510(k) SUBSTANTIAL EQUIVALENCE DETERMINATION
DECISION SUMMARY
ASSAY AND INSTRUMENT COMBINATION TEMPLATE

A. 510(k) Number:

k160062

B. Purpose for Submission:

New device

C. Measurand:

Measurement of the following in urine samples: glucose, protein, bilirubin, urobilinogen, pH, blood, ketones, nitrite, leukocytes, and specific gravity.

D. Type of Test:

Qualitative and semi-quantitative urinalysis

E. Applicant:

Arkray, Inc.

F. Proprietary and Established Names:

AUTION ELEVEN Semi-Automated Urinalysis System

G. Regulatory Information:

1. Regulation section:

Name	Regulation	Product Code	Device Class
Urinary Glucose (non-quantitative) test system	21 CFR §862.1340	JIL	II
Occult blood test	21 CFR §864.6550	JIO	II
Urinary urobilinogen (non-quantitative) test system	21 CFR §862.1785	CDM	I
Urinary pH (non-quantitative) test	21 CFR §862.1550	CEN	I
Ketones (non-quantitative) test system	21 CFR §862.1435	JIN	I

Name	Regulation	Product Code	Device Class
Urinary protein or albumin (non-quantitative) test system	21 CFR §862.1645	JIR	I
Urinary bilirubin and its conjugates (non-quantitative) test system	21 CFR §862.1115	JJB	I
Nitrite (non-quantitative) test system	21 CFR §862.1510	JMT	I
Leukocyte peroxidase test	21 CFR §864.7675	LJX	I
Specific Gravity	21 CFR §862.2800	JRE	I
Automated Urinalysis System	21 CFR §862.2900	KQO	I

2. Panel:

   Chemistry (75)
   Hematology (81)

H. Intended Use:

1. Intended use(s):

   See indications for use statements below.

2. Indication(s) for use:

   The AUTION ELEVEN Semi-Automated Urinalysis System provides a qualitative and semi-quantitative measurements for glucose, protein, bilirubin, urobilinogen, pH, blood, ketones, nitrites, leukocytes, specific gravity and color tone in urine specimens. The system is intended for in vitro diagnostic use in screening patient populations found in clinical laboratories.

   The AUTION ELEVEN Semi-Automated Urinalysis System consists of the following:

   • AUTION ELEVEN model AE-4022 Urine Analyzer (device component)
   • AUTION Sticks 10EA Test Strips (reagent component)

3. Special conditions for use statement(s):

   For prescription use only.

4. Special instrument requirements:

   AUTION ELEVEN AE-4022 Semi-automatic Urine Analyzer

I. Device Description:

AUTION ELEVEN AE-4022 Semi-automatic Urine Analyzer

The AUTION ELEVEN AE-4022 Semi-automatic Urine Analyzer is a semi-automated urine chemistry analyzer intended for use with the AUTION Sticks 10EA multi-analyte test strips for the qualitative and semi-quantitative measurement of the following parameters: glucose, protein, bilirubin, urobilinogen, pH, blood, ketones, nitrites, leukocytes, specific gravity.

The instrument is intended for professional use as an in-vitro diagnostic screening test in clinical laboratories.

Provided with the analyzer are an AUTION Check Strip set. These are strips used as a quality control check of the instrument's reflectance measurement system. The check strip bottle contains two gray and two white check strips. For the QC measurement, one test strip of each type is used, and the results compared to pre-defined reflectance levels at four wavelengths.

A hand held barcode reader is optionally available with the instrument to enter a patient ID.

AUTION Sticks 10EA

The AUTION Sticks 10EA are multi-analyte test strips intended for use with the AUTION ELEVEN AE-4022 Semi-automatic Urine Analyzer. The test strips comprise a plastic strip with 10 reagent pads impregnated with chemistries specific for the determination of each analyte. The test strips are sold separately with 100 sticks per bottle.

J. Substantial Equivalence Information:

1. Predicate device name(s):

   AUTION MAX AX-4030 Urinalysis System

2. Predicate 510(k) number(s):

   k093098

3. Comparison with predicate:

Similarities		
Item	**Subject Device k160062 AUTION ELEVEN Semi-Automated Urinalysis System**	**Predicate Device k093098 AUTION MAX AX-4030 Urinalysis System**
Intended Use	Semi-automated urine chemistry analyzer for the *in vitro* measurement of urine chemistry analytes.	Same
Measurands	Glucose, Protein, Bilirubin, Urobilinogen, pH, Blood, Ketones, Nitrites, Leukocytes, Specific Gravity	Same
Sample Type	Human urine	Same
Data type	Qualitative and semi-quantitative	Same
Measurement principle	Reflectance	Same
Assay measurement wavelengths	Each assay is measured at two wavelengths from 565, 635, and 760 nm; except blood which is measured at 635 nm.	Same

Differences		
Item	**Subject Device k160062 AUTION ELEVEN Semi-Automated Urinalysis System**	**Predicate Device k093098 AUTION MAX AX-4030 Urinalysis System**
Test Strip	AUTION Sticks 10EA 10 pads for each analytes. Uses a blank pad for urine color correction.	AUTION Sticks 9EB 9 pads for each analytes, except for specific gravity which is measured by a refractive index method. Uses blank pad for urine color correction.
Assay reaction time, and control	60 seconds Audio alarm assisted, manual control	Same Automated

K. Standard/Guidance Document Referenced (if applicable):

- EC ISO 14971: 2007 second edition, Medical devices-Application of risk management to medical devices.

