DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Food and Drug Administration
10903 New Hampshire Avenue
Document Control Center – WO66-G609
Silver Spring, MD 20993-0002

NANOENTEK USA INC.
C/O MAUREEN GARNER
NEW WORLD REGULATORY SOLUTIONS, INC
1983 HAZELWOOD ROAD
TOMS RIVER NJ 08753

October 14, 2016

Re: K153577
Trade/Device Name: FREND ™ Testosterone Test System
Regulation Number: 21 CFR 862.1680
Regulation Name: Testosterone test system
Regulatory Class: I, reserved
Product Code: CDZ
Dated: September 29, 2016
Received: October 3, 2016

Dear Maureen Garner:

We have reviewed your Section 510(k) premarket notification of intent to market the device referenced above and have determined the device is substantially equivalent (for the indications for use stated in the enclosure) to legally marketed predicate devices marketed in interstate commerce prior to May 28, 1976, the enactment date of the Medical Device Amendments, or to devices that have been reclassified in accordance with the provisions of the Federal Food, Drug, and Cosmetic Act (Act) that do not require approval of a premarket approval application (PMA). You may, therefore, market the device, subject to the general controls provisions of the Act. The general controls provisions of the Act include requirements for annual registration, listing of devices, good manufacturing practice, labeling, and prohibitions against misbranding and adulteration. Please note: CDRH does not evaluate information related to contract liability warranties. We remind you, however, that device labeling must be truthful and not misleading.

If your device is classified (see above) into either class II (Special Controls) or class III (PMA), it may be subject to additional controls. Existing major regulations affecting your device can be found in the Code of Federal Regulations, Title 21, Parts 800 to 898. In addition, FDA may publish further announcements concerning your device in the Federal Register.

Please be advised that FDA's issuance of a substantial equivalence determination does not mean that FDA has made a determination that your device complies with other requirements of the Act or any Federal statutes and regulations administered by other Federal agencies. You must comply with all the Act's requirements, including, but not limited to: registration and listing (21 CFR Part 807); labeling (21 CFR Parts 801 and 809); medical device reporting (reporting of medical device-related adverse events) (21 CFR 803); good manufacturing practice requirements as set forth in the quality systems (QS) regulation (21 CFR Part 820); and if applicable, the electronic product radiation control provisions (Sections 531-542 of the Act); 21 CFR 1000-1050.

If you desire specific advice for your device on our labeling regulations (21 CFR Parts 801 and 809), please contact the Division of Industry and Consumer Education at its toll-free number (800) 638 2041 or (301) 796-7100 or at its Internet address http://www.fda.gov/MedicalDevices/ResourcesforYou/Industry/default.htm. Also, please note the regulation entitled, "Misbranding by reference to premarket notification" (21 CFR Part 807.97). For questions regarding the reporting of adverse events under the MDR regulation (21 CFR Part 803), please go to http://www.fda.gov/MedicalDevices/Safety/ReportaProblem/default.htm for the CDRH's Office of Surveillance and Biometrics/Division of Postmarket Surveillance.

You may obtain other general information on your responsibilities under the Act from the Division of Industry and Consumer Education at its toll-free number (800) 638-2041 or (301) 796-7100 or at its Internet address http://www.fda.gov/MedicalDevices/ResourcesforYou/Industry/default.htm.

Sincerely yours,

Katherine Serrano -S

For: Courtney H. Lias, Ph.D.
Director
Division of Chemistry and Toxicology Devices
Office of In Vitro Diagnostics
and Radiological Health
Center for Devices and Radiological Health

Enclosure

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Food and Drug Administration

Indications for Use

Form Approved: OMB No. 0910-0120
Expiration Date: January 31, 2017
See PRA Statement below.

510(k) Number *(if known)*
k153577

Device Name
FREND™ Testosterone Test System

Indications for Use *(Describe)*
The FREND™ Testosterone test is a fluorescent nanoparticle immunoassay designed for in vitro quantitative measurement of total testosterone in human serum and plasma (K3-EDTA and lithium heparin). Measurements of testosterone are used in the diagnosis and treatment of disorders involving the male sex hormones (androgens), including primary and secondary hypogonadism, impotence in males and, in females, hirsutisim (excessive hair) and virilization (masculinization) due to tumors, polycystic ovaries, and adrenogenital syndromes.

