

# Laboratory Procedure Manual

*Analyte:*           **Thyroglobulin, (TGN)**

*Matrix:*           **Serum**

*Method:*           **Access 2 (Beckman Coulter)**

*Method No:*

*Revised:*

*as performed by:*

University of Washington Medical Center  
Department of Laboratory Medicine  
Immunology Division  
Director: Mark Wener M.D.  
Supervisor: Kathleen Hutchinson M.S., M.T. (ASCP)  
Authors: Michael Walsh, MT (ASCP), September 2006

*contact:*   Mark Wener M.D.

## *Important Information for Users*

University of Washington periodically refines these laboratory methods. It is the responsibility of the user to contact the person listed on the title page of each write-up before using the analytical method to find out whether any changes have been made and what revisions, if any, have been incorporated.

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**Public Release Data Set Information**

This document details the Lab Protocol for testing the items listed in the following table:

<b>File Name</b>	<b>Variable Name</b>	<b>SAS Label</b>
THYROD_E	LBXTGN	Thyroglobulin (ng/mL)

**1. SUMMARY OF TEST PRINCIPLE AND CLINICAL RELEVANCE**

The Access thyroglobulin (Tg) assay is a simultaneous one-step "sandwich" assay. A sample is added to a reaction vessel, along with biotinylated mixture of four monoclonal anti-Tg antibodies, streptavidin coated paramagnetic particles, and monoclonal anti-Tg antibody alkaline phosphatase conjugate. The biotinylated antibodies and the serum or plasma thyroglobulin bind to the solid phase, while the conjugate antibody reacts with a different antigenic site on the thyroglobulin molecule. After incubation in a reaction vessel, materials bound to the solid phase are held in a magnetic field while unbound materials are washed away. A chemiluminescent substrate, Lumi-Phos\*\* 530 is added to the reaction vessel and light generated by the reaction is measured with a luminometer. The light production is directly proportional to the concentration of thyroglobulin in the sample. The amount of Thyroglobulin in the sample is determined by means of a stored, multi-point calibration curve.

Thyroglobulin (Tg) is a large glycoprotein (MW = 660,000) that is stored in the follicular colloid of the thyroid gland. It is present in the serum of normal healthy individuals and can be elevated in numerous disorders that disrupt thyroid tissue. Elevated circulating levels of Tg have been reported in a number of thyroid conditions including Hashimoto's disease, Graves' disease, thyroid adenoma, subacute thyroiditis and thyroid carcinoma.

Thyroid cancer is a relatively common form of cancer. Tg has become a useful tool in the follow-up of patients with differentiated thyroid carcinoma. Since the thyroid is the only source of Tg, serum levels will drop to a very low or undetectable level after total or near-total thyroidectomy and successful radioiodine ablation of the residual thyroid tissue. A rise in the serum level of Tg points to recurrence of the disease. Tg levels in patients that have undergone only a partial thyroidectomy will retain measurable levels of Tg, depending on how much tissue is remaining after surgery. These patients can be monitored by Tg measurement, but the post-surgical Tg level must be taken into account.

**2. SAFETY PRECAUTIONS**

Consider all samples received for analysis potentially positive for infectious agents including HIV and the hepatitis B virus. Observe universal precautions. Wear gloves, lab coat, and safety glasses when handling all human blood products and infectious viruses. Place disposable plastic, glass, paper, and gloves that contact blood in a biohazard bag or discard pan to be autoclaved. Disinfect all work surfaces with staphene solution. Dispose of all biological samples and diluted specimens in a biohazard bag at the end of the analysis.

Do not pipette by mouth. Do not eat, drink or smoke in designated work areas. Wash hands thoroughly after removal or personal protective devices used in handling specimens and kit reagents.

Material safety data sheets for all reagents used in the performance of this assay, including but limited to staphene, and sodium azide are kept in the Immunology Division, University of Washington Medical Center (UWMC).

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**3. COMPUTERIZATION; DATA SYSTEM MANAGEMENT**

- A. Each shipment of specimens received from the NHANES mobile unit arrives with a corresponding transmittal sheet and an electronic version of the shipping/resulting file. The file structure is determined by NHANES and is described in the National Health and Nutrition Examination Survey (NHANES) Contract Laboratory Manual.
- B. After the testing is completed results from the Access 2 are transferred to the laboratory server system, which is backed up daily. This instrument file contains the following information for each sample, control and calibrator tested.