- Clinical and Laboratory Standards Institute.(2014). EP05-A3 Vol34 No.13 Evaluation of Precision of Quantitative Measurement Procedures.

- Clinical and Laboratory Standards Institute.(2003). EP06-A Evaluation of the Linearity of Quantitative Measurement Procedures: A Statistical Approach.

- Clinical and Laboratory Standards Institute.(2005). EP07-A2 Interference Testing Clinical Chemistry.

- Clinical and Laboratory Standards Institute.(2010). EP09-A2-JR Method Comparison and Bias Estimation Using Patient Samples.

- Clinical and Laboratory Standards Institute. (2009). GP-16-A2 21 No.19 Urinalysis; Approved Guideline – Third Edition.

- Clinical and Laboratory Standards Institute. (2012). EP17-A2 Vol32 No.8 Evaluation of Detection Capability for Clinical Laboratory Measurement Procedures; Approved Guideline- Second Edition.

L. Test Principle:

The AUTION ELEVEN AE-4022 Semi-automatic Urine Analyzer device uses combinations of 4 light emitting diodes to measure the reflectance of the reagent pads of the AUTION 10EA Stick test strips. Two wavelengths are used for the reflectance determination of each analyte, except blood which uses a single wavelength. The percent reflectance received by the optical sensor for each analyte on the test strip is then used to calculate a semi-quantitative value and a qualitative value.

The AUTION ELEVEN AE-4022 Semi-automatic Urine Analyzer also measures urine color tone. This is done by measuring the reflectance of a blank pad on the AUTION 10EA Stick. The concentration for each analyte is corrected for urine color tone, so that the urine color does not interfere with measurement.

Assay Principles of the AUTION 10EA Stick:

Glucose: Based on a double sequential enzyme reaction. Glucose oxidase catalyzes the formation of gluconic acid and hydrogen peroxide from the oxidation of glucose. A second enzyme, peroxidase, catalyzes the oxidative coupling of 4-amino-antipyrine and 1-Naphthol-3-6-disulfonic acid by hydrogen peroxide to form a Quinone imine purple color.

Protein: Based on the protein-error-of-indicators reaction. At a constant pH, the presence of protein causes a change in the color of the indicator to a cyan color.

Bilirubin: The test is based on azo-coupling reaction of bilirubin with diazotized 2-methyl-5- nitroaniline in acidic medium. Varying bilirubin levels will produce a reddish brown color.

Urobilinogen: The test is based on azo-coupling reaction of Urobilinogen with diazotized 3,3'-dimethyloxy-4,4'-biphenyl bis-diazonium tetrafluoroborate in acidic medium. Varying Urobilinogen levels will produce a reddish brown color.

pH: Based on a mixed indicator principle that gives a broad range of colors (yellow to cyan) covering the entire urinary pH range.

Specific Gravity: Cation extraction.

Blood: Based on the peroxidase-like activity of hemoglobin, which catalyzes the reaction of Cumene hydroperoxide and 3,3,5,5'- tetramethylbenzidine to form a cyan color.

Ketones: Legal reaction. Based on the reaction of sodium nitroprusside with acetoacetic acid to form a purple complex.

Nitrites: Griess reaction. Nitrite reacts with sulfanilamide, followed by a diazo-coupling reaction to from a pink colored product.

Leukocytes: Granulocytic leukocytes contain esterases that catalyze the hydrolysis of 3-(N-Toluenesulfonyl-L-alanyloxy) indole (TAI) to from indoxyl, which further reacts with 2-Methoxy-4-(N-morpholino) benzenediazonium (MMB) to form a purple product.

M. Performance Characteristics (if/when applicable):

1. Analytical performance:

   a. Precision/Reproducibility:

   Precision studies were conducted using the Semi-Automated Urinalysis System consisting of the AUTION ELEVEN AE-4022 Semi-Automatic Urine Analyzer and the AUTION Sticks 10EA. The studies were performed at three clinical laboratory sites. At each site, the precision study was conducted by one operator using one instrument and one lots of test strips. For the precision studies, three samples were tested in duplicate in each run, two runs per day for 20 days for a total of 80 replicates for each site.

   The samples were three levels of urine-based quality control material: negative, mid-level positive, and high-positive.

   Within run (repeatability) and total imprecision (reproducibility) were calculated.

The combined results for the three testing sites are summarized in the following tables:

Negative control:

Analyte	Expected result	REPEATABILITY (N=120)		REPRODUCIBILITY (N=240)	
		Exact Agreement (%)	Within +/- 1 block (%)	Exact Agreement (%)	Within +/- 1 block (%)
Glucose	NEG [-]	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Protein	NEG [-]	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Bilirubin	NEG [-]	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Urobilinogen	Normal	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
pH	5.0	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Blood	NEG [-]	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Ketones	NEG [-]	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Nitrite	NEG [-]	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Leukocytes	NEG [-]	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Specific Gravity	< 1.005	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)

Mid-level positive control:

Analyte	Expected result	REPEATABILITY (N=120)		REPRODUCIBILITY (N=240)	
		Exact Agreement (%)	Within +/- 1 block (%)	Exact Agreement (%)	Within +/- 1 block (%)
Glucose	2+	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Protein	1+	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Bilirubin	2+	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Urobilinogen	2+	98% (118/120)	100% (120/120)	99% (240/240)	100% (240/240)

Analyte	Expected result	REPEATABILITY (N=120)		REPRODUCIBILITY (N=240)	
		Exact Agreement (%)	Within +/- 1 block (%)	Exact Agreement (%)	Within +/- 1 block (%)
pH	7.0	95% (114/120)	100% (120/120)	97% (233/240)	100% (240/240)
Blood	2+	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Ketones	2+	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Nitrite	2+	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Leukocytes	500 Leu/µL	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Specific Gravity	1.020	98% (118/120)	100% (120/120)	99% (238/240)	100% (240/240)

