**TITLE: : Whole Blood Sysmex XN-450 Automated Hematology Analyzer**

**Principle:** The Sysmex XN-450 is a multi-parameter quantitative automated hematology analyzer for *in vitro* diagnostic use in determining 27\* whole blood diagnostic parameters. Examination of the numerical and/or morphological findings of the complete blood count by the physician are useful in the diagnosis of disease states such as anemias, leukemias, allergic reactions, viral, bacterial, and parasitic infections. This device performs hematology analyses based on the hydro dynamically focused impedance measurement, the flow cytometry method (using a semiconductor laser) and the SLS-hemoglobin method. The device counts and sizes red blood cells (RBC) and platelets (PLT) using hydrodynamic impedance counting (sheath flow DC method). At the same time the hematocrit (HCT) is measured as a ratio of the total RBC volume to whole blood via the RBC pulse height detection method. Cytometry is used to analyze physiological and chemical characteristics of cells and other biological particles. Flow cytometry is a method used to analyze those cells and particles as they pass through extremely small flow cells. Directly Measured Parameters: WBC, RBC, HGB, HCT, RDW-SD, PLT-I, NEUT%, LYMP%, MONO%, EOS%, BASO%, IG%. Calculated Parameters: MCV, MCH, MCHC, RDW-CV, MPV, NEUT#, LYMP#, MONO#, EOS#, BASO#, IG#.

**I. SPECIMEN**

* 1. Required specimen
		1. Whole blood should be collected in EDTA-2K or EDTA-3K anticoagulant. See Policy HE-0165 Criteria for Accepting Hematology Specimens.
	2. Specimen volumes required
		1. Optimal draw is a 13 x 75 tube filled to capacity
		2. A minimum of 1 mL of whole blood is required for sampler analysis.
		3. Manual analysis whole blood mode
			1. Closed tube – 1 mL minimum sample volume, 25 μL is aspirated.
			2. Open tube – 300 μL minimum sample volume, 25 μL is aspirated.
			3. Raised Bottom Tube-RBT micro collection tube – 250 μL minimum sample volume, 25 μL is aspirated.
			4. Open microtube – 100 μL minimum sample volume, 25 μL is aspirated.

In addition, XN-L series systems provide options to customize flagging and rules to identify samples with platelet clusters or fibrin.

* 1. Characteristics that may affect test results: lipemia, icterus, and cold agglutinins.
	2. Stored Specimen Stability
		1. EDTA blood samples should be analyzed with 24 hours when stored at room temperature (18-26°C).
		2. If samples cannot be analyzed within 24 hours, store in a refrigerator at 2-8°C.
		3. Allow refrigerated samples to come to room temperature and mix well before analysis.

4. **Do not place CBC and Diff samples on a mechanical rocker. Constant rocking may alter white cell membranes, resulting in false interpretive messages.**

**II. SUPPLIES & REAGENTS**

A**. Supplies**

* + 1. Lint-free lab wipes
		2. Gauze
		3. Test tubes
		4. Pipettes
		5. CELLCLEAN® AUTO
		6. Sysmex reagents
		7. XN-L CHECKTM
	1. **Sysmex Reagents**
		1. Sysmex reagents and CELLCLEAN AUTO are used on the Sysmex XN-450 Series modules.
		2. All reagents are used at room temperature and are to be used within the manufacturer’s expiration date on each container.
		3. Record date received and date opened on container.
		4. All reagents are azide free and are intended for *in vitro* diagnostic use only.
		**Do not ingest.**

**XN-L REAGENTS**  **OPEN EXPIRATION**

CELLPACK™ DCL 60 Days (20L/10L)

CELLPACK DST\* 60 Days (20L / 2 x 4L)

CELLPACK DFL\* 60 Days

SULFOLYSER™ 60 Days (3 x 500mL)

 90 Days (5.0L)

Lysercell™ WDF 90 Days (2 x 4L)

Lysercell WDF 60 Days (1L)

Fluorocell™ WDF 90 Days (2 x 42mL)

Fluorocell WDF 90 Days (2 x 22 mL)

* 1. **Diluents**
		1. CELLPACK DCL: Whole blood diluent for use in hematology analyzers.

 CELLPACK DCL Storage

1. Store at 2o-35oC away from direct sunlight.
2. If frozen, thaw and mix thoroughly before using.
3. CELLPACK DCL is clear and colorless. If it is showing signs of contamination or instability such as cloudiness or discoloration, replace container.

CELLPACK DCL Stability

1. Unopened, it is stable until expiration date printed on the container.
2. Opened, stable for 60 Days.

CELLPACK DCL Hazard Risk

The OSHA Hazard Communication Standard of 29CFR part 1910.1200 requires SDS documentation of ingredients which have been determined to be health hazards, comprise 1% or greater of the composition, are physical hazards, are capable of release to exceed permissible exposure limit/threshold limit values or have been identified as carcinogens. CELLPACK does not have ingredients with those characteristics.

* 1. **Lysing Reagents**
		1. SULFOLYSER (SLS): Reagent for the automated determination of hemoglobin concentration of blood. Sulfolyser is lysing reagent that releases the hemoglobin to be measured by the SLS hemoglobin method.