- Patient ID
- Sample ID
- Rack
- Verify
- Test Name
- Interpretation
- Result
- Units
- Comp. Time
- Flags
- LIS
- Instrument
- RLU
- Pipettor
- Sample Type
- Sample Priority
- Test ID
- Reagent Pack Lot #
- Reagent Pack Serial #
- Dilution
- Calibrator level
- Comments
- Load Date/Time

- C. QC results are transferred to an Excel file using laboratory-developed software. This file calculates the QC statistics, plots Levey-Jennings charts, displays relevant instrument flags, tracks reagent lots and recent calibrations. QC results are reviewed prior to resulting samples.
- D. Sample results are transferred to an Excel file using laboratory-developed software that enters results after matching sample identifiers from the instrument file with those provided in the NHANES shipping/resulting file. This Excel file is formatted to match the NHANES shipping/resulting file and the program uses the conventions outlined in the NHANES Contract Laboratory Manual.
- E. Data entry is checked for errors.

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- F. After the Tg testing has also been completed, resulted, and checked, the result file is transmitted electronically to NHANES WESTAT. Electronic and hard copies of the files are kept in the laboratory.
- G. Technical support for this system is provided by Westat, Rockville, MD (1-301-294-2036)

#### **4. SPECIMEN COLLECTION, STORAGE, AND HANDLING PROCEDURES; CRITERIA FOR SPECIMEN REJECTION**

- A. No special instructions such as fasting or special diets are required.
- B. Serum is the preferred specimen type. Heparin plasma is acceptable. If testing is to be done within 48 hours, samples can be refrigerated at 2 to 8°C. Freeze at -20°C or colder for longer storage.
- C. Blood should be collected aseptically and the serum separated by standard laboratory techniques. Specimens may be collected by using regular or serum-separator Vacutainers. Serum should be separated from the cells within 2 hours of collection.
- D. The requested sample volume for the assay is 1.0 mL, and the minimum sample volume is 0.3 mL.
- E. Specimens may be stored in glass or plastic vials, as long as the vials are tightly sealed to prevent desiccation of the sample.
- F. Turbid samples or those with particulate matter should be centrifuged prior to assay.
- G. More than one freeze-thaw cycles is not recommended.

#### **5. PROCEDURES FOR MICROSCOPIC EXAMINATIONS; CRITERIA FOR REJECTION OF INADEQUATELY PREPARED SLIDES**

Not applicable for this procedure.

#### **6. PREPARATION OF REAGENTS, CALIBRATORS (STANDARDS), CONTROLS, AND ALL OTHER MATERIALS; EQUIPMENT AND INSTRUMENTATION**

##### **A. Instrumentation**

1. Beckman Access or Access II Immunoassay System (Beckman Coulter, Fullerton, CA.)

The Beckman Access is a fully automated, random access, instrument that features on-board storage of reagent packs in a refrigerated compartment; an ultrasonic probe tip for level sense detection, sample and reagent delivery, mixing, and probe cleaning to minimize carryover; barcode identification of specimens and reagent packs; temperature controlled reaction reactions; and measurement and analysis of the light signal generated by the chemiluminescent reaction (RLU) using a smoothing spline math model.

The Thyroglobulin assay parameter settings for the instrument are as follows:

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Parameter	Setting
Sample Volume Requirements Minimum sample volume Sample volume used for testing	175 ul 40 ul
No. of Standard Points	6
Calibration curve calculation	Smoothing spline math model
Standard Curve Measuring Range (At initial dilution; approximate values, range is dependent upon standard value)	0 – 500 ng/mL

2. Hewlett Packard DeskJet printer (Hewlett Packard, Boise, ID)
3. Computers (Dell Computer Corporation, Round Rock, Texas).
4. Centrifuge (Jouan Inc., Winchester, VA)

**B. Equipment**

1. Reaction Vessels (Beckman Coulter, Fullerton, CA)
2. Sample Cups (Fisher Scientific, Pittsburgh, PA)
3. Latex gloves, disposable (Any manufacturer).
4. Pipettes and tips (Rainin, Emeryville, CA)

**C. Reagents**

All reagents are purchased from Beckman Coulter, Fullerton, CA.

