

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

A. 510(k) Number:

k173797

B. Purpose for Submission:

New device

C. Measurands:

pCO₂, pO₂ and pH

D. Type of Test:

pH and pCO₂ – quantitative, potentiometry
pO₂ – quantitative, amperometric

E. Applicant:

Nova Biomedical Corporation

F. Proprietary and Established Names:

Stat Profile Prime Plus Analyzer System

G. Regulatory Information:

Regulation section	Classification	Product code	Panel
21 CFR § 862.1120 Blood gases (pCO ₂ , pO ₂) and blood pH test system	Class II	CHL	Clinical Chemistry (75)

H. Intended Use:

1. Intended use(s):

See Indication(s) for Use below

2. Indication(s) for use:

The Stat Profile Prime Plus Analyzer System is intended for use by healthcare professionals in clinical laboratory settings for quantitative determination of pH, partial pressure of carbon dioxide (pCO₂), and partial pressure of oxygen (pO₂) in heparinized arterial and venous whole blood.

pH, pCO₂, pO₂ - Measurements are used in the diagnosis and treatment of life-threatening acid base disturbances.

3. Special conditions for use statement(s):

Not for point of care use.

4. Special instrument requirements:

Stat Profile Prime Plus Analyzer System

I. Device Description:

The Stat Profile Prime Plus Analyzer System is designed to be used in clinical laboratory settings. It consists of the analyzer, sensor cartridges, calibrator packs, auto-cartridge quality control packs (internal controls), ampuled quality control materials (external controls) and thermal paper for an onboard printer. Specimens may be identified by scanning a barcode or by manually entering the information via the touchscreen.

The Stat Profile Prime Plus Analyzer has slots to accommodate two sensor cartridges (Primary and Auxiliary). The analyzer will determine the configuration of the system by detecting which sensor cards are installed. The reporting of CO-Oximeter parameters (or not reporting them) will also be determined by the selection of the Sensor Cards, for which there are two options:

- Primary Sensor Card 1 reports the following analytes: pO₂, pCO₂, pH, Hct, tHb, Na, Cl, K, iCa, iMg, Glu, SO₂, O₂Hb, COHb, MetHb, HHb, tBil, HbF
- Primary Sensor Card 2 reports the following analytes: pO₂, pCO₂, pH, Hct, tHb, Na, Cl, K, iCa, iMg, Glu, SO₂

J. Substantial Equivalence Information:

1. Predicate device name(s):

Nova Biomedical Stat Profile pHox Ultra Analyzer System

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

k110648

3. Comparison with predicate:

Similarities		
Item	Candidate Device - Stat Profile Prime Plus Analyzer (k173797)	Predicate Device - Nova Biomedical Stat Profile pHox Ultra Analyzer (k110648)
Indications for Use	For use by healthcare professionals in clinical laboratory settings for quantitative determination of pH, partial pressure of carbon dioxide, and partial pressure of oxygen in heparinized arterial and venous whole blood.	Same
Measuring Range – pH	6.500 – 8.000	Same
Measuring Range – pCO ₂	3.0 to 200.0 mm Hg	Same
Measurement Principle – pH	Hydrogen ion-selective glass sensor	Same
Measurement Principle – pCO ₂	Severinghaus-type sensor	Same
Measurement Principle – pO ₂	Polarographic Clark-type sensor	Same
Touch Screen	Yes	Same

Differences		
Item	Candidate Device - Stat Profile Prime Plus Analyzer (k173797)	Predicate Device - Stat Profile pHox Ultra Analyzer (k110648)
Acceptable sample types	Lithium heparin whole blood from syringes, open tubes, small cups, and capillary tubes.	Sodium or lithium heparinized whole blood, serum, or plasma samples from syringes, open tubes, small cups, and capillary tubes.
Sample Volume	135µL	60 – 200 µL (dependent on panel selected)
Measuring Range – PO ₂	5.0 – 765 mm Hg	0 – 800 mm Hg

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

- IEC 61010-1:2010 Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: Gen. reqmnts.
- IEC 61010-2-101:2015 - Particular requirements for in vitro diagnostic (IVD) medical equipment.