SULFOLYSER Storage

1. Store at 1o-30oC away from direct sunlight.
2. Allow the container to equilibrate to environmental temperature (15-35o) prior to use.
3. Replace the reagent if it is showing signs of contamination or instability such as cloudiness or discoloration.

SULFOLYSER Stability

1. Unopened, it is stable until expiration date printed on the container.
2. Opened, stable for 60 Days (1.5L) or 90 Days (5L).

SULFOLYSER Hazard Risk

The OSHA Hazard Communication Standard of 29CFR part 1910.1200 requires SDS documentation of ingredients which have been determined to be health hazards, comprise 1% or greater of the composition, are physical hazards, are capable of release to exceed permissible exposure limit/threshold limit values or have been identified as carcinogens. SULFOLYSER does not have ingredients with those characteristics.

* + 1. Lysercell WDF: Reagent product to be combined and used with Fluorocell WDF. By hemolyzing red blood cells with Lysercell WDF and dying the white blood cell component with Fluorocell WDF, the counts and percentages of neutrophils, lymphocytes, monocytes, eosinophils and basophils are analyzed.

Lysercell WDF Storage

1. Store at 2o-35oC away from direct sunlight.
2. Use at an environmental temperature (15-35o)
3. Do not use the reagent if it is suspected to have frozen.
4. Replace the reagent if it is showing signs of contamination or instability such as cloudiness or discoloration

Lysercell WDF Stability

1. Unopened, it is stable until expiration date printed on the container.
2. Opened, 1L stable for 60 days, 2 x 4L stable for 90 days.

Lysercell WDF Hazard Risk

The OSHA Hazard Communication Standard of 29CFR part 1910.1200 requires SDS documentation of ingredients which have been determined to be health hazards, comprise 1% or greater of the composition, are physical hazards, are capable of release to exceed permissible exposure limit/threshold limit values or have been identified as carcinogens. Lysercell WDF does not have ingredients with those characteristics.

* 1. **Staining Reagents**
		1. Fluorocell WDF: Used to stain the leukocytes in diluted and lysed blood samples for determination of differential count in blood.

Fluorocell WDF Storage

1. Store at 2o-35oC in a dark place.
2. Do not use the reagent if it is suspected to have frozen.

Fluorocell WDF Stability

1. Unopened, it is stable until expiration date printed on the container.
2. Opened, stable for 90 Days.

Fluorocell WDF Hazard Risk

The OSHA Hazard Communication Standard of 29CFR part 1910.1200 requires SDS documentation of ingredients which have been determined to be health hazards, comprise 1% or greater of the composition, are physical hazards, are capable of release to exceed permissible exposure limit/threshold limit values or have been identified as carcinogens. Refer to the SDS.

* 1. **Cleaning Agent**
		1. CELLCLEAN AUTO: Detergent for fully automated hematology analyzer. To be used as a strong alkaline detergent to remove lysing reagents, cellular residuals, and blood proteins remaining in the hydraulics of the analyzer on XN Series/XN-L Series automated hematology analyzers.

CELLCLEAN AUTO Storage

1. Store at 1-30o C, away from direct sunlight.
2. Do not use the reagent if it is suspected to have frozen.

CELLCLEAN AUTO Stability

1. Unopened, it is stable until expiration date printed on the container.

CELLCLEAN AUTO Hazard Risk

The OSHA Hazard Communication Standard of 29CFR part 1910.1200 requires SDS documentation of ingredients which have been determined to be health hazards, comprise 1% or greater of the composition, are physical hazards, are capable of release to exceed permissible exposure limit/threshold limit values or have been identified as carcinogens. Refer to the SDS, CELLCLEAN AUTO is corrosive and may cause burns to skin.

* 1. **Commercial Control Material for XN-450**
		1. XN- L CHECK
1. Manufactured by Streck, available as a tri-level package.
2. Whole blood commercial control used to monitor performance of all XN-450analyzers.
3. Formulation
	1. XN-CHECK Consists of human red and white blood cells with a platelet component suspended in fluid medium. XN-L CHECK consists of human and/or animal red and white blood cells with a platelet component suspended in fluid medium.
	2. Each vial contains 3 mL of control material.
4. Storage
	1. Store vials at 2-8oC
	2. Do not freeze or expose to excessive heat.
5. Stability
	1. Unopened and properly stored, XN-L CHECK is stable until the expiration date printed on the unopened vial.
	2. Open vial stability is 15 days for XN-L CHECK when promptly refrigerated after each use.
	3. Record the date on each vial upon opening or cap piercing.
	4. Heat or freezing can damage XN-L CHECK without gross visible changes. Moderate hemolysis can be normal. Deterioration is suspected when the mean of the control results is not within the assay expected ranges after appropriate troubleshooting.
	5. If deterioration is suspected, call the Sysmex Technical Assistance Center. 1-888-879-7639 (1-888-8SYSMEX)
	6. **Calibrators**
		1. XN CALTM: for use in calibrating the analyzer for WBC, RBC, HGB, HCT, PLT

XN CAL Storage

* 1. Store the calibrator in a dark refrigerator at 2-8oC

XN CAL Stability

* + - 1. Unopened and properly stored, XN CAL is stable until the expiration date printed on the unopened vial.
	1. Open vial stability is 4 hours.