1. R1: Access Thyroglobulin Reagent Test Packs: Cat# 33860. 100 determinations, 50 tests/pack

Provided ready to use. Store upright and refrigerate packs at 2 to 10°C. Packs must be refrigerated at 2 to 10°C for a minimum of two hours before use on the instrument. Stable until the expiration date stated on the label when stored at 2 to 10°C. After initial use, the pack is stable at 2 to 10°C for 28 days. Signs of possible deterioration are a broken elastomeric layer on the pack or control values out of range.

R1a: Dynabeads Paramagnetic particles coated with streptavidin, suspended in a Tris-buffered saline, surfactant, bovine serum albumin (BSA) <0.1% sodium azide 0.1% ProClin\*\* 300.

R1b: Mouse monoclonal anti-thyroglobulin-alkaline phosphatase (bovine) conjugate in a Tris buffer, with protein (bovine), <0.1% sodium azide 0.1% ProClin\*\* 300.

R1c: Mouse monoclonal anti- thyroglobulin antibodies coupled to biotin in a HEPES buffer with protein (bovine and mouse), < 0.1% sodium azide, and 0.05% ProClin 300

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2. Access Substrate      Cat. No. 81906: 4 x 130 ml

Lumi-Phos\*530 (buffered solution containing dioxetane), Lumigen\* PPD, fluorescer, and surfactant. Bring to room temperature (15 – 30 °C) at least 18 hours before use. Stable for 14 days at room temperature or after bottle has been opened.

3. Access Wash Buffer II: Cat # A16792

Provided ready to use. Store at room temperature (15 – 30 °C), stable until expiration date on label.

4... Access Thyroglobulin Diluent: Cat # 33866

Used to dilute high thyroglobulin results. Provided ready to use.

HEPES buffer with bovine serum albumin (BSA), < 0.1% sodium azide, and 0.5% ProClin 300. Contains 0.0 ng/mL thyroglobulin. Store at 2 to 10°C, stable until expiration date on label.

D. Standards/Calibration Preparation

Access Thyroglobulin Calibrators      Cat. No. 33865: 2.5 ml/vial

Provided ready to use. Store at 2 to 10°C. Mix contents by gently inverting before use. Avoid bubble formation. Stable until the expiration date stated on the vial labels when stored at 2 to 10°C. Control values out of range are a sign of possible deterioration.

Human Thyroglobulin at levels of approx. 1.0, 10, 100, 250, and 500 ng/mL.

Zero calibrator is buffered BSA matrix, <0.1% sodium azide, 0.5% ProClin\*\* 300. S0 Std contains 0.0 ng/mL Thyroglobulin.

Calibration Card (with actual calibrator concentration information)

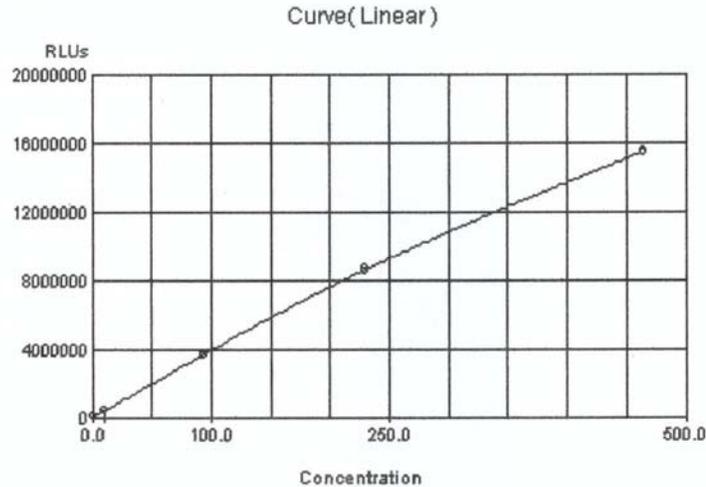
E. Preparation of Quality Control Materials

Three different levels of serum controls are run with each run. The controls are purchased from BioRad Laboratories (Hercules, CA) or prepared in-house. Commercial controls are stored and used according to the manufacturer's recommendations. In house controls are stored frozen (-20°C or colder). Once thawed, the controls are stored at 2-8 °C. All controls are used within their stated expiration dates.

**7. CALIBRATION AND CALIBRATION VERIFICATION PROCEDURES**

A. Calibration Curve

**Example Tg Calibration:**



Tg concentrations are calculated by using a calibration curve. This method utilizes a smoothing spline curve with a direct relationship of measured light produced (RLU) to concentration of Tg in the serum sample. Serum results are expressed as ng/ mL.