High-positive control:

Analyte	Expected result	REPEATABILITY (N=120)		REPRODUCIBILITY (N=240)	
		Exact Agreement (%)	Within +/- 1 block (%)	Exact Agreement (%)	Within +/- 1 block (%)
Glucose	3+	93% (112/120)	100% (120/120)	97% (232/240)	100% (240/240)
Protein	3+	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Bilirubin	4+	96% (115/120)	100% (120/120)	98% (235/240)	100% (240/240)
Urobilinogen	4+	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
pH	8.0	98% (118/120)	100% (120/120)	99% (238/240)	100% (240/240)
Blood	3+	98% (118/120)	100% (120/120)	99% (238/240)	100% (240/240)
Ketones	4+	88% (106/120)	100% (120/120)	94% (226/240)	100% (240/240)
Nitrite	2+	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Leukocytes	500 Leu/µL	100% (120/120)	100% (120/120)	100% (240/240)	100% (240/240)
Specific Gravity	1.025	88% (106/120)	100% (120/120)	91% (218/240)	100% (240/240)

b. Linearity/assay reportable range:

A study was conducted to evaluate the reportable range for each analyte of the AUTION ELEVEN Semi-Automated Urinalysis System. The reportable range was evaluated by measuring samples with known concentrations of each analyte covering all measurement color block ranks.

Samples were measured using 3 lots of test strips in replicates of 7 for a total of 21 measurements per sample. The results are summarized below:

Analyte	Level (mg/dL)	Exact match	±1 color block match
Glucose	0 (-)	100% (21/21)	100% (21/21)
	45 (±)	90.5% (19/21)	100% (21/21)
	85 (1+)	100% (21/21)	100% (21/21)
	170 (2+)	100% (21/21)	100% (21/21)
	340 (3+)	100% (21/21)	100% (21/21)
	2700 (4+)	100% (21/21)	100% (21/21)

Analyte	Level (mg/dL)	Exact match	±1 color block match
Protein	0 (-)	100% (21/21)	100% (21/21)
	15 (±)	100% (21/21)	100% (21/21)
	30 (1+)	100% (21/21)	100% (21/21)
	120 (2+)	100% (21/21)	100% (21/21)
	480 (3+)	100% (21/21)	100% (21/21)
	1000 (4+)	100% (21/21)	100% (21/21)

Analyte	Level (mg/dL)	Exact match	±1 color block match
Bilirubin	0 (-)	100% (21/21)	100% (21/21)
	1.5 (1+)	100% (21/21)	100% (21/21)
	3 (2+)	100% (21/21)	100% (21/21)
	6 (3+)	100% (21/21)	100% (21/21)
	12 (4+)	100% (21/21)	100% (21/21)

Analyte	Level (mg/dL)	Exact match	±1 color block match
Urobilinogen	Normal	100% (21/21)	100% (21/21)
	3 (1+)	100% (21/21)	100% (21/21)
	5 (2+)	100% (21/21)	100% (21/21)
	10 (3+)	95.2% (20/21)	100% (21/21)
	20 (4+)	100% (21/21)	100% (21/21)

Analyte	Level	Exact match	±1 color block match
pH	5.0	100% (21/21)	100% (21/21)
	5.5	100% (21/21)	100% (21/21)
	6.0	100% (21/21)	100% (21/21)
	6.5	100% (21/21)	100% (21/21)
	7.0	95.2% (20/21)	100% (21/21)
	7.5	100% (21/21)	100% (21/21)
	8.0	100% (21/21)	100% (21/21)
	8.4	95.2% (20/21)	100% (21/21)
	9.0	100% (21/21)	100% (21/21)

Analyte	Level	Exact match	±1 color block match
Specific gravity	1.005	100% (21/21)	100% (21/21)
	1.010	100% (21/21)	100% (21/21)
	1.015	95.2% (20/21)	100% (21/21)
	1.020	90.5% (19/21)	100% (21/21)
	1.025	100% (21/21)	100% (21/21)
	1.030	100% (21/21)	100% (21/21)

Analyte	Level (mg/dL)	Exact match	±1 color block match
Blood	0 (-)	100% (21/21)	100% (21/21)
	0.03(±)	100% (21/21)	100% (21/21)
	0.08 (1+)	100% (21/21)	100% (21/21)
	0.6 (2+)	95.2% (20/21)	100% (21/21)
	1.3 (3+)	100% (21/21)	100% (21/21)

Analyte	Level (mg/dL)	Exact match	±1 color block match
Ketone	0 (-)	100% (21/21)	100% (21/21)
	5 (±)	100% (21/21)	100% (21/21)
	15 (1+)	100% (21/21)	100% (21/21)
	60 (2+)	100% (21/21)	100% (21/21)
	120 (3+)	90.5% (19/21)	100% (21/21)
	240 (4+)	100% (21/21)	100% (21/21)

Analyte	Level (mg/dL)	Exact match	±1 color block match
Nitrite	0 (-)	100% (21/21)	100% (21/21)
	0.1 (1+)	100% (21/21)	100% (21/21)
	0.8 (2+)	100% (21/21)	100% (21/21)

Analyte	Level (Leu/µL)	Exact match	±1 color block match
Leukocyte	0 (-)	100% (21/21)	100% (21/21)
	25	100% (21/21)	100% (21/21)
	75	95.2% (20/21)	100% (21/21)
	250	100% (21/21)	100% (21/21)
	520	100% (21/21)	100% (21/21)