The FREND™ Testosterone microfluidic flow cartridge is designed for use in the FREND™ System fluorescent immunoassay reader. The FREND™ Testosterone Test System is intended for use in clinical laboratories. For in vitro diagnostic use only. The test is not intended for use in point-of-care settings.

Type of Use *(Select one or both, as applicable)*

☒ Prescription Use (Part 21 CFR 801 Subpart D) ☐ Over-The-Counter Use (21 CFR 801 Subpart C)

CONTINUE ON A SEPARATE PAGE IF NEEDED.

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510(k) Summary

As required by the Safe Medical Devices Act (SMDA) of 1990 and in accordance with 21 CFR §807.92, a 510(k) summary is provided.

A. Applicant

Company Name: NanoEnTek, Inc.
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Seoul 152-740, KOREA
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B. 510(k) Preparer Information (Contact Person)

Company Name: New World Regulatory Solutions, Inc.
Address: P.O. Box 5374
Toms River, New Jersey 08754, USA
Contact Person: Maureen Garner
Phone Number: (732) 779-7422
Facsimile Number: (732) 270-4829
Email: NWRSinc@gmail.com

C. Purpose for Submission:

New Analyte on FREND™ System

D. Measurand:

Testosterone

E. Type of Test:

Quantitative, Fluorescence Immunoassay

F. Proprietary and Established Device Name:

FREND™ Testosterone Test System

G. Regulatory Information:

	Assay
Proprietary Name	FREND™ Testosterone (reagent cartridge)
Generic Name	Competitive Immunoassay, Testosterone
Regulation Number:	21 CFR §862.1680
Product Code	CDZ
Classification	Class I, Reserved
Classification Name	Testosterone Test System
Panel	Chemistry (75)

NanoEnTek FREND™ Testosterone Test System
Premarket Notification
510(k) Summary

H. Intended Use:

1. Intended use(s):
   See indications for use below:

2. Indication(s) for use:
   The FREND™ Testosterone test is a fluorescent nanoparticle immunoassay designed for *in vitro* quantitative measurement of total testosterone in human serum and plasma (K_3EDTA and lithium heparin). Measurements of testosterone are used in the diagnosis and treatment of disorders involving the male sex hormones (androgens), including primary and secondary hypogonadism, impotence in males and, in females, hirsutisim (excessive hair) and virilization (masculinization) due to tumors, polycystic ovaries, and adrenogenital syndromes.

   The FREND™ Testosterone microfluidic flow cartridge is designed for use in the FREND™ System fluorescent immunoassay reader. The FREND™ Testosterone Test System is intended for use in clinical laboratories. For *in vitro* diagnostic use only. The test is not intended for use in point-of-care settings.

3. Special conditions for use statement(s):
   For prescription use only.

4. Special instrument requirements:
   NanoEnTek FREND™ System

I. Device Description

The FREND™ Testosterone is a rapid fluorescence immunoassay that measures testosterone levels in human serum and plasma using the FREND™ system.

The FREND™ Testosterone test is a single-use rapid “competitive” immunoassay utilizing fluorescent nanoparticle in microfluidic flow to capture and quantify total testosterone levels in human serum and plasma (K_3EDTA and lithium-heparin) specimens using the FREND™ system. The FREND™ Testosterone Test is a two-step competitive immunoassay with gold micro-particles labeled with mouse monoclonal anti-testosterone antibody, testosterone-biotin labeled with fluorescence nanoparticles and fluorescence detection by the FREND™ System.

The FREND™ Testosterone test utilizes microfluidic technology and detects immune-complexes bound to testosterone. In Step 1, a 70 µL patient sample is first incubated for 5 minutes at 98.6 °F (37 °C) in the Testosterone Gold Antibody pretreatment tube, where the sample interacts with a proprietary mix of a pretreatment solution. In Step 2, the Test Cartridge is placed on the warming platform of the heating block and 35 µL of the mixture from Step 1 is manually loaded into the inlet of the cartridge. The cartridge remains on the warming platform for 30 seconds, while the sample hydrates the testosterone-biotin fluorescent bead conjugate and migrates along the test strip. During migration the bound testosterone in the sample and the testosterone-biotin fluorescent bead conjugates compete to form antigen-antibody complexes in the test zone. Unbound testosterone-biotin fluorescent conjugates flow through and bind to the anti-testosterone antibody that is immobilized on the surface in the reference zone. The cartridge is inserted into the FREND instrument for analysis where fluorescent signals in the test and reference zones are measured, typically within 4 minutes.