Calibrators are traceable to the European Community Bureau of Reference (BCR) CRM 157 thyroglobulin standard.

An active calibration curve is required for all tests. For the Access Tg assay, calibration is required every 56 days or whenever new lot numbers of reagents are placed into use. Refer to the Operator's Guide and Reference Manual for complete instructions on calibration procedures.

B. Verification

1. Three levels of control are run for each test series. If, within a testing series, these controls do not conform to specifications as defined in the quality control manual, the entire series is invalidated.
2. New lot numbers of calibrator are verified by running 100 or more samples tested on the previous lot number. The correlation is analyzed using one or more linear regression formulas.

**8. PROCEDURE OPERATING INSTRUCTIONS; CALCULATIONS; INTERPRETATION OF RESULTS**

A. Preliminaries

1. Bring all controls and patient specimens to room temperature before use. Mix any specimens or controls that have been frozen. Centrifuge samples with particulate matter prior to testing.
2. Prime system: pipettor - 1 time, and substrate - 4 times
3. Check reagent, substrate, wash buffer, and reaction vessel status. Load any needed supplies onto the instrument. Mix reagent pack contents by gently inverting pack several times before loading on the instrument. Do not invert open (punctured) packs — mix reagents by swirling gently.

B. Instrument Operation (see operator's manual for details).

1. Check sample volume to make sure that there is sufficient volume to perform testing. Gently mix, uncap and load specimens into specimen racks, with the barcode in the open slot. Make sure there are no bubbles. Alternately, use the barcode wand to identify the specimens. If the barcode is not reading properly, sample IDs can be entered manually. Load the racks onto the instrument.
2. Select the Tg test. Note: if other thyroid testing is also ordered, the entire 8 test panel can be ordered as a group. Testing is done in singlicate. Select the sample(s) to be used for the random repeat testing.
3. The instrument automatically calculates all results. After testing is completed, results are printed and review by the technologist.
4. Remove specimens and controls soon after the instrument finishes pipetting from the sample. Return controls to the refrigerator and refreeze specimens.
5. Perform scheduled instrument maintenance (daily, weekly, and monthly) as outlined on the maintenance log. See the operator's manual for specific instructions.

C. Recording of Data

1. Using a lab developed program, specimen results are transferred from the instrument data file into the assay specific results table created from the send file corresponding to the specific sample box. The file format is Excel (Microsoft Corporation, Redmond WA). A copy of this file is printed out and checked for accuracy of data entry.
2. Control results are entered to the Assay Specific QC/Levy-Jennings Table using the Excel program. Compliance with the Westgard rules is evaluated. A copy of this table is printed out and checked for accuracy of data entry.

D. Replacement and Periodic Maintenance of Key Components

1. Daily Maintenance:

**Start-up:**

Inspect fluidics module.

Check system supplies and replace as needed.

Clean exterior of substrate, dispense, and aspirate probes.

Prime pipettor – 1X and substrate - 4X.

Verify temperature.

**Shut-down:**

Check waste containers, empty if needed

Perform clean

2. Weekly Maintenance:

Change probes and clean them

Clean exterior of the analyzer

Clean upper portion of the main pipettor with alcohol wipe

Inspect waste filter bottle for fluid

Run system check

3. Periodic Maintenance to be performed by the manufacturer's service engineer.

E. Calculations

Patient test results are determined automatically by the system software. The amount of analyte in a sample is determined from the measured light production by means of a stored nonlinear calibration curve. Patient test results can be reviewed using the Sample Results screen. Refer to the Operator's Guide for complete instructions on reviewing results.

**9. REPORTABLE RANGE OF TEST RESULTS**

Results are reported to the nearest hundredth (0.01). The lowest reportable Tg result is 0.10 ng/mL. Results above the top standard (generally near 500 ng/mL) are repeated after a 1:10 dilution with Tg diluent. Further dilutions may be needed for samples with extremely high levels. Estimates of imprecision can be generated from long-term quality control pool results.

**10. QUALITY CONTROL (QC) PROCEDURES**

A. Bench quality controls are used in this analytical method. Bench quality control specimens are tested with each analytical run (a set of consecutive assays performed without interruption) so that judgements may be made on the day of analysis. The data from these materials are then used in estimating methodological imprecision and in assessing the magnitude of any time-associated trends.