**III. XN-450 Reagent Replacement – QC ( all levels) Must be ran after any reagent change**

* + 1. When the replacement of reagent is required, an error message appears. Promptly acknowledge the error message by clicking execute to enter the reagent replace dialog box and proceed to replace the indicated reagent. Verify that “CAPS LOCK is off.
		2. Replacing a new diluent / hemolytic agent
			1. Touch the name of the reagent to be replaced.
			2. Place a check-mark next to ‘Replace the reagent,’ then place the cursor in the reagent code text box.

3. Using the hand-held reader, scan the reagent code on the new reagent container. **NOTE:** Scan Reagent Code 2 when available on the reagent container.

4. Remove the cap from the expired/empty container and carefully remove the spout.

5. Pull out the dispensing, set straight up.

6. Insert the dispensing set straight into the new reagent container and close the cap.

7. Select [Execute]

a. Reagent replacement starts. When complete, the dialog box closes

 automatically.

* + 1. Replacing Dye
			1. Display the [Reagent Replacement] dialog box.
			2. Prepare the new reagent cartridge.
				1. Confirm the reagent has not expired.
			3. Pull out the dye holder.
			4. Slowly remove the dye cover, taking care that dye does not drip.
			5. Remove the entire dye holder.
				1. When the dye holder is removed, a Help dialog box appears in the IPU screen.
			6. Remove the old reagent cartridge from its holder.
			7. Install the new reagent cartridge into the holder
				1. Make sure the color of the label on the new reagent cartridge matches the color of the dye cover and install. Analyzer will beep as confirmation of new reagent installation.
				2. If the wrong reagent is installed, the analyzer beeps repeatedly and the Help dialog box appears in the IPU screen.
			8. Place the dye cover.
				1. Place into dye holder.
				2. The ID of the new reagent is read automatically and the information is registered.
			9. Close the dye holder.
				1. Reagent replacement starts.
				2. When complete, the reagent replacement window closes automatically

 ***CAUTION:***

* Do not use the reagent outside of the written intended use, or not according to the written directions for use.
* When replacing this reagent, do not refill and use the same container.
* Handle the reagent with care to prevent air bubbles from foaming.
* Do not use expired reagents.
* If the reagent is removed after it has been connected, (i.e. opened), it may become contaminated with bacteria causing its performance to deteriorate. Therefore, reconnecting an open reagent is not recommended.
* NEVER allow contact of the reagent with the human body. Avoid contact with skin and eyes, and avoid ingestion. If it comes in contact with the skin, rinse skin thoroughly. If it gets in the eye, rinse with large amounts of water and seed immediate medical attention. If swallowed, seek medical advice immediately.
* Before use, please read the safety data sheet carefully.

**IV. PRECISION and CALIBRATION**

Initial calibration is performed during installation by the Sysmex Service Engineer.

Perform calibration as needed, e.g., when QC data is fluctuating. However, if the abnormality in the QC analysis data was caused by an error in the analyzer, degradation of the reagent, or degeneration of the control blood, do not perform calibration. Calibrators traceable to reference methods are used in the calibration of the analyzer. The laboratory must verify calibration every six months or on an "as-needed" basis to ensure accuracy of system. Calibration verification is also required if one or more of the following occur:

* Critical parts are replaced, Controls show an unusual trend or are outside of acceptable limits and cannot be corrected by maintenance or troubleshooting.
* When advised by Sysmex Service Engineer.

Calibration should only be completed when troubleshooting indicates that there is no major underlying problem with the analyzer, reagents or quality control materials.  Calibration verification may be performed by review and documentation of commercial control data, proficiency testing results. The operator may calibrate the following parameters using XN CAL calibrator: WBC, RBC, HGB, HCT, PLT. Calibration verification may also be accomplished by processing a commercial calibrator and comparing results to those published on the calibrator assay sheet.

**Option One**

The most common processes for Precision and Calibration of the Sysmex analyzer is the utilization of Sysmex sponsored calibration/precision events defined by the analyzer service contract. Calibration verification procedures may be done by a Sysmex SE on-site or remotely through the Sysmex Network Communications System (SNCS™) with the Sysmex Calibration Specialist.  The following items are completed by the Sysmex representative during the calibration verification process:

* Documentation and review of analyzer service history.
* Documentation and review of QC testing results.
* Documentation and review of historical Sysmex ***Insight***™ reports.
* Analyzing the Sysmex calibrator according to the manufacturer’s recommendations to verify precision and calibration (accuracy) of the analyzer.
* Documentation of calibration verification results and generation of a calibration verification certificate for laboratory records.

 **Option Two**

Precision and Calibration may be performed by the operator. The operator may calibrate the following parameters using XN CAL calibrator: WBC, RBC, HGB, HCT, PLT.