NanoEnTek FREND™ Testosterone Test System
Premarket Notification
510(k) Summary

Testosterone quantification is based upon the ratio of the intensity of the test and reference zones. The magnitude of the fluorescent ratio is inversely proportional to the amount of testosterone in the sample.

The measuring range of the FREND™ Testosterone Test System is 20 to 1500 ng/dL. Results are determined via a lot-specific calibration curve which is generated by the manufacturer using a six-point calibration determined from values averaged from 5 replicates at each level. The established curve is uploaded to the FREND™ System via the Testosterone Code-chip and is valid until the lot expiration date.

The FREND™ Testosterone test cartridge is a disposable plastic device that houses the reagents and contains a port or opening (inlet) where the sample is applied. Once the sample is applied, it will mix with the reagents and travel towards the detection area via capillary action.

The FREND™ System is a portable, automated FREND™ cartridge reader. The FREND™ System is based on quantitative immunoassay technology capable of quantifying single or multiple analytes by measuring laser-induced fluorescence in a single-use disposable reagent cartridge. The FREND™ cartridge utilizes micro-fluidics lateral flow technology where the analyte of interest in the sample forms immune complexes while moving through the fluidics pathway in the cartridge. The concentration of the analyte of interest in an unknown sample is calculated using the ratio of the fluorescent intensity of the test zone and the reference zone.

The FREND™ System is a bench top fluorescence reader containing a touch screen user interface. The System has a slot that accepts the FREND™ Testosterone Test Cartridge (which contains the reagents and sample), and is programmed to analyze the Test when the sample has fully reacted with the on-board in-cartridge reagents. Results of the test are displayed on the screen and can be printed on an optional printer.

The FREND™ System software controls the graphical user interface, communication with hardware, database management and data analysis. The software also controls the functions of the mechanical components including the motor, laser, printer control and acquisition of data from the sensor. The user can set the time and date and enter patient ID through the graphic user interface. The user cannot make any changes to the software.

The FREND™ Testosterone Test System includes the following in the kit:

- 20 FREND™ Testosterone cartridges
- 20 Testosterone Gold Antibody Pretreatment Tubes
- Disposable pipette tips
- 1 FREND™ Testosterone Code Chip
- 1 FREND™ Testosterone Package Insert

The FREND™ System (previously cleared in K124056 (FREND™ PSA Plus) K131928 (FREND™ TSH), and K152422 (FREND™ Free T4)) is not provided with the kit but is required for the use of the FREND™ Testosterone test cartridge.

J. Substantial Equivalence Information:

An overview of the similarities and differences between the FREND™ Testosterone Test System and the predicate is provided in the table below:

Similarities		
Item	**FREND™ Testosterone Test System**	**Abbott ARCHITECT 2nd Generation Testosterone (K120009)**
Intended Use	The FREND™ Testosterone test is a fluorescent nanoparticle immunoassay designed for *in vitro* quantitative measurement of total testosterone in human serum and plasma (K_3EDTA and lithium heparin). Measurements of testosterone are used in the diagnosis and treatment of disorders involving the male sex hormones (androgens), including primary and secondary hypogonadism, impotence in males and, in females, hirsutisim (excessive hair) and virilization (masculinization) due to tumors, polycystic ovaries, and adrenogenital syndromes. The FREND™ Testosterone microfluidic flow cartridge is designed for use in the FREND™ System fluorescent immunoassay reader. The FREND™ Testosterone Test System is intended for use in clinical laboratories. The FREND™ Testosterone Test is for *in vitro* diagnostic use only. The test is not intended for use in point-of-care settings.	The ARCHITECT 2nd Generation Testosterone is a Chemiluminescent Microparticle Immunoassay (CMIA) for the quantitative determination of testosterone in human serum and plasma. Measurements of testosterone are used in the diagnosis and treatment of disorders involving the male sex hormones (androgens), including primary and secondary hypogonadism, delayed or precocious puberty, impotence in males and, in females, hirsutisim (excessive hair) and virilization (masculinization) due to tumors, polycystic ovaries, and adrenogenital syndromes. The ARCHITECT 2nd Generation Testosterone Calibrators are for the calibration of the ARCHITECT *i* System when used for the quantitative determination of testosterone in human serum and plasma. The ARCHITECT 2nd Generation Testosterone Controls are for the verification of the accuracy and precision of the ARCHITECT *i* System when used for the quantitative determination of testosterone in human serum and plasma. For *in vitro* diagnostic use only.
Sample Type	Human serum and K_3EDTA and lithium heparin plasma	Same
Analyte	Testosterone	Same
Type of Test	Fluorescent immunoassay determination of testosterone	Chemiluminescent immunoassay determination of testosterone
Quality Control	Internal procedural/instrument quality controls; commercially-available external positive and negative assay controls	Internal procedural/instrument quality controls; external positive and negative assay controls cleared with test kit
Interpretation of Results	Interpolation from a lot-specific calibration curve	Same
Dynamic Range	20 ~ 1500 ng/dL	4.33 ~ 1500 ng/dL