B. The bench controls are purchased in sufficient quantity to provide serum samples for all the assays for approximately 1 year. Ranges are established after 20 parallel runs with previously established controls. The quality control pools comprise three levels of concentration spanning the low, borderline and high ranges for Tg.

C. Bench quality controls are placed at the beginning of each analytical run. After

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analysis, the long-term quality control charts (Levey-Jennings) for each control material are consulted to determine if the system is "in control." The Levey Jennings chart plots the quality control material observations on the y-axis and the date of the observation on the x-axis. Quality control material observations are compared with the 95% and 99% confidence limits as well as with the center line (the overall mean of the characterization runs) prior to reporting any results. The system is out of control if any of the following events occur for any one of the quality control materials:

The observation from a single pool falls outside the 99% confidence limits.

The observations from two pools fall either both above or both below the 95% confidence limits.

The observations from eight successive runs for one pool fall either all above or all below the center-line and the current result is above or below the 95% confidence limits.

### 11. REMEDIAL ACTION IF CALIBRATION OR QC SYSTEMS FAIL TO MEET ACCEPTABLE CRITERIA

If the run is declared "out of control", the system (instrument, calibration standards, etc.) is investigated to determine the root of the problem before any results are released. Consult with the supervisor for appropriate actions.

### 12. LIMITATIONS OF METHOD; INTERFERING SUBSTANCES AND CONDITIONS

- A. **WARNING:** The presence of serum autoantibodies to thyroglobulin (TgAb) can interfere with assays for thyroglobulin (Tg). Therefore, sera which contain TgAb, even at very low levels, should not be tested for Tg.
- B. The lowest reportable value is approximately 0.10 ng/mL. According to studies in the Immunology laboratory this is the lowest level that can be measured with a CV of approximately 20%. According to the manufacturer, this is the lowest detectable level of Tg distinguishable from zero with 95% confidence.
- C. The Tg results should be interpreted in light of the total clinical presentation of the patient, including: symptoms, clinical history, data from additional tests, and other appropriate information.
- D. There is no upper limit of the reportable values since high samples are diluted until they contain a measureable Tg level. However, in rare circumstance the Tg concentration may be grossly underestimated because of high dose hook. Although this assay does not demonstrate "high dose hook" below 40,000 ng/mL, it is vulnerable to this type of error because of the nature of the assay (single step sandwich) and the nature of the analyte (tumor marker).
- E. According to the manufacturer the following substances do not interfere with the assay:
  - Hemoglobin up to 1 g/dL
  - Bilirubin up to 10 mg/dL
  - Triglycerides up to 1800 mg/dl
  - Human albumin levels up to 5 g/dL
  - Aspirin levels up to 50 mg/dL
  - Acetaminophen levels up to 20 mg/dL

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Ibuprofen levels up to 40 mg/dL  
Thyroxine levels up to 218.5 ug/dL

- F. For assay employing antibodies, the possibility exists for interference by heterophile antibodies in the patient sample. Patients that have been regularly exposed to animals or have received immunotherapy or diagnostics procedures utilizing immunoglobulins or immunoglobulin fragments may produce antibodies, e.g. HAMA, that interfere with immunoassays. Additionally, other heterophile antibodies such as human anti-goat antibodies may also be present in patient samples. Such interfering antibodies may cause erroneous results. Carefully evaluate the results of patients suspected of having these antibodies.
- G. **WARNING:** The concentrations of Tg in a given specimen determined with assays from different manufacturers can vary due to differences in assay methods and reagent specificity. Values obtained with different assay methods cannot be used interchangeably.

### 13. REFERENCE RANGES (NORMAL VALUES)

0-35.0 ng/mL based on manufacturer's studies of 152 apparently healthy TgAB negative subjects.

### 14. CRITICAL CALL RESULTS ("PANIC VALUES")

Not applicable to this procedure.

### 15. SPECIMEN STORAGE AND HANDLING DURING TESTING

Specimens should be maintained at 20-25 °C during testing. After testing, the samples are stored at -70 °C or colder.

### 16. ALTERNATIVE METHODS FOR PERFORMING TEST OR STORING SPECIMENS IF TEST SYSTEM FAILS

There are no acceptable alternative methods of analysis. Specimens may be stored at 4-8 °C for no longer than 2 days. Otherwise, specimens should be stored -70 °C or colder until the system is returned to functionality.