The reportable ranges of each analyte of the AUTION ELEVEN Semi-Automated Urinalysis System are summarized below:

Analyte	Reportable range
Glucose	Qualitative: negative to 4+ Semi-quantitative: negative to 1000 mg/dL
Protein	Qualitative: negative to 4+ Semi-quantitative: negative to 1000 mg/dL
Bilirubin	Qualitative: negative to 4+ Semi-quantitative: negative to 14 mg/dL
Urobilinogen	Qualitative: normal to 4+ Semi-quantitative: normal to 16 mg/dL
Blood	Qualitative: negative to 3+ Semi-quantitative: negative to 1.0 mg/dL
Ketones	Qualitative: negative to 4+ Semi-quantitative: negative to 150 mg/dL
Nitrite	Qualitative: negative to 2+
pH	Measured value: 5.0 to 9.0
Specific gravity	Measured value: <1.005 - >1.030
Leukocytes	Semi-quantitative: negative to 500 mg/dL

c. *Traceability, Stability, Expected values (controls, calibrators, or methods):*

Traceability:

Each assay of the AUTION ELEVEN Semi-Automated Urinalysis System is traceable to the following standards:

Analyte	Reference Method	Standardization
Glucose	GOD electrometry	D-Glucose
Protein	Pyrogallol red method	Human albumin
Bilirubin	Shibata method *Zn- Azobilirubin method	Bilirubin IV
Urobilinogen	Watson method	Phenolsulfon-phthalein
pH	pH Meter	Calibrator
Specific Gravity	Refractometer	Sodium chloride
Blood	Reference material gravimetry	Human hemoglobin
Ketones	Reference material gravimetry	Lithium acetoacetate
Nitrite	Reference material gravimetry	Sodium nitrite
Leukocyte	Fuchs rosenthal counting	Human leukocytes

Shelf life stability of AUTION Sticks 10EA:

Stability studies were performed to assess the shelf life (closed bottle) stability for the AUTION Stick 10EA urine strips used on the AUTION ELEVEN AE-4022 Semi-automatic Urine Analyzer. The protocol and acceptance criteria were reviewed and found sufficient. The stability studies supports the claim that AUTION Sticks 10EA, unopened, are stable for 2 years from date of manufacture when stored within temperature range of 34 to 86°F.

Open bottle stability of AUTION Sticks 10EA:

Open bottle stability studies were performed on the AUTION Stick 10EA urine strips used on the AUTION ELEVEN AE-4022 Semi-automatic Urine Analyzer. The protocol and acceptance criteria were reviewed and found sufficient. Based on the studies, once opened, the test strips are stable for 31 days when stored from 34 to 86 °F.

Transport (High Temperature) stability for AUTION Sticks 10EA:

High temperature stability studies were performed on the AUTION Stick 10EA urine strips to establish stability performance at high temperatures that may be experienced during product shipment. The protocol and acceptance criteria were reviewed and found sufficient. Based on the studies, the test sticks may be stored or transported in closed bottle containers at a temperature up to 50°C for 1 week without deterioration.

d. Detection limit:

Study 1: A detection limit study was conducted on each analyte of the AUTION ELEVEN Semi-Automated Urinalysis System to determine the concentration which changed the rank measurement block from negative to the next level rank measurement block (rank 1 to rank 2).

Samples were prepared by spiking analyte into negative pooled urine. Each pool was spiked with the target analyte concentration, plus a concentration on each side of the target in order to determine the sensitivity concentration. Each samples was analyzed in replicates of 5 using 3 strip lots, for a total of n=30 results. The analytical sensitivity for each rank measurement color block is defined as the lowest concentration at which ≥50% of the test results are positive between the negative color block, and the first positive (1+) or trace (±) color block. The results are summarized in the following table:

Analyte	Sensitivity	% Sensitivity
Glucose	30 mg/dL	100
Protein	10 mg/dL	100
Bilirubin	0.5 mg/dL	50
Urobilinogen	2 mg/dL	100
Blood	0.023 mg/dL	100
Ketones	3 mg/dL	73
Nitrites	0.08 mg/dL	50
Leukocytes	25 Leu/uL	100

Study 2: A sensitivity study was conducted to demonstrate the cut-off concentration between the qualitative measurement blocks for each analyte of the AUTION Stick 10EA. The low cut-off concentration for each measurement block is defined as the lowest concentration at which ≥ 50% of the test results are positive for the greater color block. Samples were prepared by spiking analyte into negative pooled urine pool. Each pool was spiked with the target analyte concentration. Additionally, a sample was prepared at a slightly lower concentration than the target concentration. Each sample was created twice, using 2 urine pools, and tested in replicates of 5 on each pool. Each urine pool was tested with 3 lots of reagent strips for a total of 30 replicates per sample.

The low cut-off concentrations for each qualitative measurement rank of each analyte are summarized in the table below.