Differences		
Item	**FREND™ Testosterone Test System**	**Abbott ARCHITECT Testosterone (K120009)**
Sample Size	70 µL for the incubation step and 35 µL for running the test	150 µL for the first Testosterone test plus 100 µL for each additional Testosterone from the same test cup
Test Cartridge	Disposable single-use cartridge	No single-use cartridge
Random Access / Degree of Automation	No random access, manual manipulation	Random access, semi-automated

K. Performance Characteristics (if/when applicable)

1. Analytical performance

a. *Precision/Reproducibility*

A single lot imprecision study was performed at the NanoEnTek laboratory as described in the CLSI protocol EP5-A3. Three serum pools with low, intermediate and high testosterone levels were assayed in duplicate twice per day for 20 days (80 total measurements per level). The results are summarized below:

FREND™ Testosterone Single Site Single Lot Precision

Sample Pool	Mean Testosterone Level, (ng/dL)	Repeatability		Within-laboratory	
		SD	CV%	SD	CV%
1	39.723	4.451	11.2%	4.692	11.8%
2	202.965	16.670	8.2%	17.296	8.5%
3	1012.208	54.748	5.4%	57.480	5.7%

b. *Linearity/assay reportable range:*

Linearity was established according to CLSI-EP6-A in three reagent lots using seven levels of serum testosterone tested in quadruplicate. Linearity was demonstrated across a measuring interval of 17 ~ 1650 ng/dL, in support of the FREND™ Testosterone reportable range of 20 ng/dL ~ 1500 ng/dL.

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

The standards/calibrators are prepared gravimetrically and confirmed by measurement on the ARCHITECT *i* 2nd Generation Testosterone assay (K120009). There is no need for calibration by the operator as the calibration information is coded in the individual cartridge.

d. Stability

Real-time stability testing for the Testosterone reagent kit was performed according to CLSI EP25-A, *Evaluation of Stability of* In Vitro *Diagnostic Reagents*. Reagent stability studies based on procedures and criteria in the NanoEnTek quality system showed that the cartridges for FREND™ Testosterone will meet performance acceptance criteria for one year from the date of manufacturer if stored refrigerated appropriately as directed.

e. *Detection Limit:*
The Limit of Detection (LoD) for the FREND™ Testosterone was established at 14.3 ng/dL according to the CLSI EP17-A2 protocol. The functional sensitivity was established at 19.66 ng/dL. The analytical sensitivity of the FREND™ Testosterone is claimed at 20 ng/dL.

f. *Analytical specificity:*

Interference Studies
Interference was determined according to CLSI EP07-A2. No interference was found if recoveries were between 90% to 110% of the expected testosterone value. Results are summarized in the table below.

Class	Interferent (Concentration Tested)	%Recovery Testosterone Low	%Recovery Testosterone High
Endogenous substances	Hemoglobin (500 mg/dL)	97.2	96.5
	Bilirubin, conjugated (30 mg/dL)	106.6	100.4
	Bilirubin, unconjugated (30 mg/dL)	99.6	98.9
	Triglyceride (3 g/dL)	99.3	94.4
	Total protein (12 g/dL)	96.5	100.8
	Biotin (30 ng/mL)	101.8	104.3
	Sex Hormone Binding Globulin (100 nmol/L)	99.9	100.2
Pharmaceuticals	Acetylcysteine (415 µg/mL)	97.9	99.4
	Ampicillin-Na (50.3 µg/mL)	98.7	100.6
	Ascorbic acid (60 µg/mL)	96.3	101.2
	Ca-Dobesilate (40 µg/mL)	101.3	101.5
	Cyclosporine (3 µg/mL)	97.4	96.8
	Cefoxitin (66 µg/mL)	101.1	97.9
	Heparin (3,000 U/L)	102.6	99.7
	Levodopa (4 mg/mL)	96.7	100.9
	Methyldopa (15 µg/mL)	101.0	97.1
	Metronidazole (120 µg/L)	104.7	104.8
	Doxycycline (30 µg/mL)	100.5	97.9
	Acetylsalicylic Acid (250 µ/g/mL)	94.7	98.4
	Rifampin (640 µg/mL)	97.1	99.7
	Acetaminophen (200 µg/mL)	99.6	100.3
	Ibuprofen (250 µg/mL)	95.7	97.4
	Theophylline (400 µg/mL)	102.1	99.5
Heterophilic Antibodies	RF (1075 IU/mL)	104.3	98.2
	HAMA (70 ng/mL)	103.8	100.2

Cross Reactivity
The following substances were evaluated for potential cross-reactivity with the FREND™ Testosterone at two concentrations. Testing was done according to the CLSI protocol EP07-A2. No significant cross-reactivity was found.

Cross-reactant	Conc. of cross-reactant (ng/dL)	% Cross-reactivity	
		Low	High
Androstenedione (1,000 nmol/L)	28641	0.0032	0.0337
Androsterone (1,000 nmol/L)	29044	0.0004	0.0158
Cortisone (1,000 nmol/L)	36044	0.0077	0.0300
Danazol (1,000 nmol/L)	33746	0.0007	0.0496
Estradiol (200 nmol/L)	5447.6	0.0033	0.5160
Estrone (500 nmol/L)	13518.5	0.0144	0.0378
17a-Ethinyl estradiol (1,000 ng/mL)	100000	0.0033	0.0081
Progesterone (2,000 nmol/L)	62892	0.0007	0.0167
Dexamethasone (5 µmol/L)	196230	0.0255	0.0122
Ethisterone (20 nmol/L)	624.9	0.0437	0.3840
D(-) Norgestrel (20 ng/mL)	2000	0.0125	0.1667
Prednisolone (2,000 nmol/L)	61288	0.0001	0.0175
Prednisone (2,000 nmol/L)	71686	0.0031	0.0040
Spironolactone (500 ng/mL)	50000	0.0039	0.0172
Cortisol (10,000 nmol/L)	362460	0.0004	0.0070
DHEA (50 nmol/L)	1442.1	0.0178	1.0463
DHEAS (50 µmol/L)	1842500	0.0002	0.0009
Dihydrotestosterone (40 nmol/L)	1161.68	0.2040	0.4134
Epitestosterone (100 nmol/L)	2884.2	0.0467	0.1502
Ethynodiol diacetate (50 ng/mL)	5000	0.0274	0.1280

% Cross-reactivity = 100 x ((Measured value - true value)/concentration of cross-reactant))

g. *Assay cut-off:*

Not applicable

2. Comparison studies

a. *Method comparison with predicate device:*
Comparison studies with 157 de-identified leftover samples were performed in a CLIA-certified laboratory testing facility. The reference method was the Abbott ARCHITECT 2nd Generation Testosterone Assay (K120009) run on the Abbott ARCHITECT *i* System. The samples spanned the measuring range of the FREND Testosterone Test System. An additional 2 samples gave values beyond the range of one or both test methods. All samples were assayed using sera split between the applicant device and the reference method.

Results from the FREND™ Testosterone on the FREND™ System (y) were compared with the reference results (x) by Passing-Bablok regression analysis, giving a slope of 0.983 and intercept of -2.353.

b. *Matrix comparison:*
The matrix comparison study was performed at the NanoEnTek laboratory according to CLSI EP14-A3. Testosterone concentrations in the serum, lithium heparin and K_3EDTA from 40 individuals were measured using the FREND™ Testosterone Test System, giving equivalent results.

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:
   Serum samples from a total of 488 normal, apparently healthy adult male and female individuals were assayed on 3 lots of the FREND™ Testosterone assay using two FREND™ Systems according to CLSI C28-A3 guidelines. The reference interval for the FREND™ Testosterone Test System, stratified by age range and gender, is provided in the table below.

Gender (Age Range)	Testosterone, ng/dL	Number Tested
F (21 – 49)	<20 ~ 107.5	120
F (50 - 90)	<20 ~ 150.3	124
M (21 – 49)	170.1 ~ 1263.6	123
M (50 - 88)	152.4 ~ 1095.2	121

L. Proposed Labeling

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

M. Conclusion

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