**Before calibration, ensure that routine cleaning has been performed and precision check is within acceptable limits.**

1. Precision Check
2. Perform routine maintenance on the analyzer and perform a background count to ensure counts are within acceptable limits.
3. Verify that there is sufficient volume of all reagents. Precision and Calibration procedures will be aborted if the XN-450 runs out of reagent.
4. Obtain a sample of fresh normal whole blood. **Do not** use commercial controls or calibrators for precision. The blood donor specimen should:
5. Be a healthy person who is not taking any medication.
6. Have morphologically and numerically normal CBC.
7. Be drawn in potassium EDTA anticoagulant tube using proper collection technique.
8. Have a minimum of 2.5 mL of sample.
9. On the main unit, check the Status indicator LED. Confirm the LED is green indicating the analyzer is Ready.
10. Select the Analyzer menu button on the control menu.
11. Select [Calibration] – [Precision Check]
12. Mix the vial containing the sample – 10 end-over-end inversions confirming cell button is dispersed
13. Place the vial in the sample tube holder
14. Press the start switch on the analyzer.
15. Repeat mixing and analysis (total of 11 times).
16. The results are displayed in the [Precision Check] analysis dialog box.
17. If the analysis results do not satisfy conditions for normal results or if results are outside acceptable limits, the test numbers of the tests that must be repeated are displayed. Select and redo the manual analysis.
18. When all analysis results satisfy the conditions, select [OK] in the dialog box.
19. Select [Yes] to record passing precision results in the precision check history.

NOTE: If an error occurs during analysis and the analysis can no longer continue, stop precision check. Once the error is cleared, redo the manual analysis.

1. Calibration – XN CAL
2. On the main unit, check the Status indicator LED. Confirm the LED is green indicating the analyzer is Ready
3. Select the Analyzer menu button on the control menu
4. Select [Calibration] – [Calibrator Calibration]
5. Mix the vial containing the calibrator according to package insert
6. If sample tube holder is not ejected, press the sample tube holder open/close
7. Place the vial in the sample tube holder
8. Press the start switch on the analyzer.
9. Repeat mixing and analysis (total of 11 times)
10. The results are displayed in the [Calibrator Calibration] analysis dialog box.
11. If the analysis results do not satisfy conditions for normal results, or if results are outside acceptable limits, the test numbers of the tests that must be repeated are displayed. Select and redo the manual analysis
12. When all analysis results satisfy the conditions, select [Calibration] in the dialog box.
13. Select [OK] to display results in the [Calibrator Calibration] execution dialog box.
14. Select the check box to include the calibration parameter in the calibration exercise,

clear the check box to exclude the parameter in the calibration exercise. If a parameter meets all of the following criteria, the check box will automatically be selected:

* + - 1. 80% < New Rate < 120%
			2. New Rate – Current Rate < +5
			3. Range Value < Max Range
			4. Acceptable Limit < Delta Percent < Service Limit

If a parameter meets all of the conditions and the Delta Percent is less than the Acceptable Limit, it is excluded from calibration as there is no need for calibration. If a parameter does not meet all of the conditions and the Delta Percent is greater than the Acceptable Limit, the calibration cannot be performed. Calibration is performed with the parameter excluded. Selecting the check box enables you to manually enter a value in [New Rate (%)]. A range of 80% to 120% may be entered.

14. Select [OK] to update the compensation rates. The calibration process is logged in the calibrator calibration history.

**V. QUALITY CONTROL**

Quality control is performed in order to monitor an analyzer’s performance over time. XN-L CHECK is the material used to monitor the performance of the XN-450 analyzer. Quality control should be run in accordance with regulatory agency requirements. Three levels of quality control will be ran every 12 hours. The BeyondCare Quality Monitor program is a toll that will help you determine when troubleshooting is necessary and dynamic screen prompts will guide the end user for the next action. All troubleshooting actions are logged in the Activity Log. (Reference the BeyondCare Quality Monitor User Manual)

**XN-L CHECK Commercial Controls Instructions for Use**

1. Remove vials from refrigerator and allow them to come to room temperature (18-25oC), for approximately 15 minutes.
2. Mix vials according to the package insert accompanying the product until the cell button in the bottom of the vial is completely suspended.
3. Perform a close visual inspection of each vial confirming the cell button is completely removed from the bottom of the vial and cellular elements are uniformly suspended with no aggregates.

  **Frequency of Control use and review**

XN CHECK/XN-L CHECK control levels: L, N, H will be run on DAY shift.

XN CHECK/XN-L CHECK control levels: L, N, H will be run on NIGHT shift.

The supervisor reviews the following QC reports at the following intervals:

* Insight IQAP every 30 DAYS
* Exception Report every 30 DAYS
* Summary Report every 30 DAYS
* Continuous Calibration Verification Certificate every 6 MONTH / Daily QC
* Calibration Certificates every calibration.
* Detailed Daily Verification Report every 30 DAYS
* Parameter Report every 30 DAYS
* Traceability Report every 30 DAYS

A**. Registering and modifying a QC file – lot information input**

* 1. Select [QC File] icon
	2. Select a QC file that does not have a lot registered.
	3. Select [Register[
	4. Select [Read Assay file]
	5. Select the correct QC product, lot number, and level
	6. Select [Ok]
	7. Verify the QC lot number, level and expiration date matches the QC vials received by the lab.
	8. Repeat for each level of XN-L CHECK to be registered.
	9. Perform parallel studies between production lot and new lot prior to production lot expiration.