Glucose		
Block output	Low concentration cut-off (mg/dL)	Sensitivity
1+	60	100%
2+	125	100%
3+	250	100%
4+	750	87%

Protein		
Block output	Low concentration cut-off (mg/dL)	Sensitivity
1+	25	63%
2+	85	100%
3+	250	100%
4+	800	97%

Bilirubin		
Block output	Low concentration cut-off (mg/dL)	Sensitivity
2+	1.9	53%
3+	5.3	87%
4+	12	100%

Urobilinogen		
Block output	Low concentration cut-off (mg/dL)	Sensitivity
2+	3.5	50%
3+	6.5	100%
4+	14	100%

pH		
Block output	Low cut-off	Sensitivity
5.5	5.3	100%
6.0	5.8	100%
6.5	6.3	87%
7.0	6.8	100%
7.5	7.3	87%
8.0	7.8	97%
8.5	8.3	50%
9.0	8.9	50%

Specific Gravity		
Block output	Low cut-off	Sensitivity
1.010	1.008	53%
1.015	1.013	100%
1.020	1.019	100%
1.025	1.023	97%
1.030	1.028	83%

Blood		
Block output	Low concentration cut-off (mg/dL)	Sensitivity
1+	0.05	97%
2+	0.18	87%
3+	0.9	50%

Ketones		
Block output	Low concentration cut-off (mg/dL)	Sensitivity
1+	7.5	100%
2+	30	100%
3+	70	87%
4+	130	100%

Nitrites		
Block output	Low concentration cut-off (mg/dL)	Sensitivity
2+	0.3	100%

Leukocytes		
Block output	Low concentration cut-off (Leukocytes/µL)	Sensitivity
75	50	100%
250	180	100%
500	390	87%

e. *Analytical specificity:*

Analytical specificity studies were performed to assess the interfering effect of various substances to the AUTION ELEVEN Semi-Automated Urinalysis System.

Urine samples were prepared at one concentration for each analyte. A high positive sample was prepared by spiking each analyte into pooled negative urine. The sample pools were spiked with potential interfering substances at the concentrations listed below:

	Concentrations tested			
Substance	**Low**	**Middle**	**Positive**	**Units**
Acetoacetate	60	-	150	mg/dL
Albumin	300	-	1000	mg/dL
Ammonium chloride	100	-	400	mg/dL
Ascorbic acid	50	-	200	mg/dL

	Concentrations tested			
Substance	**Low**	**Middle**	**Positive**	**Units**
Bilirubin	4	-	16	mg/dL
Calcium chloride	40	-	160	mg/dL
Citric acid	65	-	130	mg/dL
Creatinine	300	-	600	mg/dL
Fructose	100	-	300	mg/dL
Galactose	100	-	300	mg/dL
Glucose	200	500	2000	mg/dL
Glycine	450	-	900	mg/dL
Hemoglobin	0.3	-	50	mg/dL
Potassium chloride	500	-	1000	mg/dL
Lactose	100	-	300	mg/dL
MESNA	50	-	200	mg/dL
Sodium chloride	1000	-	2000	mg/dL
Oxalic acid	20	-	70	mg/dL
pH (Citric acid) pH (Sodium phosphate)	3, 4, 8, 9			n/a
Phenolphthalein	2	-	10	mg/dL
Riboflavin	2	-	5	mg/dL
Sodium acetate	300	-	1200	mg/dL
Sodium bicarbonate	500	-	1000	mg/dL
Sodium nitrate	0.5	-	10	mg/dL
Sodium nitrite	0.5	-	2	mg/dL
Sodium phosphate	500	-	1000	mg/dL
Specific gravity (Sucrose)	1.010	-	1.030	n/a
Tetracycline	20	-	100	mg/dL
Urea	1000	-	3000	mg/dL

Each sample was measured on the instrument in replicates of 5. The mean reflectance was calculated for each sample type. To assess whether a substance caused significant interference, the %reflectance from samples with no interfering substance was compared against the mean %reflectance of the sample spiked with the interfering substance. Interference was determined based on the acceptance criteria stated below:

Negative Samples: If mean values are 1+ (75 for Leukocytes) or greater, interference is considered positive.

For pH and Specific gravity: If mean value is greater than +/-1 rank, there is significant interference.

Positive Samples: If sample results differ by greater than +/- 1 color block between samples containing the interfering substance and samples without it, interference will be considered positive.

Additional testing was conducted on certain substances that showed significant interference at the highest level. The concentration of the interferent reduced until, the rank measurement block change was with +/- 1. This is given in the table below:

Analyte	Substance	Concentrations
Glucose	Ascorbic acid	0, 50, 100 mg/dL
Protein	Hemoglobin	0, 20, 30 mg/dL
Specific gravity	Ammonium chloride	0, 200, 300 mg/dL
pH 8	Ascorbic acid	0, 100, 300 mg/dL
pH 8	Calcium chloride	0, 100, 130 mg/dL
Urobilinogen	Bilirubin	2, 3, 4 mg/dL
Ketones	MESNA	5, 20, 30, 40, 50, 60 mg/dL
Bilirubin	Urobilinogen	4, 8, 16, 32 mg/dL

Based on the results of this testing the substance listed in the table below were found to significantly interfere.

Analyte	Substances causing false negative	Substances causing false positive
Glucose	Ascorbic acid (> 50 mg/dL)	< pH 4
Protein		Hemoglobin (> 20 mg/dL)
Bilirubin		Urobilinogen (> 8 mg/dL)
Urobilinogen		Bilirubin (> 3 mg/dL)
pH		
Specific gravity		Albumin (> 300 mg/dL); Ammonium chloride (> 200 mg/dL); < pH 4
Blood	MESNA (> 50 mg/dL)	
Ketones		MESNA (> 5 mg/dL)
Nitrite		
Leukocytes	Albumin (> 300 mg/dL); Glucose (> 200 mg/dL); < pH 4	

Concentrations of the potentially interfering substances that will not have influence on the test results are shown below:

Substance	Highest Concentration not affecting the test (mg/dL)
Acetoacetate	150
Albumin	300
Ammonium chloride	100
Ascorbic acid	50
Bilirubin	3