### 17. TEST RESULT REPORTING SYSTEM; PROTOCOL FOR REPORTING CRITICAL CALLS (IF APPLICABLE)

Not applicable to this procedure. However, e-mail notification is sent to NHANES for results that are high enough to require a dilution (greater than approximately 500 ng/mL).

### 18. TRANSFER OR REFERRAL OF SPECIMENS; PROCEDURES FOR SPECIMEN ACCOUNTABILITY AND TRACKING

Standard record keeping should be used for tracking specimens. Samples are inspected upon arrival and new boxes are added to an Excel worksheet (sample log) used to track boxes. This sample log is used to track the status of testing and resulting.

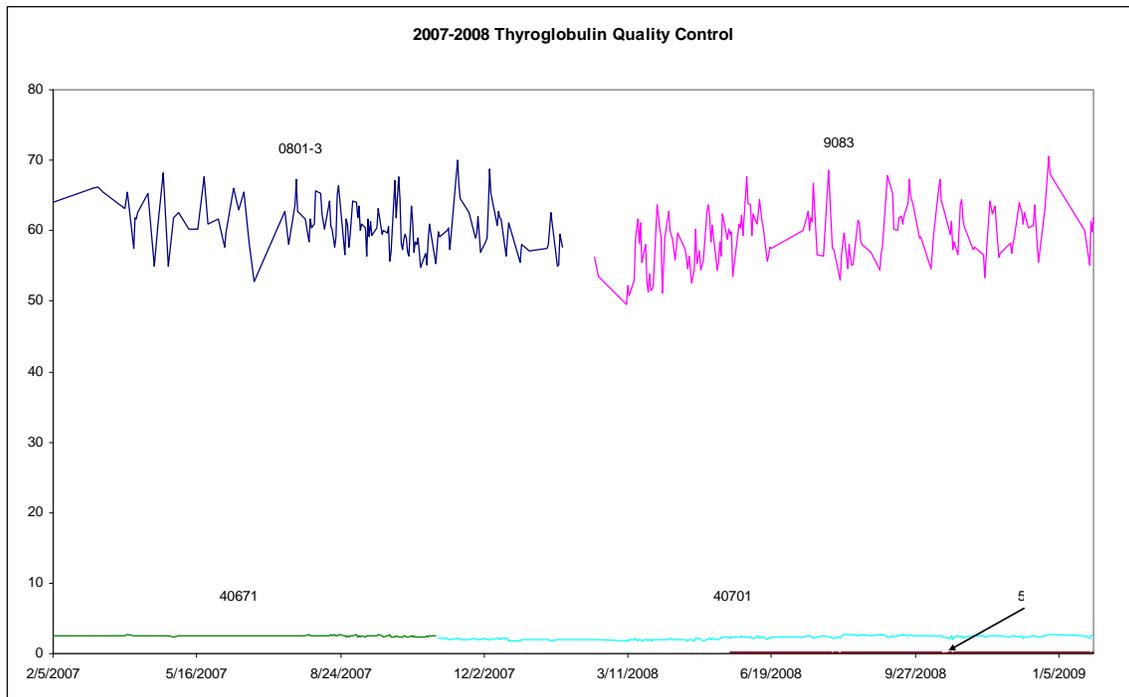
The residual serum is stored at  $\leq -70$  °C for 6 months after analysis, then it is returned to the NHANES Repository in Rockville, MD for long-term storage.

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## 19. Summary Statistics and QC Graphs

### Summary Statistics for Thyroglobulin by Lot

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
40671	99	2/5/2007	10/29/2007	2.516	0.093	3.7
0801-3	134	2/5/2007	1/25/2008	60.764	3.451	5.7
40701	200	10/31/2007	1/29/2009	2.268	0.259	11.4
9083	165	2/17/2008	1/29/2009	59.284	4.086	6.9
508	112	5/21/2008	1/29/2009	0.118	0.014	12.1



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**REFERENCES**

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Beckman Access Immunoassay System Operator's Guide and Reference Manual  
Thyroglobulin kit inserts, Beckman Coulter, Inc. 2003 Beckman Coulter
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5. National Academy of Clinical Biochemistry, Laboratory support for the diagnosis and monitoring of thyroid disease. LA Kaplan, ed. Monograph EDP 9990284, 10/1996. pp. 34-39