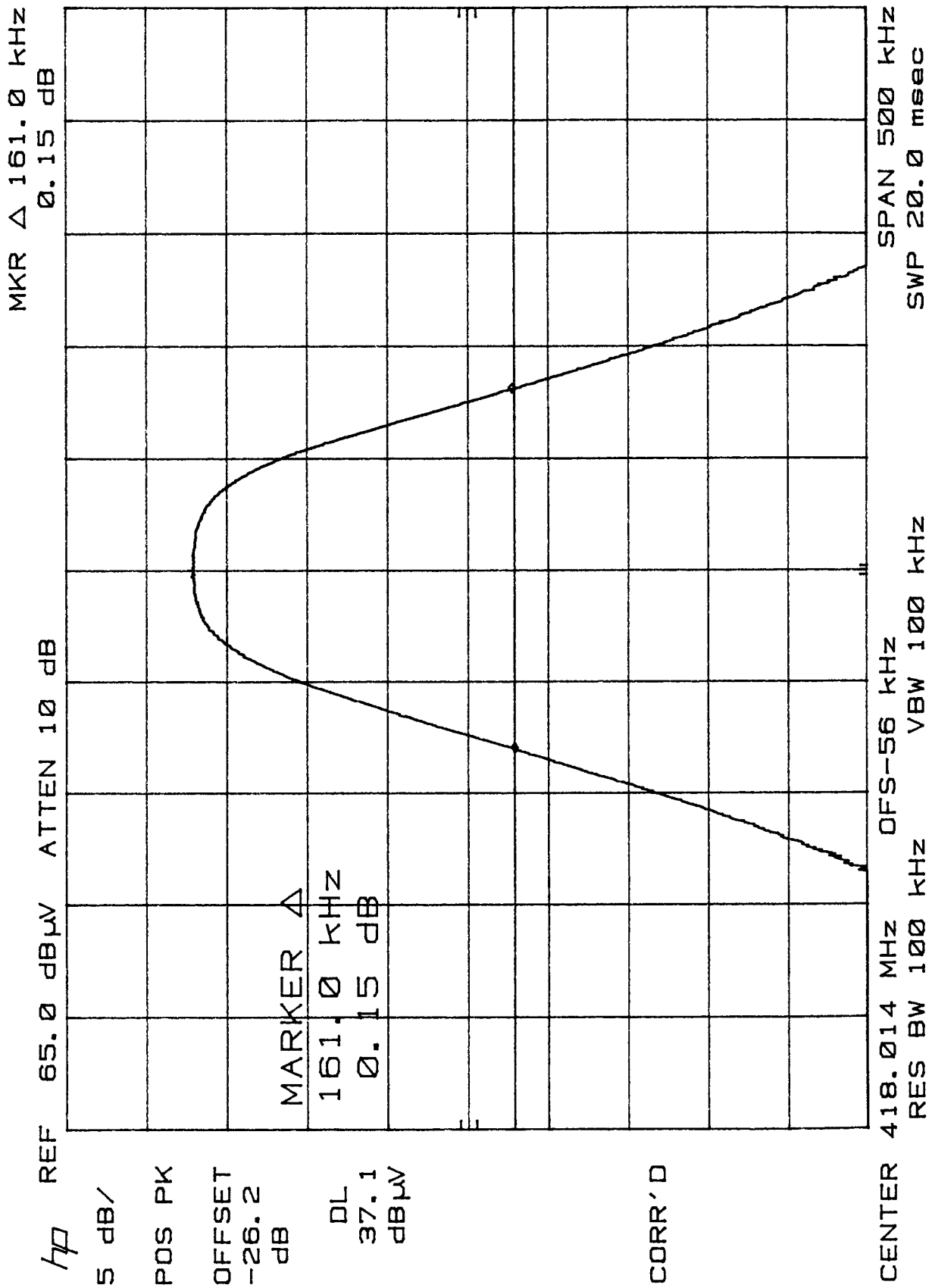

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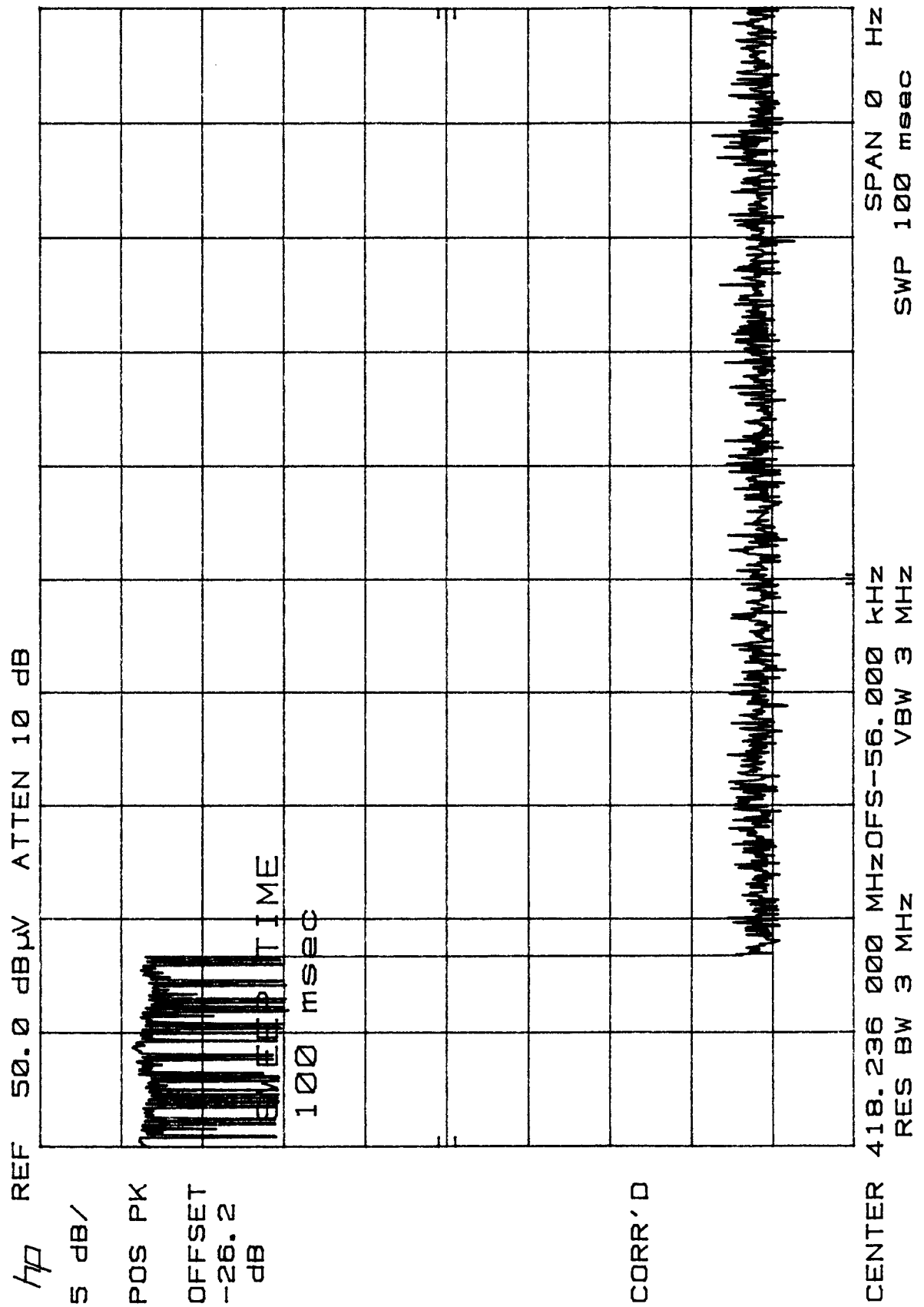

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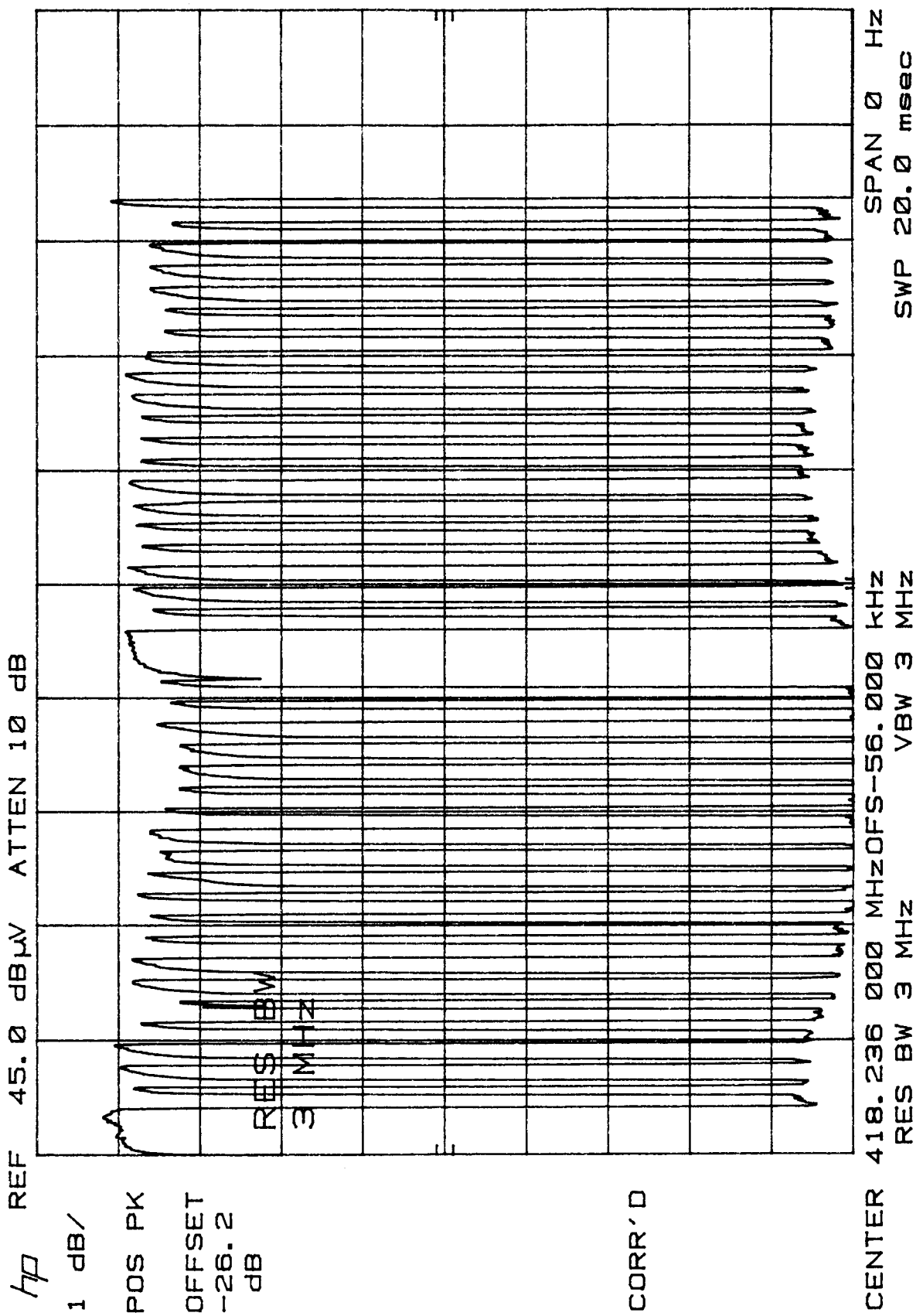
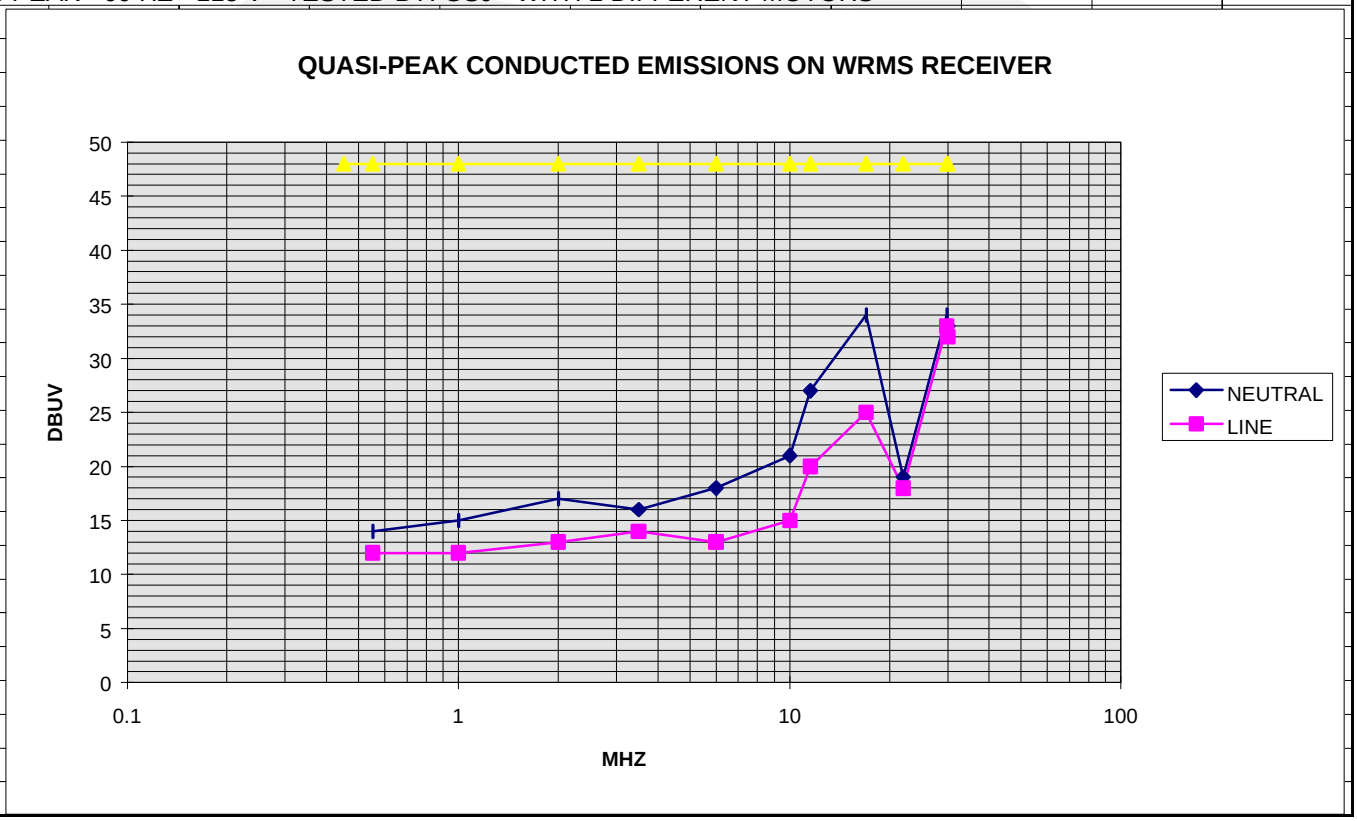

REF 45.0 dBµV ATTEN 10 dB
1 dB/
POS PK
OFFSET
-26.2
dB
RES BW
3 MHz
CORR'D
CENTER 418.236 000 MHz
RES BW 3 MHz
OFS-56.000 kHz
VBW 3 MHz
SPAN 0 Hz
SWP 20.0 msec

CONDUCTED EMISSIONS ON CONTROLLER AC POWER

TEST REPORT #W9552 DATE 04 NOVEMBER 1999

MHz	dBuV NEUTRAL	dBuV LINE	spec limit FCC B	margin-dB FCC B
0.45			48	48
0.55	14	12	48	34
1	15	12	48	33
2	17	13	48	31
3.5	16	14	48	32
6	18	13	48	30
10	21	15	48	27
11.54	27	20	48	21
17.02	34	25	48	14
22	19	18	48	29
29.8	34	33	48	14
30	33	32	48	15

QUASI-PEAK - 60 HZ - 115 V - TESTED BY: GSJ - WITH 2 DIFFERENT MOTORS



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Appendix B

Constructional Data Form

and

Product Information Form(s)

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

Constructional Data Form
for Electromagnetic Compatibility Testing

TÜV PRODUCT SERVICE

A completed form helps ensure that product testing will go smoothly. Add attachments as necessary for additional documentation. For additional help, please contact your TÜV Product Service Representative.

Applicant – Enter company information pertaining to the location where the product is manufactured and for the manufacturer's contact soliciting the testing.

Company: EcoWater Systems, Inc.

Address: 1890 Woodlane Drive

Woodbury, MN 55125

Phone: 651-731-7474 Fax: 651-739-7610

Contact: Jeff Zimmerman Position: Principle Design Engineer

General Equipment Description – Indicate which attachments you are providing with this document. It is recommended that you provide those listed.

Type of Equipment: Transmitter Model No.: 7213206 Rev A

Serial No.: _____ FCC ID No.: _____

General description: A Water Softener, using micro-controller based electronics, drives a 418 Mhz SAW based transmitter. A remote receiver then indicates to the customer the condition of the softening system.

Product Variant/Options: _____

Attachments: (only required for certification)

☐ External Photographs ☐ Product Literature ☐ High Level Bill of Materials

Date and sign each page of the CDF. Original signatures must be present on each page.

Date: Dec 1 1999 **Signature of Applicant:** Jeff Zimmerman

Constructional Data Form
for Electromagnetic Compatibility Testing

TÜV PRODUCT SERVICE

System Configuration Block Diagram -- Provide a line drawing identifying the EUT, simulators, support equipment, I/O cables, power cables, and any other pertinent components to be used during testing. Use a dashed line to separate the equipment in the testing field versus equipment outside testing field.

Date and sign each page of the CDF. Original signatures must be present on each page.

Date: Dec 1 1999 **Signature of Applicant:**

Constructional Data Form
for Electromagnetic Compatibility Testing

TÜV PRODUCT SERVICE

Installation and Environmental Conditions (describe) – Describe the intended installation. Include details such as power connection and system grounding approaches. Describe the intended operating environment, include details such as humidity, cooling, heating and hazardous environments. Attaching a copy of an installation manual is recommended for proper documentation of your system. Please indicate.

The transmitter is mounted on a micro-controller based circuit board. This board supplies 5 VDC along with control signals to turn the transmitter on and off. The two circuits are mounted together on a water softener faceplate which in turn is mounted into the entire water softener assembly. The micro-controller based circuit board is supplied with 24 Volt AC power from a UL approved, class 2, 120V to 24 Vac 60Hz wall mount transformer. The micro-controller based circuit board uses a linear power supply to derive 5 VDC from 24VAC which s used to drive the transmitter assembly.

Typical installations of the water softener/ transmitter system are in basements, garages, and other dwelling locations where the necessary access to plumbing exists. It is not recommended for outdoor installations.

☐ Installation manual/instructions (attached, only required for certification)

Power Requirements – Indicate your system power requirements for the equipment to be tested.

Rated Voltage _____ Rated Input Power _____

Protection Class – Indicate your product's protection class. Contact your TÜV Product Service representative and is only required for certification.

Type: _____ Class: _____

Date and sign each page of the CDF. Original signatures must be present on each page.

Date: Dec 1st 1999 **Signature of Applicant:** _____

Constructional Data Form
for Electromagnetic Compatibility Testing

TÜV PRODUCT SERVICE

I/O Ports and Cables

Indicate all interface cables which can be attached to the equipment even if they are not sold as part of your system. Describe the port (e.g., Parallel, Serial, SCSI), list its type (e.g., AC, DC, Signal, Control) and number of ports/cables of type. Indicate if the I/O port is to be exercised during testing. List the type of transmission and if the cable is an EUT assembly-to-assembly interconnection cable (PC to printer, to modem). Indicate whether the cable is shielded or not, type of shield (e.g. Braid, Foil) and how terminated (e.g. 360 degree to conductive shell, pigtail) at both ends of the cable. If a cable can have a typical length of ≥ 3.0 meters, then it is required to test with a cable of at least 3.0 meters.

I/O Ports and Cables

Description: NONE

Type of Port: _____ # of ports/cables of type _____

Exercised during testing?	☐ Yes	☐ No
Assembly ↔ Assembly Interconnect	☐ Yes	☐ No
Cable shielded:	☐ Yes	☐ No
Shield Type (describe)		
Termination: (describe)		
Transmission Type:	☐ Analog	☐ Digital
Length of cable: Maximum:	Tested:	

I/O Ports and Cables

Description: _____

Type of Port: _____ # of ports/cables of type _____

Exercised during testing?	☐ Yes	☐ No
Assembly ↔ Assembly Interconnect	☐ Yes	☐ No
Cable shielded:	☐ Yes	☐ No
Shield Type (describe)		
Termination: (describe)		
Transmission Type:	☐ Analog	☐ Digital
Length of cable: Maximum:	Tested:	

I/O Ports and Cables

Description: _____

Type of Port: _____ # of ports/cables of type _____

Exercised during testing?	☐ Yes	☐ No
Assembly ↔ Assembly Interconnect	☐ Yes	☐ No
Cable shielded:	☐ Yes	☐ No
Shield Type (describe)		
Termination: (describe)		
Transmission Type:	☐ Analog	☐ Digital
Length of cable: Maximum:	Tested:	

Date and sign each page of the CDF. Original signatures must be present on each page.

Date: Dec 1 1999 Signature of Applicant: _____

Constructional Data Form
for Electromagnetic Compatibility Testing

TÜV PRODUCT SERVICE

EUT configurations – Provide a technical description of all possible EUT configurations. Specify if more than one configuration is to be tested.

One Configuration:
The transmitter (7213206 Rev A) is mounted on the micro-controller based circuit board (7209875 Rev A) which is mounted on a plastic water softener faceplate. The system is to be powered with a wall mount 120/24 VAC transformer (7095373).

EUT Software and Operation Modes to be Tested – list the operating modes to be used during test. It is recommended the equipment be tested while operating in a typical operation mode. Consult with your TÜV Product Service Representative when typical operating modes are not practical. FCC testing of personal computers and/or peripherals requires that a simple program generate a complete line of upper case H's. This pattern must be sent to the parallel port device, serial port device, and must be write/read/verified to each storage device. Monitors must display the H pattern, typically in white letters on a black background. Provide a general description of all software, firmware, and PLD algorithms used in the equipment. List all code modules as described above, with the revision level used during testing.

General Description: (describe)	There is one typical operating mode. The transmitter is On & Off Keyed (OOK) for 16 ms (10 ms total carrier on time), once a minute. There is a test mode, which transmits the same signal once every 3 seconds. This mode along with a continuous ON transmission will be tested.
Software Revision Level: (list and describe)	Software revision of Main Controller PWA is M0.2.
Operating modes to be tested: (list and describe)	1. Continuous transmission @ 418 Mhz 2. OOK transmission for 16 ms (10 ms total carrier on time), once every 3 seconds.

☐ Operation manual/Instructions (attached)

Date and sign each page of the CDF. Original signatures must be present on each page.

Date: Dec 1st 1999 **Signature of Applicant:** Jeff Gammon

Constructional Data Form
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System, Subsystem, Major Subassemblies or Internal Peripherals -- List and describe all system, subsystem, major subassemblies and all internal peripherals. This should include such things as an external monitor, parallel interface peripheral, serial interface peripheral, internal disk drives or internal circuit boards. It is recommended that circuit diagrams, assembly and subassembly drawings be attached. Please indicate.

Description	*Model #*	*Serial #*	*FCC ID #*
none			

☐ Technical Drawings attached

Interfacing Equipment and/or Simulators (which are not part of the EUT) -- List and Describe all equipment or peripherals that will be connected to the EUT. For FCC testing a minimum configuration is required. If you have questions about this minimum configuration contact your TÜV Product Service representative.

Description	*Model #*	*Serial #*	*FCC ID #*
Main Water Softener PWA	7209875 Rev A		

Date and sign each page of the CDF. Original signatures must be present on each page.

Date: Dec. 1 1999 **Signature of Applicant:** Jeff Simmons

Constructional Data Form
for Electromagnetic Compatibility Testing

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EMC System Details – List all frequencies and sub-harmonics which are 10kHz or above for such things as oscillators, horizontal line rate of monitors, and clock rates of incorporated OEM assemblies. List all power supplies. Indicate switching frequencies. List power line filters and indicate the manufacturer, model and location on EUT. Indicate all components used for high frequency noise reduction. (e.g., ceramic capacitor, 0.01µF, 1 ea. at C12 - C20).

Oscillator Frequencies

Frequency	*Sub-harmonics*	*EUT Location*	*Description of Use*
418 Mhz	NONE		

Power Supply

Frequency	*Manufacturer*	*Model #*	*Serial #*	*Type (list frequency)*
60HZ	Basler	7095373		120/24VAC 60HZ

Power Line Filters

Manufacturer	*Model #*	*Qty*	*Location on EUT*
NONE			

Critical EMI Components (Capacitors, ferrites, etc.)

Description	*Manufacturer*	*Part # or Value*	*Qty*	*Location on EUT*
NONE				

Date and sign each page of the CDF. Original signatures must be present on each page.

Date: Dec 1 1999 **Signature of Applicant:** Jeff Zimmerman

Constructional Data Form
for Electromagnetic Compatibility Testing

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Other EMI Critical Construction Detail – Indicate any other measures taken to reduce high frequency noise, (e.g., grounding the circuit board on the right rear corner with 0.25" braid, 3 inches long to the chassis).

NONE

Description of Enclosure – Describe the principle materials of the enclosure (e.g., plastic, plastic with shielding material, metal, metal with specific shielding contact points, metal with paint on all surfaces).

Plastic Enclosures

No Shielding

Date and sign each page of the CDF. Original signatures must be present on each page.

Date: Dec 1st 1999 **Signature of Applicant:**

MEASUREMENT PROTOCOL

GENERAL INFORMATION

Measurement Uncertainty

The test system for conducted emissions is defined as the LISN, tuned receiver or spectrum analyzer, and coaxial cable. The test system for radiated emissions is defined as the antenna, the pre-amplifier, the spectrum analyzer and the coaxial cable. These test systems have a measurement uncertainty of ±4.5 dB. The equipment comprising the test systems are calibrated on an annual basis.

Justification

The Equipment Under Test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral into it's characteristic impedance or left unterminated. When appropriate, the cables are manually manipulated with respect to each other to obtain maximum emissions from the unit.

CONDUCTED EMISSIONS

The final level, expressed in dBµV, is arrived at by taking the reading directly from the EMI receiver. This level is compared directly to the FCC limit.

To convert between dBµV and µV, the following conversions apply:

dBµV = 20(log µV)
µV = Inverse log(dBµV/20)

RADIATED EMISSIONS

The final level, expressed in dBµV/m, is arrived at by taking the reading from the spectrum analyzer (Level dBµV) and adding the antenna correction factor and cable loss factor (Factor dB) to it. This result then has the FCC limit subtracted from it to provide the Delta which gives the tabular data as shown in the data sheets in Attachment B. The amplifier gain is automatically accounted for by using an analyzer offset.

Example:

Frequency (MHz)	Level (dBµV)	+	Factor & Cable (dB)	=	Final (dBµV/m)	-	FCC B Limit (dBµV/m)	=	Delta FCC B (dB)
32.21	13.9	+	16.3	=	30.2	-	40.0	=	-9.8

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

DETAILS OF TEST PROCEDURES

General Standard Information

The test methods used comply with ANSI C63.4-1992 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz."

Conducted Emissions

Conducted emissions on the 60 Hz power interface of the EUT are measured in the frequency range of 450 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection, and a Line Impedance Stabilization Network (LISN), with 50 Ω/50 μH (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 centimeters above the floor and is positioned 40 centimeters from the vertical ground plane (wall) of the screen room. In some cases, a pre-scan using a spectrum analyzer is initially performed on the units comprising the system under test to locate the highest emissions. If the minimum passing margin appears to be less than 20 dB with a peak mode measurement, the emissions are re-measured using a tuned receiver or spectrum analyzer with quasi-peak and average detection and recorded on the data sheets.

Radiated Emissions

Radiated emissions from the EUT are measured in the frequency range of 30 to 1000 MHz using a spectrum analyzer and appropriate broadband linearly polarized antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection and measurements above 1000 MHz are made with a 1 MHz/6 dB bandwidth and peak detection. Table top equipment is placed on a 1.0 X 1.5 meter non-conducting table 80 centimeters above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. Interface cables that are closer than 40 centimeters to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 centimeters from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screen room located outside the test area. The antenna is positioned 3 meters horizontally from the EUT. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 meters, measurement scans are made with both horizontal and vertical antenna polarizations and the EUT are rotated 360 degrees. Intentional radiators are rotated through three orthogonal axes to determine the attitude that maximizes the emissions.

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