Substance	Highest Concentration not affecting the test (mg/dL)
Calcium chloride	160, except pH
Citric acid	130, except pH
Creatinine	600
Fructose	300
Galactose	300
Glucose	200
Glycine	900
Hemoglobin	20
Potassium chloride	1000
Lactose	300
MESNA	5
Sodium chloride	1000
Oxalic acid	20
Phenolphthalein	10
Riboflavin	5
Sodium acetate	1200
Sodium bicarbonate	1000, except pH
Sodium nitrate	10
Sodium nitrite	2
Sodium phosphate	1000, except pH
Tetracycline	100
Urea	3000

The labeling includes a list of the interfering substance and statement as shown below:

Analyte	Interferent	Concentration	Result
Glucose	Ascorbic acid	> 50 mg/dL	False negative (-2 to -3 color block change)
	pH	< pH 4	False positive (+2 color block change)
Protein	Hemoglobin	> 20 mg/dL	False positive (+2 color block change)
Bilirubin	Urobilinogen	> 8 mg/dL	False positive (+1 color block change)
Urobilinogen	Bilirubin	> 3 mg/dL	False positive (+1 color block change)
pH			
Specific gravity	pH	< pH 4	Elevated (+2 color block change)
	Albumin	> 300 mg/dL	Elevated (+2 color block change)
	Ammonium	> 200 mg/dL	Elevated

Analyte	Interferent	Concentration	Result
	chloride		(+2 color block change)
Blood	Substance that contain MESNA	> 50 mg/dL	False negative (-2 color block change)
Ketones	Substance that contain MESNA	> 5 mg/dL	False positive (+2 to +5 color block change)
Nitrite			
Leukocytes	Glucose	> 200 mg/dL	False negative (-2 color block change)
	Albumin	> 300 mg/dL	False negative (-2 color block change)
	pH	< pH 4	False negative (-2 color block change)

The effect of pH

The following tests were found to be affected by pH of 3 of lower: Glucose, Specific gravity, and Leukocytes.

The effect of Specific gravity

No interference was found on the analytes due to urine specific gravity using sucrose as additive to change specific gravity.

Color tone detection and correction

A study was conducted to verify that the system is insensitive to interference from red, brown, orange and green colored urine samples.

The samples were two levels of commercial control material (negative and high-positive); ThermoScientific MAS Controls 1 and 2. To the samples were spiked dyes to create the colors of red, orange, brown, and green. For reference, the control materials were spiked with water. No significant effect on color on the results was if the sample with added dye read with +/- 1 rank measurement block.

Based on the results, is no interference on measurement results due to variations in sample color tone.

Results for Low control:

Analyte	Reference	Red	Brown	Orange	Green
Glucose	negative	negative	negative	negative	negative
Protein	negative	negative	negative	negative	negative
Bilirubin	negative	negative	negative	negative	negative
Urobilinogen	2+	1+	2+	2+	2+
pH	8.0	8.0	8.0	8.0	7.5
Specific gravity	<1.005	<1.005	<1.005	<1.005	1.010

Blood	negative	negative	negative	negative	negative
Ketones	2+	2+	2+	2+	2+
Nitrite	negative	negative	negative	negative	negative
Leukocytes	500	250	250	250	250
Color	yellow	red	brown	orange	light green

Results for High control:

Analyte	**Reference**	**Red**	**Brown**	**Orange**	**Green**
Glucose	2+	2+	2+	2+	2+
Protein	2+	2+	2+	2+	2+
Bilirubin	2+	2+	2+	2+	2+
Urobilinogen	normal	normal	normal	normal	normal
pH	6.5	6.5	6.5	6.5	6.0
Specific gravity	1.020	1.020	1.020	1.020	1.020
Blood	1+	1+	1+	1+	1+
Ketones	negative	negative	negative	negative	negative
Nitrite	2+	1+	2+	2+	2+
Leukocytes	negative	negative	negative	negative	negative
Color	Dark yellow	red	brown	orange	green

f. Assay cut-off:

Not applicable.

2. Comparison studies:

a. Method comparison with predicate device:

Method comparison studies were conducted to evaluate the performance of the AUTION ELEVEN Semi-Automated Urinalysis System for the measurement of urine chemistry analytes. Results were compared to those from the predicate AUTION MAX AX-4030 Automated Urine Analyzer for all analytes except Specific Gravity. The AUTION JET AJ-4270 Urine Analyzer (k030600) was the comparator method for specific gravity.

Testing was performed at multiple sites by at least4 operators and using at least 4 instruments, and 3 different lots of test sticks. The urine samples for analysis were provided by either local hospitals or each site's internal clinical laboratory. Specimens were single daily urine. These were refrigerated at 2-8°C within 2 hours of collection, and tested within 24 hours of collection. For testing, the samples were allowed to warm to room temperature (10 to 30°C) for 30 minutes, and were tested within 2 hours. In order to obtain the necessary range in concentration for each analyte, a small number of the samples were prepared by spiking analyte into urine. These samples constituted no more than 7% of the total.

The data from each site was combined and are presented in concordance charts showing percentage of exact agreement and percentage agreement within ±1 color block agreement, as shown in the following tables.

Glucose		REFERENCE: AX-4030					
		neg	±	1+	2+	3+	4+
AE-4022	neg	1845	4	0	0	0	0
	±	4	69	8	0	0	0
	1+	0	0	35	8	0	0
	2+	0	0	1	45	2	0
	3+	0	0	0	4	54	8
	4+	0	0	0	0	4	108
	total	1849	73	44	57	60	116
exact match		99.8%	94.5%	79.6%	78.9%	90.0%	93.1%
within ±1 color block		100%	100%	100%	100%	100%	100%
Overall exact agreement = 98.0% Within +/- 1 block agreement = 100%							

Protein		REFERENCE: AX-4030					
		neg	±	1+	2+	3+	4+
AE-4022	neg	222	9	0	0	0	0
	±	24	118	11	0	0	0
	1+	0	13	98	3	0	0
	2+	0	0	9	27	2	0
	3+	0	0	0	3	11	0
	4+	0	0	0	0	3	10
	total	246	140	118	33	16	10
exact match		90.2%	84.3%	83.0%	81.8%	68.8%	100%
within ±1 color block		100%	100%	100%	100%	100%	100%
Overall exact agreement = 86% Within +/- 1 block agreement = 100%							

Bilirubin		REFERENCE: AX-4030				
		neg	1+	2+	3+	4+
AE-4022	neg	2125	0	0	0	0
	1+	8	53	1	0	0
	2+	0	0	56	0	0
	3+	0	0	0	40	0
	4+	0	0	0	3	37
	total	2133	53	57	43	37
exact match		99.6%	100%	98.2%	93.0%	100%
within ±1 color block		100%	100%	100%	100%	100%
Overall exact agreement = 99.5% Within +/- 1 block agreement = 100%						

Urobilinogen		REFERENCE: AX-4030				
		normal	1+	2+	3+	4+
AE-4022	normal	2009	7	0	0	0
	1+	13	126	1	0	0
	2+	0	13	60	0	0
	3+	0	3	3	37	0
	4+	0	0	0	4	35
	total	2022	146	64	41	35
exact match		99.4%	86.3%	93.8%	90.2%	100%
within ±1 color block		100%	100%	100%	100%	100%
Overall exact agreement = 98.2% Within +/- 1 block agreement = 100%						

pH		REFERENCE: AX-4030								
		5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0
AE-4022	5.0	289	8	0	0	0	0	0	0	0
	5.5	30	514	9	0	0	0	0	0	0
	6.0	0	44	424	6	0	0	0	0	0
	6.5	0	0	63	382	10	0	0	0	0
	7.0	0	0	0	12	216	13	0	0	0
	7.5	0	0	0	0	10	93	5	0	0
	8.0	0	0	0	0	0	18	69	4	0
	8.5	0	0	0	0	0	0	3	38	0
	9.0	0	0	0	0	0	0	0	14	33
	total	319	566	496	400	236	124	77	56	33
exact match		91%	91%	86%	96%	92%	75%	90%	69%	100%
within ±1 color block		100%	100%	100%	100%	100%	100%	100%	100%	100%
Overall exact agreement = 89.2% Within +/- 1 block agreement = 100%										

Specific Gravity		REFERENCE: AJ-4270					
		<1.005	1.010	1.015	1.020	1.025	>1.030
AE-4022	<1.005	101	5	2	0	0	0
	1.010	13	26	13	1	0	0
	1.015	0	12	77	31	0	0
	1.020	0	0	4	102	1	0
	1.025	0	0	0	11	77	0
	1.030	0	0	0	0	9	63
	total	114	43	96	145	87	63
exact match		89%	60%	80%	70%	89%	100%
within ±1 color block		100%	100%	98%	99%	100%	100%
Overall exact agreement = 81% Within +/- 1 block agreement = 99%							

Blood		REFERENCE: AX-4030				
		neg	1+	2+	3+	4+
AE-4022	Neg	289	7	0	0	0
	1+	9	48	3	0	0
	2+	2	4	52	1	0
	3+	0	0	7	42	1
	4+	0	0	0	11	72
	total	300	59	62	54	73
exact match		96.3%	81.4%	83.9%	77.8%	98.6%
within ±1 color block		99.3%	100%	100%	100%	100%
Overall exact agreement = 92% Within +/- 1 block agreement =100%						

Ketones		REFERENCE: AX-4030					
		neg	±	1+	2+	3+	4+
AE-4022	neg	1584	14	0	0	0	0
	±	26	151	12	0	0	0
	1+	0	10	219	13	0	0
	2+	0	0	1	101	8	0
	3+	0	0	0	0	46	4
	4+	0	0	0	0	0	32
	total	1610	175	232	114	54	36
exact match		98.4%	86.3%	94.4%	88.6%	85.2%	88.9%
within ±1 color block		100%	100%	100%	100%	100%	100%
Overall exact agreement = 96.0% Within +/- 1 block agreement = 100%							

Nitrites		REFERENCE: AX-4030		
		neg	1+	2+
AE-4022	neg	2058	0	0
	1+	12	44	0
	2+	0	3	92
	total	2070	47	92
exact match		99.4%	93.6%	100%
within ±1 color block		100%	100%	100%
Overall exact agreement = 99.3% Within +/- 1 block agreement = 100%				

Leukocytes		REFERENCE: AX-4030				
		neg	25	75	250	500
AE-4022	Neg	318	5	0	0	0
	25	9	34	5	0	0
	75	1	5	37	3	0
	250	0	0	9	48	1
	500	0	0	0	8	65
	total	328	44	51	59	66
exact match		96.9%	77.3%	72.6%	81.4%	98.5%
within ±1 color block		100%	100%	100%	100%	100%
Overall exact agreement = 92% Within +/- 1 block agreement = 100%						

b. Matrix comparison:

Not applicable. This device is for testing with human urine only.

3. Clinical studies:

a. Clinical Sensitivity:

Not applicable.

b. Clinical specificity:

Not applicable.

c. Other clinical supportive data (when a. and b. are not applicable):

Not applicable.