B**. XN-L CHECK QC Analysis**

1. Confirm the analyzer is in a Ready state.
2. If sample tube holder is not ejected, press the sample tube holder open/close switch.
3. Touch [Mode] on the control Menu.
4. Touch the Analysis Mode. Select Whole Blood.
5. Touch OK.
6. Touch the [QC] icon on the Menu screen.
7. Touch the [QC Analysis] icon.
8. From the QC file list, touch the file you want to analyze.
9. Perform Manual analysis on thoroughly mixed vial.
10. Check the analysis results in dialog box. Touch [Accept].

a. If analyzer displays **GREEN**, this indicates QC passed and analyzer is

 ready to process samples.

b. If analyzer displays **YELLOW**, more information is needed or QC is

 overdue. The resolve button becomes active if there is a QC value

 outside of limits.

c. **RESOLVE** is activated: If a QC error has been detected, resolve button

 becomes active and dynamic troubleshooting prompt guides the end

 user to the next course of action. The instructions button gives details

 on how to perform the troubleshooting action.

d. **QC is overdue**: End user needs to analyze QC since it exceeds the

 timeframe from the preferences screen.

e. If analyzer displays **RED**, QC failed analysis and analyzer is

 determined out of service with a reference to a service call.

For a calendar view of whether the QC passed or failed, access the Summary report which will also display background status,

* + - P= Last 2 different levels of QC passed
		- F= QC failed
		- B= Background counts pass
		- X= Background counts failed
		- ?= Run QC
		- L=XNBF QC passed
		- D=XNBF QC failed
		- S= service event
		- Calibration (EBC)

 C**. New QC lot crossover or parallel studies**

As soon as the new QC lot is received, the new lot is analyzed in conjunction with the current QC. The BeyondCare Quality Monitor program establishes the target and limit values for the new QC lot as soon as the first vial of each level gets analyzed.

D**. Reviewing Quality Control Results in BeyondCare Quality Monitor**

* + - 1. If analyzer displays **GREEN**, this indicates QC passed and analyzer is ready to process samples.
			2. If analyzer displays **YELLOW**, more information is needed or QC is overdue.
			3. **More information is needed**: If a QC error has been detected, a

 Dynamic troubleshooting prompt guides the end user to the next

 course of action. A video display is also a selectable feature.

* + - 1. **QC is overdue**: End user needs to analyze QC since it exceeds the timeframe from the preferences screen.
			2. If analyzer displays **RED**, QC failed analysis and analyzer is determined out of service with a reference to a service call.

For a calendar view of whether the QC passed or failed, access the Summary report which will also display background status,

* + - P= Last 2 different levels of QC passed
		- F= QC failed
		- B= Background counts pass
		- X= Background counts failed
		- ?= Run QC
		- L= XNBF QC passed
		- D= XNBF QC failed
		- S= service event
		- Calibration (EBC)

BeyondCare Quality Monitor will automatically not manage (exclude) a QC run if a corrective action has taken place and the same QC level is repeated and falls within the BeyondCare Quality Monitor specification limits. A “SM” (system managed) symbol will appear next to the raw data in the ***Insight*** report. No QC runs are ever deleted.

If the QC reviewer decides to manage (include data in calculations) or not manage (exclude data from calculations the BeyondCare Quality Monitor application), log into ***Insight*** ([www.sysmex.com/Insight](http://www.sysmex.com/Insight)) and select Review QC data which will allow QC data management by the ***Insight*** user.

**E. Quality Control Management**

* 1. From the QC Chart view, select the [Manage] button on the toolbar.
	2. Select Cursor Data Management.
	3. Specify whether a QC run should be excluded from quality control
	4. Select [Not Manage] to exclude data from the following:
		+ Statistical computations (SD, Mean, CV)
		+ Variable target computation
		+ Number of data points = n
	5. An open circle will be displayed on the L-J Chart when the QC run is not managed or excluded and is not connected by a line to the adjacent QC runs.

**NOTE**: XN-L Managed and Not Managed comments and results **“Do Not”** upload to ***Insight.*** To keep ***Insight*** consistent with the QC file on the XN-L analyzer, log into ***Insight*** and manage the same data point.

* 1. A comment may be added to the QC data selected by the cursor
		+ Select [Any Comment] to input a free text comment.
		+ Select [Comments Settings] to use a comment from a list of preset comments in the QC settings menu.
		+ Select [OK]
		+ A comment bubble will be displayed when a comment exists for a QC run.
		+ The comment will be visible in the comment display area when the cursor is placed on the QC run.

**F. Recording and Storage of QC Data**

 **1.** . Printing and saving QC Data

* + - Select [QC Files] icon and highlight file to output.
		- Select [QC Chart] icon.
		- Set Range of points to output by clicking [Range] and capturing the points with the cursors.
		- Select [Output] to print the selected chart to either GP or LP.
		- Select [File] to save the data to removable media.

**NOTE**: Comments that were added to the data do not print on the GP and LP report.

* + - The BeyondCare Quality Monitor application stores the last 2.5 years of QC data on demand. All QC data older than 2.5 years is archived.

**G. Review of QC Data**

* + 1. The following reports should be reviewed at regular intervals according to the laboratory’s policy: ***Insight*** *Report, Detailed Daily Verification Report, and Continuous Calibration Verification Certificate.*
		2. Once these reports have been reviewed through the BeyondCare Quality Monitor application, they can be accessed by going to

Activity \_ Reviewed Documents.

* + 1. Reports are archived for 2.5 years in BeyondCare Quality Monitor. Reports that are older than 2.5 years can be attained by contacting Sysmex Technical Assistance Center.

**H. Printing and saving QC Data**

1. Select [QC Files] icon and highlight file to output.
2. Select [QC Chart] icon.
3. Set Range of points to output by clicking [Range] and capturing the points with the cursors.
4. Select [Output] to print the selected chart to either GP or LP.
5. Select [File] to save the data to removable media.

NOTE: Comments that were added to the data do not print on the GP and LP report. In the event SNCS (Sysmex network communication system) loses connection:

a. BeyondCare Quality Monitor becomes unavailable until SNCS connection is restored.

b. Review the QC files on the analyzer IPU

**I. *Insight*™ Quality Assurance Program (QAP)**

If your laboratory maintains an SNCS connection, the QC results will transmit automatically to ***Insight*** after each run. There is no need to batch upload the data to ***Insight***. The ***Insight*** account number is 33095 The XN-450serial # is 12310. Lead Technologist is responsible for saving the data to a USB memory device and submitting by due date in lieu of an SNCS connection.

* 1. Each XN-CHECK lot has 2 data submission dates, approximately every 30 days for the 84-day dated product ***OR*** each XN-L CHECK lot has 3 data submission dates for the 100-day dated product.
	2. Data may be managed in the XN-IPU and/or in ***Insight***. See ***Insight*** User Manuals.
	3. Insert flash drive into USB port on the back of XN-L.
	4. Select the QC file you want to output, click [File], [Output in Sysmex ***Insight***]. Save the file to the flash drive.
	5. Repeat for each file needing ***Insight*** submission.
	6. Properly eject the flash drive from the IPU.
	7. At a networked PC, establish connection with the ***Insight*** program via [www.sysmex.com/us](http://www.sysmex.com/us) and submit the data. Contact the ***Insight*** team with questions at: 888-879-7639 (888-8SYSMEX).

**VI. OPERATING PROCEDURE**

**A. Start-Up Procedure**

* + 1. Checks prior to turning on:
			- 1. Visual inspections of analyzer / system / reagents
				2. If applicable, verify waste container is empty.
				3. Verify network / host connections are properly working.
				4. Verify sufficient reagent supply is nearby.
		2. Turning ON the entire system
			- 1. Verify that all power switches for the device is in the ON position
				2. Press the **Green** power button on the front of XN-L to power ON the entire system
		3. Log on to the XN-450 IPU
			- 1. When the logon dialog box appears, enter user name and password.
		4. Analyzers self-checks
			- 1. XN-450: Initialization of the mechanical parts; Rinse; Temperature stabilization;
				2. Background Check (up to 3 times).

|  |
| --- |
| **XN-L Acceptable Background Counts** |
| **Parameters** | **Acceptable Limit** |
| WBC | 0.10 x 103/ μL |
| RBC | 0.02 x 106/μL |
| HGB | 0.1 g/dL |
| PLT-I | 10 x 103/ μL |

5. Analyze Quality Control Material

* 1. **Patient Sample Processing**
1. Manual Analysis
	* 1. Check the status of the analyzer. Confirm the analyzer is ready.
		2. If the sample tube holder is not ejected, press the sample tube holder open/close switch.
		3. If you want to change the analysis mode, touch [Mode] in the control menu
		4. Select analysis mode

1. [Whole blood] is selected when whole blood is being analyzed

2. [Low WBC] Select this to perform low WBC analysis on Whole Blood

3. [Pre-Dilution] select when running 1:7 diluted blood.

e. Select [OK]

f. Select Manual Analysis button on the control menu

g. Input sample ID or use handheld barcode reader to scan sample ID.

 1. Patient information- Touch Input to enter patient ID.

 2. Query to Host-Specify whether or not the host is queried for the analysis order.

3. Aspiration Sensor- Specify whether or not the aspiration sensor is used.

4. Cap Open- Select this checkbox to perform micro sample analysis (analysis with the sample tube cap open.)

5. Raised Bottom Tube-– *See Instructions for Use Manual.*

6. Dispense- Used to prepare diluted blood. Touch to start dispensing

CELLPACK DCL. For the dispensing procedure, see the following. (section 4.8

Preparing diluted blood with the diluent dispensing function in the XN-L Series XN-450 Basic Operation Manual)

h. Select [OK]

i. Properly mix the specimen and place in the tube holder.

1. If running microtainer, remove the cap using caution to avoid splattering.

j. Press the start switch on the analyzer.

1. The tube holder will slide in and the sample will be aspirated.

2. When the analysis is complete, the tube holder slides out.

k. Remove the sample, repeat steps for additional samples.

l. Review results in IPU to determine whether repeat or reflex testing is required.

 m. Rerun sample if required. Make smear if required.

**VII. Maintenance**

**A. XN- 450 Shutdown – performed daily**

1. Confirm analyzer and sample unit are at ready.

2. If sample tube holder is not ejected, press the sample tube holder open/close

 switch.

3. If any tubes remain in holder, remove.

4. Touch [Menu] on Toolbar.

5. Touch [Shutdown]. Touch [OK].

 a. XN-L on-board maintenance history will auto-populate Shutdown.

 b. IPU will automatically shut off at the conclusion.

 c. Press **Green** power button to restart IPU.

**B. XN-450 Routine Cleaning – performed weekly**.

CELLCLEAN AUTO is used to shut down the entire system. Refer to the

XN-L Series *Troubleshooting Manual* for detailed, illustrated procedures.

1. Confirm analyzer is at ready.

2. Touch the [Maintenance] Icon in the Menu screen.

3. Touch [Rinse Instrument].

4. Touch [Routine Cleaning].

 a. If sample tube holder is not ejected, press the sample tube holder open/close

 switch and place CELLCLEAN AUTO in tube holder.

 b. Press start switch.

 c. XN-450 on-board maintenance history will auto-populate Routine

 Cleaning.

 ***CAUTION:***

* Use 1 vial of CELLCLEAN AUTO for each instrument. Do not reuse CELLCLEAN AUTO that has previously been used.
* During Shutdown, other sample tubes are not accepted.

Maintenance performed on the XN-450 will be automatically tracked in the maintenance history. Refer to the XN-L Series *Troubleshooting Manual* for ‘as needed’ maintenance.

**VIII**. **PROCEDURAL NOTES AND CALCULATIONS**

 A. If making a dilution of a patient specimen and running in XN-L Whole Blood mode,

 multiply the parameters by the dilution factor.

 B. Do not use undiluted CELLPACK DST for dilution of patient samples.

 C. If correcting the HGB or HCT due to interfering substances, recalculate and correct the

 affected indices:

1. MCHC = HGB / HCT x 100

2. MCH = HGB / RBC x 10

3. MCV = HCT / RBC x 10

 D. Current on-board rules must be exported and saved on external storage device each

 time a change is made. A printout of the rules should be inserted in the XN-L Series

 Application Manual.

 E**. Do not place samples on a mechanical rocker. Excessive mixing may alter white cell membranes resulting in false interpretive messages.**

 F. For troubleshooting specifics refer to the XN-L Series *Troubleshooting Manual*.

**XI. LIMITATIONS OF PROCEDURE**

1. **XN-L Series Linearity**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Range** | **Units** |
| WBC | 0.04-440.0  | x103/μL |
| RBC | 0.02-8.60  | x106/μL |
| HGB | 0-26.0  | g/dL |
| HCT | 0.2-75.0  | % |
| PLT | 1-5000  | x103/μL |

1. Parameters that exceed these limits are flagged with @ beside the result. The sample must be diluted, rerun and multiplied by the dilution factor.
2. Note the use of dilution for linearity on the patient report.

**Laboratory Verified Reportable Range**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Operating Range** | **Units** |
| WBC | 0.0 - 150 | X 103 cells/µL |
| RBC | 0.00 – 8.0 | X103 cells/µL |
| HgB | 0.00 – 30.0 | g/dL |
| MCV | 50.0 – 150.0 | fL |
| PLT | 0.00 – 3000 | X 103 cells/µL |
| LY% | 0 – 100 | % |
| MO% | 0 – 100 | % |
| GR% | 0 – 100 | % |
| LY# | 0 – 99.9 | X 103 cells/µL |
| MO# | 0 – 99.9 | X 103 cells/µL |
| GR# | 0 – 99.9 | X 103 cells/µL |

**B. Possible Sample Interferences (For additional information, reference the analyzer** *Instructions for Use*, *Flagging Guides, and Clinical Case Reports* located on the CRC).

1. Specimens must be free of clots and fibrin strands.
2. Marked changes in plasma constituents (e.g., low sodium, extremely elevated glucose) may cause cells to swell or shrink. The blood to anticoagulant ratio is important.
3. Red cell fragments, microcytic RBCs or white cell cytoplasmic fragments may interfere with automated platelet counts.
4. Cold agglutinins produce spurious macrocytosis, elevated MCHs MCHCs, falsely decreased RBC counts and HCTs. Rare warm agglutinins produce the same spurious results as a cold agglutinin.
5. Extremely elevated WBCs may cause turbidity and falsely increase the hemoglobin, in addition to RBC and HCT values.
6. Severely hemolyzed samples (*in vitro*) falsely decrease RBC and hematocrit. Recollect hemolyzed specimens.
7. Giant platelets and clumped platelets may falsely elevate the WBC count and falsely decrease the platelet count. Platelet clumping and/or "platelet satellitism" can occur in specimens collected in EDTA.  This may falsely elevate the WBC count and falsely decrease the platelet count.   There are different methods for handling samples with platelet clumping or “platelet satellitism”.  These methods include vortexing of the original sample and reanalyzing or adding amikacin to the original sample and reanalyzing.  Laboratories should define and validate the method(s) used by their facility.
8. Abnormal paraproteins found in blood from patients with Multiple Myeloma can falsely increase the HGB. To correct HGB perform plasma replacement.
9. Severely icteric samples may falsely elevate the HGB value and related indices. Make a 1:5 dilution with CELLPACK DCL.
10. Rocking specimen excessively, may affect the WBC differential.
11. Megakaryocytes may falsely increase WBC counts on automated hematology analyzers.
12. **Flagging and Action Messages**

Abnormal samples on the XN-L Series are identified using flagging systems to alert the user of a possible abnormality.

1. Suspect flags generate a message (e.g., Atypical Lymphocyte, WBC Abnormal Scattergram). Numerical results will display an asterisk and the specimen result will display as “Positive”.
2. Analyzer generated error codes (e.g., DIFF channel errors). Error will display in both the Browser and Explorer screens.
3. User defined flags (e.g., leukocytosis, anisocytosis). These flags are programmable by the customer in the settings menu. When threshold limits are exceeded, a message appears and the specimen result will display as “Positive”.
4. Action Messages - The results are displayed in the Browser Screen.
5. **Any (\*) next to a parameter indicates these results may be unreliable and should be confirmed by reviewing the smear.**
6. Specimens judged as NEGATIVE does not indicate the sample as normal it indicates the results will be auto-verified and do not need any review.
7. Refer to XN-Series Automated Hematology Systems Flagging Interpretation Guide for more information on flags.
8. Abnormal Flags Code Display



**\*\*All Flagged Abnormal specimens need either a diff or a slide review follow Diff criteria.**

**\*\*NOTES\*** **MANUAL DIFFERENTIALS ARE PERFORMED ON ALL CHILDREN, 0 through 2 years.**

 **1. Review the WBC and differential data:**

1. Perform a differential if there are any action flags. To include: %LY >60.0, %MO >20.0, %EO >20.0 or %BA >5.0.
2. Refer to procedure 7180-HE-0470. Note your estimate on the printout as you review the smear. Report the WBC count matching your WBC estimate from the peripheral smear.
3. Perform a manual diff if the WBC is < 2.0 or > 25.0x10³/uL. Dilute any WBC > 440.0 x 10³/uL. Refer to procedure 7180-HE-0465 “DILUTION OF A HIGH WBC”.
4. Pseudoleukocytosis can be due to: Platelet clumps, giant platelets, unlysed RBC’s, NRBC’s, megakaryocytes, red cell inclusions, cryoproteins or circulating mucin.
5. Any WBC Flags need a differential performed on them excluding HGMDF
6. Any asterick (\*) appears next to the Lymphocyte, Neutrophil, Immature Granulocyte and Monocyte % and # indicates results may be unreliable and need a manual differential performed.
7. If dashes (--) are in place of numeric data, verify differential results by repeating sample and perform manual differential if indicated.

|  |  |
| --- | --- |
| **WBC Flag** | **Action** |
| NRBC Present  | Manual Differential / Partial Post |
| IG Present  | Manual Differential / Partial Post(IG includes Metas, Myel, and Pro’s) |
| Blasts/Abn Lympho? | Manual Differential / Partial Post |
| Atypical lympho? | Manual Differential / Partial Post |
| Left Shift? | Manual Differential / Partial Post |
| Neutropenia or Neutrophilia | Manual Differential / Partial Post |
| Lymphopenia or Lympocytosis | Manual Differential / Partial Post |
| Leukocytopenia or Leukocytosis | Manual Differential / Partial Post |
| Monocytosis | Manual Differential / Partial Post |
| Eosinophilia | Manual Differential / Partial Post |
| Basophilia | Manual Differential / Partial Post |
| WBC Abn Scattergram | Manual Differential / Partial Post |

**2. Review the RBC parameters:**

1. Review a stained peripheral smear for red cell morphology if there are any RBC flags. Scan a smear if Hgb is <7.0g/dL.
2. RBC indices should be monitored to check for random errors.
3. Interfering substances such as in-vitro **hemolysis, lipemia, cold agglutinins, rouleaux, microclots and osmotic matrix effects** will alter the RBC parameters and may present with pseudomacrocytosis. Indices can be affected by leukocytosis. Extreme microcytosis can cause a falsely decreased RBC and Hematocrit. ***Hemolysis*** may: falsely lower RBC counts and the Hematocrit, falsely increase the Platelet Count from red cell stromas.
***Lipemia*** may: falsely elevate the Hemoglobin and MCHC

***Cold agglutinins*** may: falsely lower the RBC count falsely increase the MCV and MCHC

* See procedure 7180-HE-0320 “PLASMA REPLACEMENT FOR INTERFERING SUBSTANCES IN HEMOGLOBIN DETERMINATION”
* 7180-HE-0135 “COLD AGGLUTININS”
* And for MCHC’s greater than 37.5 “REPORTING MCHC’s” 7180-HE-0255.

d. **If dashes (--) appear in place of RDW results perform a RBC Morphology on slide and result out RDW as a comment “Unable to Calculate**”

 **If dashes (--) appear in place of MPV results perform a Platelet Estimate on slide and result out MPV as a comment “Unable to Calculate**”

e. Any result with an asterisk (\*) indicates the result may be unreliable and should be confirmed with RBC Morphology slide review.

f.

|  |  |
| --- | --- |
| **RBC Flag** | **Action** |
| RBC Abn Distribution | RBC Morphology / Partial Post |
| Dimorphic Population | RBC Morphology / