



# Wastewater Analysis using the Prodigy High Dispersion ICP

## INTRODUCTION

The U.S. EPA is responsible for establishing analytical procedures used for compliance monitoring of both drinking and wastewater. This responsibility is given to the U.S. EPA under the Safe Drinking Water Act (SDWA) and the Clean Water Act (CWA).

Under the Safe Drinking Water Act, the EPA declares National Primary Drinking Water Regulations (NPDWR), specifying maximum contaminant levels (MCLs) for drinking water contaminants. The goal of SDWA is to ensure an adequate supply of safe drinking water.

The Clean Water Act was originated in 1972 and has since undergone many changes. Under this Act, all toxic and nontoxic discharges to surface waters are to be regulated. Guidelines are set by the EPA and individual states issue National Pollutant Discharge Elimination System (NPDES) Permits. Individual States may have stricter guidelines than those of the U.S. EPA.

The analysis of drinking and wastewater is performed under the U.S. EPA 600 Series of methods (CFR 40 Part 136). Any treatment facility that discharges to surface waters must use the appropriate method from this series. For facilities using Inductively Coupled

Plasma (ICP) for compliance monitoring of metals, the required procedure is *Method 200.7: Determination of Metals and Trace Metals in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry*. The sample types covered by this method are drinking water, water, wastewater and solid wastes. Method 200.7 is applicable to 32 metals. For a particular treatment facility, the metals determined depend on the issued NPDES permit. Most facilities usually determine only a subset of the entire method.

As with other U.S. EPA mandated methods, 200.7 requires adherence to specific procedures to ensure analytical quality control. Some of these procedures are designed to demonstrate the initial performance of the instrument, while others assess the ongoing performance of the laboratory. The purpose of this application note will be to demonstrate the initial performance of the Teledyne Leeman Labs Prodigy ICP Spectrometer using both axial and radial views for use with Method 200.7. The initial performance parameters to be characterized are 1.) Instrument Detection Limit (IDL), 2.) Method Detection Limit (MDL), 3.) Linear Dynamic Range (LDR) and 4.) Performance on a Quality Control Sample (QCS). In addition, the long-term stability of the instrument and the determination of metals in a certified sludge sample will be illustrated.

## Experimental

### Instrument

A Prodigy High Dispersion Inductively Coupled Plasma (ICP) Spectrometer equipped with a dual view torch was used to generate the data for this application note. The optical design of this spectrometer permits high dispersion and high spectral resolution in a relatively small package and provides continuous wavelength coverage from 165-1100 nm. Prodigy's innovative image stabilized ICP source and thermostated long focal length optical system work together to provide unexcelled analytical stability.

For this work, the instrument was equipped with the following options: dual view torch and an 88-position autosampler. All data presented were collected using the autosampler in unattended operator. The sample introduction system of the Prodigy consists of a four-channel peristaltic pump,

cyclonic spray chamber with knockout tube, single-piece quartz torch and a Glass Expansion SeaSpray AR30 nebulizer.

### Operating Parameters

The initial performance parameters measured for this application note were determined as specified in Method 200.7, Rev. 4.4.

In order to determine the initial performance characteristics of the instrument, a protocol was created using the elements listed in Table 1. Also included in this table are the wavelength, background correction points and integration times. For all elements, the background point integration was taken simultaneously with the peak measurement. This results in improved detection limits. The instrument operating conditions are shown in Table 2. All data were generated using these conditions.

Element	Wavelength (nm)	Left Background Position (pixel position)	Right Background Position (pixel position)	Simultaneous Integration Time (sec.)
Ag	328.068	1	13	30
Al	308.215	3	13	30
As	189.042	1	13	30
B	249.677	2	13	30
Ba	493.409	3	13	30
Be	313.042	3	13	30
Ca	315.887	3	13	30
Cd	226.502	3	13	30
Co	228.615	3	13	30
Cr	205.552	3	13	30
Cu	324.754	3	13	30
Fe	259.940	3	13	30
K	766.491	3	13	30
Li	670.791	3	13	30
Mg	279.078	3	13	30
Mn	257.610	3	13	30

Table continued on the next page

Mo	202.030	3	13	30
Na	589.592	3	13	30
Ni	231.604	3	13	30
P	214.914	3	13	30
Pb	220.353	2	13	30
Sb	217.581	3	13	30
Se	196.090	3	13	30
Si	251.611	3	13	30
Sn	189.991	3	13	30
Sr	421.552	3	13	30
Ti	334.941	3	13	30
Tl	190.864	3	13	30
V	292.401	3	13	30
Zn	206.200	3	13	30

*Table 1. Wavelengths, Background Correction Points and Integration Times*

Parameter	Setting
Coolant Gas	18 l/min
Auxiliary Gas	0.5 l/min
Nebulizer Gas	34 psi
RF Power	1.2 kW
Pump Rate	1.3 ml/min
Sample Uptake Time	45 sec
Autosampler Rinse Time	60 sec

*Table 2. Plasma Operating Conditions*

Calibration standard concentrations are given in Table 3. These standards were prepared from Teledyne Leeman Labs PLASMA-PURE™ ALT-EPA standard series, diluted 10 fold. The standards are prepared from high purity starting

materials and are traceable to NIST SRM's. The acid matrix was 5% nitric acid. In addition, the Mn in STD 1 was used to optimize the torch observation height.

		Concentration, mg/L
<b>STD 1</b>		
As, Ca		10
Sb, Se		5
B, Cd, Cu, Mn		2
Ba		1
Ag		0.5
<b>STD 2</b>		
K		20
Mo, Na, Ti		10
Li		5
Sr		1
<b>STD 3</b>		
P		10
Co, V		2
<b>STD 4</b>		
Al, Si		10
Cr, Zn		5
Sn		4
<b>STD 5</b>		
Fe, Mg, Pb		10
Tl		5
Ni		2
Be		1
<b>STD 6</b>		calibration blank

**Table 3. Calibration Standards (5 % HNO<sub>3</sub>)**

The procedure for collecting the performance data was as follows:

1. Ignite plasma, allow 10 minute warm-up
2. Set torch observation height using Mn in STD 1
3. Calibrate entire element suite (3 replicates of each element using autosampler)
4. Collect Data (using autosampler)

## Results and Discussion

### Instrument Detection Limit (IDL)

The instrument's IDLs were determined as specified in Section 3.5 of Method 200.7. The IDL is defined as the concentration equivalent to the analyte signal, which is equal to three times the standard deviation of a series of ten replicate

measurements of the calibration blank signal at the same wavelength.

After the initial calibration of Prodigy, 10 sample tubes containing the calibration blank were placed in the autosampler and analyzed. Using the reporting capabilities of the Prodigy's software, the standard deviation of each of the elements was determined and the IDL calculated. The IDLs are presented in Table 4, along with the estimated detection limits from Section 17, Table 1 of Method 200.7. Upon inspection, it is clear Prodigy exceeds the estimated detection limits for all the elements. According to the definition from the previous page, the measurement of the IDL must be made at the same wavelength at which the analyte is measured.

### **Method Detection Limit (MDL)**

From Section 3.13 in Method 200.7, the MDL is defined as the minimum concentration of an analyte that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero. The procedure to determine MDLs is given in Section 9.2.4 of the method. The MDLs are measured by fortifying a reagent blank with analytes at a concentration 2 to 3 times the IDL. This solution is then analyzed 7 times and the standard deviations of the analyte concentrations is multiplied by 3.14 (the student's t-statistic for a 99% confidence interval). To obtain a better estimate of the MDL, the procedure can be repeated on three non-consecutive days and the MDL values averaged.

MDL values for Prodigy were determined by fortifying a reagent blank with analyte concentrations at 2 times the IDLs given in Table 4. This standard was made by adding single element PLASMA-PURE™ standards to obtain the appropriate concentration. (Initially, 3 times the IDL was used, but the RSDs of some of the analytes were below 10%, which may result in unrealistically low MDLs.) In addition, the experiment was run on 3 non-consecutive days to obtain more realistic estimates of the MDLs. For each of the MDL runs, fresh calibration standards were used to encompass as much variability as possible.

The average of the MDLs collected over the three days is presented in Table 4, along with the IDLs for comparison. As expected, the MDLs are higher than the IDLs, but not by very much.

### **Linear Dynamic Range (LDR)**

Method 200.7 requires that the upper limit of the LDR be established (Section 9.2.2). This is accomplished by analyzing increasingly higher concentration analyte standards. The LDR is considered exceeded when the measured concentration is no more than 10% below the true concentration.

For this experiment single element PLASMA-PURE™ standards of 1, 5, 10, 25, 50 and 100 mg/L were analyzed. Prodigy was calibrated using standard concentrations indicated in Table 2. Other concentration standards were prepared as necessary if the LDR was not determined or exceeded using the original three standards.

Results of the LDR study are shown in Table 4. These LDR values emphasize one of the advantages of using ICP for compliance monitoring. ICP is known for its excellent linear range, particularly when compared with Atomic Absorption Spectrometry (AAS). The LDRs exhibited by Prodigy permit the analysis of samples with wide concentration ranges for a particular element without the need to dilute samples frequently. The limited linear range of AAS requires multiple dilutions to cover such wide concentration ranges.

The LDRs presented in Table 4 were determined using single element solutions. In real samples, LDRs may be affected by the presence of multiple elements at high concentrations or different sample matrices. Due to the multitude of possible analyte and matrix element combinations, this approach was not used for this application note. Analysts are advised to use caution in applying the LDR data determined using single element standards. For the most accurate LDRs, multi-element standards in a matrix similar to that of the sample should be used.

Element	Wavelength (nm)	IDL (ug/L)	MDL (ug/L)	Method 200.7, Table 1 (ug/L)	LDR, mg/L (upper limit)
Ag	328.068	0.4	0.5	7.0	10
Al	308.215	2.0	6.5	45	100
As	189.042	4.5	5.0	53	10
B	249.677	0.1	0.2	5.7	100
Ba	493.409	0.1	0.3	2.3	1
Be	313.042	0.02	0.04	0.27	1
Ca	315.887	1.2	1.5	30	10
Cd	226.502	0.2	0.4	3.4	10
Co	228.615	0.3	1.4	7.0	100
Cr	205.552	0.8	1.7	6.1	10
Cu	324.754	0.2	0.4	5.4	10
Fe	259.940	0.1	0.3	6.2	10
K	766.491	0.8	1.0	700	20
Li	670.791	0.10	0.13	3.7	10
Mg	279.078	0.9	1.7	30	100
Mn	257.610	0.2	0.2	1.4	10
Mo	202.030	1.0	1.3	12	100
Na	589.592	0.6	1.1	29	20
Ni	231.604	0.4	1.1	15	100
P	214.914	10.0	10.7	76	1000
Pb	220.353	1.0	1.4	42	500
Sb	217.581	2.3	2.6	32	10
Se	196.090	4.0	4.5	75	10
Si	251.611	1.9	2.3	26	100
Sn	189.991	4.9	5.2	25	100
Sr	421.552	0.04	0.13	.77	2
Ti	334.941	0.20	0.37	3.8	10
Tl	190.864	1.6	2.2	40	100
V	292.401	0.07	0.08	7.5	100
Zn	206.200	0.09	0.10	1.8	50

*Table 4. Instrument Detection Limits (3σ)*

## Quality Control Samples

In order to verify the accuracy of calibration an Instrument Performance Check (IPC) must be analyzed prior to analysis of samples (Section 7.11, Method 200.7). This sample must be analyzed three times and the mean concentration can differ by no more than  $\pm 5\%$  of the certified value.

In order to verify the calibration standards, a Quality Control Sample (QCS) must be analyzed (Section 7.12, Method 200.7). The QCS must be obtained from a different source than that of the calibration standards.

As a QCS, two independent solutions were purchased. The first of these was a PotableWatR™ metals standard (Catalog #697, Lot # S072697, Environmental Resource Associates). The second was a Trace Metals Water Pollution (Catalog # QC-TM-WP, Lot #'s 14-56T, 14-57T and 14-58T, Spex Certiprep Inc.). The samples were prepared according to the instructions and analyzed under the identical conditions used to generate the data presented above.

## Interfering Element Correction (IEC)

Method 200.7 requires the wavelengths used for analysis to be checked for the presence of interfering elements. For this purpose, a series of Spectral Interference Check (SIC) solutions are used (Section 7.13.1).

To determine the interfering element correction factors (IEC), the instrument is calibrated normally and each of the single element SIC solutions are analyzed as samples. The concentrations of the SIC solutions are 300 mg/L Fe, 200 mg/L Al and 50 mg/L for all remaining elements. The results are then compared to the 3-sigma control limits of the calibration blank, of which the upper limit is the IDL. The Prodigy software will automatically calculate the IEC factors.

The results are displayed in Tables 5 and 6. The measured IEC factors are quite small. This is due to the superior resolution and dispersion of the Prodigy's optical system.

The small IEC factors have two benefits. First, sample results are more accurate because the magnitude of correction is relatively low. And second, smaller IEC factors do not have to be checked on a daily basis. The criterion for a daily check is if the IEC factor multiplied by 100 for Fe or Al (10 for all other elements) exceeds the 3-sigma control level for the calibration blank. If the factor fails this test, it must be checked daily.

The results from the analysis of the QCS are presented in Tables 7 and 8. The reported concentrations are the average of three replicate analyses. All of the elements determined are within the required Performance Acceptance Limits (PAL), validating the calibration standards and protocol. These particular samples were chosen to demonstrate both the initial calibration verification and show results for real samples.

SIC	Ag 328.068	Al 308.215	As 189.042	B 249.677	Ba 493.409	Be 313.042	Ca 315.887	Cd 226.502
Fe	-0.000014	-0.000019			0.000004	-0.000001	0.000054	0.000099
Al					0.000001	-0.000002	0.000014	
Ca					0.000001	0.000031		
Ba								
Be	-0.000169	-0.007224				-0.000007	0.000372	
Cd		-0.00016	0.000317			0.000399		
Co	-0.000025	-0.003988	-0.002257	0.003028		0.000015	0.00221	0.000416
Cr			0.007855	0.000269		0.000007	0.000261	0.000018
Cu	-0.000028					-0.000002	-0.000035	
Mn	0.000142	0.000562			0.000004	-0.000005	-0.000041	
Mo	0.000059	0.020772	0.00765	-0.001342	0.000012	-0.000005	-0.001308	-0.000044
Ni						-0.000006	-0.000121	-0.00019
Sn						-0.000006	-0.000109	0.000859
Si		0.000178				-0.000005	-0.000116	
Ti	0.000469	-0.000425	-0.002075	0.000128		0.000009	-0.00026	0.000193
Tl						0.00035	0.000475	0.000009
V	-0.001136	0.023115			-0.000009	0.001022	-0.002893	0.000014

SIC	Co 228.615	Cr 205.552	Cu 324.754	Fe 259.940	K 766.491	Li 670.784	Mg 279.078	Mn 257.610
Fe	-0.000016	-0.000235	-0.000012		0.000021			0.000008
Al	-0.000024	0.000024			0.000029	0.000003	0.000031	0.000005
Ca			-0.000021	0.000018				0.000004
Ba	-0.000887			-0.000044	-0.000282	-0.000373		0.000006
Be		-0.008096		0.00005				0.000005
Cd	0.000098			0.000034				0.000008
Co				0.000026			-0.000543	0.000006
Cr	0.000573		0.000148	0.000051	0.000083		-0.000407	0.000006
Cu	0.000067			-0.000052		0.000011		0.000009
Mn		0.000052		0.000052				
Mo		0.001272	0.000931	0.000059	0.000108		-0.000456	0.00007
Ni	0.000154		0.000088	-0.000054				0.000026
Sn			0.000076	-0.000051				
Si			0.000066	-0.000037				0.00001
Ti	0.002175	0.000055	-0.000015	-0.000221	-0.000109		-0.000249	0.000013
Tl			0.00003	-0.000043				0.000058
V		0.000054	-0.000368		-0.000097		-0.000428	-0.000048

*Table 5. Interelement Correction Factors Ag - Mn*



SIC	Mo 202.030	Na 589.592	Ni 231.604	P 214.914	Pb 220.353	Sb 217.581	Se 196.090	Si 251.611
Fe			-0.000017	0.001095	0.000072	-0.000249		-0.000044
Al			0.000007	-0.000558	-0.000098	-0.000081	0.000128	
Ca			0.000014					-0.000064
Ba			-0.000032					
Be						-0.001376		-0.000117
Cd								
Co			0.000382		0.000559		0.000923	
Cr				0.002935				-0.000155
Cu			0.000041	0.096001			0.000494	
Mn			0.000059	-0.003493	0.00029	-0.000901	0.001301	0.000239
Mo			-0.000093	0.011263	-0.001206	-0.000452	0.000879	
Ni	0.000531				0.000337			
Sn				-0.0049				
Si				-0.00078				
Ti				-0.003428	-0.000783	-0.000346		
Tl			0.000511					0.000149
V	-0.00029			-0.00088	-0.000155	0.003638	0.001102	-0.002002

SIC	Sn 189.991	Sr 421.552	Ti 334.941	Tl 190.864	V 292.401	Zn 206.200
Fe					0.000056	0.000036
Al						
Ca	-0.000161	0.000017	-0.000043		0.000006	
Ba		-0.000056				
Be						
Cd				0.000196		
Co			0.00004	0.006481	0.000041	0.000049
Cr		-0.000002	0.000323	0.00036	0.000204	0.000314
Cu						
Mn				-0.00037	-0.000105	
Mo			0.000089	-0.000221	-0.001598	0.000243
Ni						-0.000164
Sn				0.006432		
Si	0.000669		0.000011	0		
Ti	0.000308	0.000007		-0.002819	0.000941	
Tl						
V		-0.000008	0.00004	-0.021558		

*Table 6. Interelement Correction Factors Mo - Zn*

ELEMENT	FOUND (µg/L)	RSD %	CERTIFIED (µg/L)	Performance Acceptance Limits (µg/L)
Al	2312	0.81	2260	1940 - 2560
As	87	2.6	80	62.8 - 96.7
Cd	47	0.8	49	41 - 56.9
Cr	426	0.5	421	366 - 477
Co	953	0.3	920	809 - 1030
Cu	424	0.5	413	374 - 455
Fe	1611	0.5	1590	1410 - 1790
Pb	288	0.7	285	245 - 324
Mn	335	0.4	330	295 - 367
Ni	1683	0.3	1640	1490 - 1830
Se	1300	0.8	1270	1010 - 1470
V	9691	0.5	9890	8940 - 10900
Zn	857	0.3	856	758 - 962
Be	12	0.5	12	8.78 - 13.8
Mo	308	1.0	310	265 - 355
Sb	248	0.9	255	172 - 310
Ag	26	0.9	28	23.3 - 32.4
Sr	241	0.7	245	208 - 281
Tl	753	1.1	820	662 - 950
Ti	144	0.7	145	124 - 164
Ba	266	0.8	260	228 - 300
Sn	2378	0.5	2390	1880 - 2910

**Table 7. Analytical Results for Spex Certiprep QC-TM-WP Lot #'s 14-56T, 14-57T, 14-58T**

ELEMENT	FOUND (µg/L)	RSD %	CERTIFIED (µg/L)	Performance Acceptance Limits™ (ug/L)
Al	327	1.5	293	256 - 354
Sb	223	0.8	240	207 - 269
As	465	0.5	456	407 - 487
Ba	494	0.5	519	466 - 564
Be	40	0.7	40.3	36.2 - 44.4
B	326	0.6	291	269 - 357
Cd	572	0.5	587	522 - 618
Cr	193	0.3	194	178 - 208
Co	112	0.8	107	102 - 118
Cu	103	0.8	102	90.6 - 111
Fe	428	0.5	431	379 - 479
Pb	430	0.4	433	394 - 474
Mn	695	0.5	694	638 - 756
Mo	332	0.7	334	302 - 362
Ni	756	0.3	751	692 - 812
Se	909	0.7	901	812 - 986
Ag	126	0.3	130	119 - 143
Sr	58	0.8	59.2	52.8 - 64.8
Tl	380	0.6	382	340 - 426
V	435	0.7	463	426 - 496
Zn	167	0.7	177	162 - 196

*Table 8. Average concentration of ERA PotableWatR lot# S072697*

### Long-Term Analytical Stability

When samples are analyzed according to Method 200.7, one of the quality control requirements is that a check standard be analyzed after every ten samples and at the end of the run. The concentrations for this standard are specified in Section 7.11 of the method and the acceptance range is  $\pm 10\%$ . If an element falls outside this range, the instrument must be recalibrated and all samples analyzed since the last successful QC standard must be reanalyzed. Though the Prodigy can recalibrate and rerun the necessary samples automatically, it is clearly desirable that QC standard failures be eliminated if possible. For this to occur, the instrument must have high spectral resolution minimizing the impact of any

interferents and be analytically stable over extended periods of time.

In order to demonstrate the stability of Prodigy, an extended sample run was prepared. This run consisted of replicate analysis of the two QCS samples. Prodigy was calibrated for all elements in the protocol and the samples analyzed over the next 4 hours. No recalibration of Prodigy was performed during the run.

Data collected are given in Tables 9 and 10. For each of the different samples, the tables contain the mean concentrations of all the analyses and the RSD. The mean concentrations for each of the QCS samples are in excellent agreement with all of the certified values and certainly within all the Performance Acceptance Limits™.

ELEMENT	FOUND (µg/L)	RSD %	CERTIFIED (µg/L)	Performance Acceptance Limits (ug/L)
Al	2326	0.6	2260	1940 - 2560
As	91	2.6	80	62.8 - 96.7
Cd	47	0.8	49	41 - 56.9
Cr	412	0.4	421	366 - 477
Co	913	0.4	920	809 - 1030
Cu	449	0.4	413	374 - 455
Fe	1620	0.3	1590	1410 - 1790
Pb	287	1.2	285	245 - 324
Mn	337	0.5	330	295 - 367
Ni	1651	0.7	1640	1490 - 1830
Se	1277	0.6	1270	1010 - 1470
V	9338	0.3	9890	8940 - 10900
Zn	844	0.5	856	758 - 962
Be	12	0.8	12	8.78 - 13.8
Mo	308	0.4	310	265 - 355
Sb	246	1.0	255	172 - 310
Ag	26	1.4	28	23.3 - 32.4
Sr	236	0.9	245	208 - 281
Tl	733	1.0	820	662 - 950
Ti	158	0.6	145	124 - 164
Ba	249	0.4	260	228 - 300
Sn	2332	0.5	2390	1880 - 2910

**Table 9. Average Concentrations of Spex Certiprep QC-TM-WP Lot #'s 14-56T, 14-57T, 14-58T analyzed over 4 hours (n = 16)**

ELEMENT	FOUND (µg/L)	RSD %	CERTIFIED (µg/L)	Performance Acceptance Limits™ (ug/L)
Al	295	1.3	293	256 - 354
Sb	225	0.9	240	207 - 269
As	463	1.0	456	407 - 487
Ba	496	1.4	519	466 - 564
Be	41	0.4	40.3	36.2 - 44.4
B	313	0.5	291	269 - 357
Cd	553	0.7	587	522 - 618
Cr	190	0.6	194	178 - 208
Co	105	0.5	107	102 - 118
Cu	109	0.6	102	90.6 - 111
Fe	433	1.1	431	379 - 479
Pb	426	0.9	433	394 - 474
Mn	690	0.6	694	638 - 756
Mo	331	0.5	334	302 - 362
Ni	738	0.8	751	692 - 812
Se	896	0.9	901	812 - 986
Ag	123	0.7	130	119 - 143
Sr	60	1.2	59.2	52.8 - 64.8
Tl	370	1.3	382	340 - 426
V	440	0.5	463	426 - 496
Zn	167	1.2	177	162 - 196

*Table 10. Average concentrations of ERA PotableWatR lot# S072697 analyzed over 4 hours (n=16)*

## CONCLUSIONS

The types of samples that are analyzed under Method 200.7 represent routine analysis on a daily basis for a great number of laboratories. This method is respected as a standard operating protocol for ICP and is frequently considered the standard by which ICP instrumentation is measured both inside and outside the US.

The data presented in this application note demonstrate that the Prodigy ICP is an excellent tool for compliance monitoring for wastewater under U.S. EPA Method 200.7. The initial performance characteristics of the instrument (IDLs, MDLs and LDRs) are well within the required specifications. Successful analyses of certified samples and the demonstration of long-term stability provide further proof that Prodigy is capable of providing accurate and precise compliance monitoring on a routine basis.

Prodigy's ability to perform this type of analysis derives from its robust design. A stable, free-running 40 MHz power supply and high sensitivity sample introduction system ensure

sufficient and steady emission signals are introduced into the spectrometer. The autosampler provides reliability, flexibility and confidence in unattended operation.

The heart of the Prodigy is in its large format programmable array detector (LPAD) and an advanced high dispersion Echelle spectrometer. The high resolution and dispersion inherent in the design result in a compact optical system that offers outstanding low IEC values and long-term stability as shown above. The use of the LPAD detector allows all the analytes to be measured simultaneously and gives the largest dynamic range with true simultaneous background correction.

With software designed to automatically perform the necessary QC tasks, including spikes, duplicates and method of standards additions and excellent analytical performance, the Leeman Labs Prodigy ICP spectrometer represents an outstanding choice for compliance monitoring under U.S. EPA Method 200.7.