4. Clinical cut-off:

Not applicable.

5. Expected values/Reference range:

Reference ranges:

Analyte	Expected Value
Glucose	Negative
Protein	Negative or trace
Bilirubin	Negative
Urobilinogen	0.2-1mg/dL
pH	4.6-8.0

Blood	Negative
Ketones	Negative
Nitrite	Negative
Leukocytes	Negative
Specific Gravity	1.001-1.035

Literature references are provided to support the stated reference ranges.

1. Brunzel, N.A. Fundamentals of Urine and Body Fluid Analysis. 2nd ed. Philadelphia: Saunders. 2004.
2. Free, A. H., et al. Clinical Chemistry, 1957; 3: 716
3. Henry, J.B. et al. Clinical Diagnosis and Management of Laboratory Methods, 21st ed. Philadelphia: Saunders; 2007.
4. Tietz Fundamentals of Clinical Chemistry, 4th ed. Philadelphia: Saunders. 1996.

N. Instrument Name:

AUTION ELEVEN AE-4022 Semi-automatic Urine Analyzer

O. System Descriptions:

1. Modes of Operation:

   Does the applicant's device contain the ability to transmit data to a computer, webserver, or mobile device?

   Yes ____X___ or No _____

   Does the applicant's device transmit data to a computer, webserver, or mobile device using wireless transmission?

   Yes _____ or No ___X_____

2. Software:

   FDA has reviewed applicant's Hazard Analysis and software development processes for this line of product types:

   Yes ___X____ or No _____

3. Specimen Identification:

   A patient ID is entered either manually using the keypad or scanned using the barcode reader.

4. Specimen Sampling and Handling:

   The AUTION ELEVEN AE-4022 Semi-automatic Urine Analyzer requires the user to dip an AUTION Stick 10EA test strip into a patient urine specimen of sufficient volume. The user then removes the strip and excess urine, and places the test trip onto the instrument. The remaining operations of the test are carried out automatically. The test strip feeding mechanism transports the test strip to the photometric section of the instrument. After 60 seconds to allow for the analyte reacting with the reagent chemistries, the instrument measures each pad's reflectance, and converts the reflectance to a qualitative and semi-quantitative result.

5. Calibration:

   Calibration of the AUTION Sticks 10EA by the user is not required.

6. Quality Control:

   Use of control material is recommended in labeling. Controls should be run: 1) daily, 2) whenever a new bottle of test sticks is opened, 3) before reporting unusual results, and 4) when training new operators.

   Control material is not provided with the system. Instead, user manual recommends use of commercially available control material.

P. Other Supportive Instrument Performance Characteristics Data Not Covered In The "Performance Characteristics" Section above:

1. Temperature and Humidity Study:

   Temperature and humidity operating conditions of the analyzer were evaluated at temperatures ranging from 8 to 32ºC and relative humidity from 28% to 62%. The conditions included combinations of the lowest humidity and highest temperature. The results support the sponsor's claimed operating temperature for the AUTION ELEVEN AE-4022 Semi-automatic Urine Analyzer of 10 to 30ºC with relative humidity ranging from 30% to 60%.

2. EMC:

   Sponsor provided test reports from independent testing firm demonstrating compliance with the following EMC standards:

   UL 61010-1: Electrical Equipment For Measurement, Control, and Laboratory Use; Part 1: General Requirements.

   IEC 61010-2-101: Safety requirements for electrical equipment for measurement, control and laboratory use - Part 2-101: Particular requirements for in vitro diagnostic

(IVD) medical equipment.

CAN/CSA 61010-1-04: Safety Requirements for Electrical Equipment For Measurement, Control, and Laboratory Use; Part 1: General Requirements.

IEC 61010-2-081: Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 2-081: Particular requirements for automatic and semi-automatic laboratory equipment for analysis and other purposes.

FCC Part 15 Radio Frequency Device Subpart B Unintentional Radiators.

Operating mode: During testing, an exercise program was used to run the instrument (included the barcode reader) in a manner similar to typical use.

3. Software:

The software documentation was reviewed and found to be acceptable. The sponsor provided documentation to support that the device was designed, developed and is under good software lifecycle processes.

4. Barcode reader

A hand held barcode reader is optionally available with the AUTION ELEVEN AE-4022 Semi-automatic Urine Analyzer for entering patient IDs. The functional performance of the barcode reader was verified against the design specifications. The manual input of patient ID was compared for data integrity to a scanned barcode input across 5 different test ID's, and across two different field formats; (1) full 13 numeric characters and (2) 10 numeric characters starting at the second numeric character. The verification test demonstrated that the bar code reader operates as intended to the design specifications.

5. Color tone measurement

The AUTION ELEVEN AE-4022 Semi-automatic Urine Analyzer measures 23 urine color tones. This is done by measuring the reflectance of a blank pad on the AUTION 10EA Stick. The concentration for each analyte is corrected for urine color tone.

Studies were conducted to verify that the system is able to detect a broad range in colors. Because the occurrence of patient samples covering the 23 possible color tones is rare, the samples used in the testing were urine spiked with dyes. Each of 23 different colored samples (yellow, red, green, blue, violet, orange, brown with hues of dark, normal, light) was manually dispensed onto a test strip pad. The reflectance was read and transformed into a color measurement. These results were compared to a visual read. All colors were detected.

Q. Proposed Labeling:

The labeling is sufficient and it satisfies the requirements of 21 CFR Part 809.10.

R. Conclusion:

The submitted information in this premarket notification is complete and supports a substantial equivalence decision.