L. Test Principle:

pH: pH is measured using a hydrogen ion selective glass membrane. One side of the glass is in contact with a solution of constant pH. The other side is in contact with a solution of unknown pH. A change in potential develops which is proportional to the pH difference of these solutions. This change in potential is measured against a reference electrode of constant potential. The magnitude of the potential difference is a measure of the pH of the unknown sample.

pCO₂: pCO₂ is measured with a modified pH sensor. Carbon dioxide in the sample makes contact with a gas permeable membrane mounted on a combination measuring/ reference electrode. CO₂ diffuses across the membrane into a thin layer of electrolyte solution in response to partial pressure difference. This solution then becomes equilibrated with the external gas pressure. CO₂ in the solution becomes hydrated producing carbonic acid, which results in a change in hydrogen ion activity, according to the equation:



The electrolyte solution behind the membrane is in contact with a glass hydrogen ion selective sensor. The change in hydrogen ion activity in the electrolyte solution produces a potential which is measured against the internal filling solution. This change in potential is measured against the constant potential of the reference electrode half cell and is logarithmically related to the pCO₂ of the unknown sample.

pO₂: pO₂ is measured amperometrically by the generation of a current at the sensor surface. As oxygen diffuses through a gas permeable membrane, the oxygen molecules are reduced at the cathode, consuming 4 electrons for every molecule of oxygen reduced. This flow of electrons is then measured by the sensor and is directly proportional to the partial pressure of oxygen in the sample.

M. Performance Characteristics (if/when applicable):

1. Analytical performance:

a. *Precision/Reproducibility:*

Within run and between analyzer precision was assessed by analyzing QC materials and whole blood samples in replicates of 20 on each of three analyzers. Results are summarized below.

Internal Quality Control within – run results:

All three analyzers yielded similar results. The results of one representative analyzer are summarized in the table below.

Within-Run Precision				
Parameter	n = 20	Control Level 1	Control Level 2	Control Level 3
pH (pH units)	Mean	7.175	7.391	7.598
	SD	0.001	0.001	0.001
pCO ₂ (mmHg)	Mean	63.0	41.8	20.4
	SD	0.7	0.1	0.3
	CV%	1.1	0.2	1.3
pO ₂ (mmHg)	Mean	57.9	90.7	135.0
	SD	0.7	0.5	0.3
	CV%	1.2	0.5	0.2

External Quality Control within-run results:

Within-Run Precision				
Parameter	n = 20	Control Level 1	Control Level 2	Control Level 3
pH (pH units)	Mean	7.159	7.386	7.560
	SD	0.003	0.001	0.002
pCO ₂ (mmHg)	Mean	47.9	39.9	21.6
	SD	0.6	0.2	0.1
	CV%	1.3	0.5	0.4
pO ₂ (mmHg)	Mean	63.1	105.6	141.1
	SD	1.1	1.3	1.6
	CV%	1.7	1.2	1.1

Within – run precision using whole blood:

All three analyzers yielded similar results. The results from one representative analyzer are summarized in the tables below. Note: the samples below were selected to evaluate a specific parameter over a specific range, so all three parameters were not evaluated on all samples.

pH, (n=20)		
Sample	Mean	SD
Sample 1	7.328	0.002
Sample 2	7.319	0.002
Sample 3	7.702	0.005
Sample 5	7.134	0.004

pCO₂, mmHg (n=20)			
Sample	Mean	SD	%CV
Sample 1	44.0	0.8	1.7
Sample 2	50.4	1.0	2.0
Sample 4	16.6	0.2	1.9
Sample 5	78.8	1.1	1.4

pO₂, mmHg (n=20)			
Sample	Mean	SD	%CV
Sample 1	66.5	1.3	2.0
Sample 2	38.4	1.0	2.6
Sample 4	46.9	0.6	0.4
Sample 5	94.9	0.4	0.4

Run-to-run precision using internal QC material

Estimates of the run-to-run precision were determined for each of three Stat Profile Prime Plus Analyzers by testing Stat Profile Prime Plus Internal Controls, Levels 1- 3 for each parameter in QC mode in duplicate, with two runs per day for a total of forty runs.

pH				
Sample	Pooled Mean	N	Within run SD (Sr)	Total Imprecision SD (St)
QC Level 1	7.177	240	0.003	0.005
QC Level 2	7.390	240	0.001	0.003
QC Level 3	7.599	240	0.001	0.005

pCO₂						
Sample	Pooled Mean	N	Within run SD (Sr)	Within run %CV	Total Imprecision SD (St)	Total Imprecision %CV
QC Level 1	62.5	240	0.7	1.2	3.1	4.9
QC Level 2	42.0	240	0.3	0.7	1.6	3.9
QC Level 3	19.5	240	0.2	1.0	0.9	4.4

pO ₂						
Sample	Pooled Mean	N	Within run SD (Sr)	Within run %CV	Total Imprecision SD (St)	Total Imprecision %CV
QC Level 1	61.2	240	1.8	3.0	2.6	4.2
QC Level 2	94.9	240	1.7	1.8	3.0	3.1
QC Level 3	130.4	240	1.8	1.4	2.2	1.7

Day-to-day imprecision using whole blood

To simulate total day-to-day precision for whole blood, triplicate analyses were performed on a single whole blood sample in ten separate runs during a single day. Samples were delivered to the instrument from syringe or capillary tubes. The systems were recalibrated before each triplicate run. The results from one representative analyzer are summarized in the tables below.

pH		
Sample	Mean	SD
WB - syringe	7.484	0.010
WB - capillary tube	7.416	0.009

pCO ₂ mmHg			
Sample	Mean	SD	%CV
WB - syringe	29.3	0.6	1.9
WB - capillary tube	33.4	0.4	1.2

pO ₂ mmHg			
Sample	Mean	SD	%CV
WB - syringe	106.7	1.0	0.9
WB - capillary tube	106.4	0.8	0.7

b. Linearity/assay reportable range:

A linearity study was performed using lithium heparin whole blood samples. Some samples were altered to provide a total ten or eleven analyte concentrations throughout the analytical measurement range. Each blood level was analyzed in triplicate on each of the three Stat Profile Prime CCS analyzers and on the Stat Profile pHox Ultra analyzer. The pHox Ultra analyzers were used to establish the target value of each blood level for each parameter. Results of the linear regression analysis for one representative analyzer are shown below.

Parameter	Specimen Range Tested	Claimed Measuring Range	Slope	Intercept	r
pH (pH units)	6.474 - 8.008	6.500 - 8.000	1.0089	-0.0548	0.9998
pCO ₂ (mmHg)	0.04 - 223.4	3.0 - 200.0	0.9895	1.0156	0.9992
pO ₂ (mm Hg)	4.5 - 755.8	5.0 - 765.0	0.9827	3.1471	0.9994

The results of the linearity study support the sponsor's claimed measuring ranges (as described in the table above).

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

Traceability:

pH: The pH standards and reagents are traceable to NIST primary pH reference material SRM 21861 and 218611.

pO₂/pCO₂: Nova's CO₂/O₂ gases are gravimetrically prepared and are traceable to NIST SRM 1700a, (pCO₂) and 1702a (pCO₂ and pO₂)

d. Detection limit:

Refer to the linearity study above in M.2.b for measuring range claims for pH, pO₂, and pCO₂.

e. Analytical specificity:

An interference testing study was performed using whole blood collected in lithium heparin vacutainers. The possible interfering substances were tested at two analyte concentrations. Samples were divided to create two separate pools of blood, one for control samples and the other for test samples that were spiked with potential interferent substance. The control and test samples were measured on the same analyzers in replicates of eight. The sponsor defined significant interference as a difference between test and control samples of $> \pm 0.020$ for pH and $> \pm 10\%$ for pCO₂ and pO₂.

The results of the interference studies are summarized below:

pH

Test Substance	Highest concentration tested that did not cause significant interference
Benzalkonium Chloride	10 mg/L
Bilirubin	20 mg/dL
Calcium Chloride	2 mmol/L

Test Substance	Highest concentration tested that did not cause significant interference
Dobutamine	2 mg/dL
Ethanol	86.8 mmol/L
Fluorescein	0.4 mg/mL
Hemoglobin	2 g/L
Intralipid	4000 mg/dL
Potassium Chloride	5 mmol/L
Sodium Bromide	37.5 mmol/L
Sodium Chloride	10 mmol/L

pCO₂:

Test Substance	Highest concentration tested that did not cause significant interference
Bilirubin	20 mg/dL
Calcium Chloride	2 mmol/L
Ethanol	86.8 mmol/L
Fluorescein	0.4 mg/mL
Hemoglobin	2 g/L
Intralipid	4000 mg/dL
Sodium Chloride	10 mmol/L
Potassium Chloride	5 mmol/L

pO₂:

Test Substance	Highest concentration tested that did not cause significant interference
Bilirubin	20 mg/dL
Calcium Chloride	2 mmol/L
Ethanol	86.8 mmol/L
Fluorescein	0.4 mg/mL
Hemoglobin	2 g/L
Intralipid	4000 mg/dL
Potassium Chloride	5 mmol/L
Sodium Chloride	10 mmol/L

f. Assay cut-off:

Not applicable.

2. Comparison studies:

a. *Method comparison with predicate device:*

Method comparison studies were conducted by testing lithium heparinized arterial and venous whole blood specimens in singlet on the three Stat Profile Prime Plus analyzers and two pHox Ultra analyzers. In order to evaluate the claimed measuring range, some venous whole blood specimens were tonometered, spiked or diluted to achieve the desired concentrations. The singlet result from each test analyzer was compared to the average of the results from each comparative method. Linear regression analysis of one representative analyzer is shown below.

Analyte	n	Sample concentration range	Slope	Intercept	r
pH (pH units)	210	6.841 – 7.980	1.0053	-0.0396	0.9963
pCO ₂ (mm Hg)	209	5.1 – 193.5	0.9799	0.2799	0.9942
pO ₂ (mm Hg)	204	17.2 – 645.1	1.0104	1.3563	0.9980

b. *Matrix comparison:*

Not applicable. For use with lithium heparinized whole blood 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 of pH, pCO₂ and pO₂ are cited from the literature:

pH: 7.350 - 7.450 (pH units)
pCO₂: 35 - 45 mm Hg
pO₂: 83 - 108 mm Hg

Statland, Bernard, Clinical Decision Levels for Lab Tests, Medical Economics Books, 1987.

Burtis, Carl A. and Ashwood, Edward R., ed. 1994. Tietz Textbook of Clinical Chemistry, W. B. Saunders Co. Philadelphia, PA.

Tietz, Norbert W., ed. 1983. Clinical Guide to Laboratory Tests, W. B. Saunders Co., Philadelphia, PA.

N. Instrument Name:

Stat Profile Prime Plus Analyzer System

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 ☐ or No ☐

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

Yes ☐ or No ☐

2. Software:

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

Yes ☐ or No ☐

3. Specimen Identification:

Specimens may be identified by scanning a barcode or by manually entering the information via the touchscreen.

4. Specimen Sampling and Handling:

Lithium heparinized arterial and venous whole blood from syringes and open blood collection tubes.

5. Calibration:

The Stat Profile Prime Plus analyzer utilizes a replaceable internal Calibrator Cartridge to calibrate the Blood Gas, Electrolyte, Metabolite and CO-Ox sensors contained in the analyzer. Calibrations are initiated by the analyzer automatically but can also be started manually if necessary.

After startup, the analyzer performs a CO-Ox Light Initialization sequence and, once complete, initiates a System Calibration and an Air Detector Calibration sequence. The System Calibration performs a 2-point calibration of the Blood Gas, Electrolyte, and Metabolite sensors, and a 1-point optical calibration of the CO-Oximeter module. The Air Detector Calibration sequence calibrates the internal air detectors that position fluids in the analyzer correctly.

- 2-point calibrations are repeated every 2 hours to ensure the analyzer continues to perform optimally.
- A 1-point calibration is performed with every sample analysis.
- During the first System Calibration to occur after midnight each day, the analyzer also performs a CO-Ox Light Initialization sequence and an Air Detector Calibration.

A System Calibration or Air Detector Calibration can be initiated manually, if needed. Manual calibrations may be necessary after certain maintenance functions or in response to unexpected error conditions.

6. Quality Control:

The Stat Profile Prime Plus Blood Gas/CO-Oximeter Controls 1, 2, and 3 is a quality control material intended for in vitro diagnostic use by healthcare professionals for monitoring the performance of Stat Profile Prime Plus Analyzer.

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

Not applicable

Q. Proposed Labeling:

The labeling is sufficient and it satisfies the requirements of 21 CFR Parts 801 and 809, as applicable.

R. Conclusion:

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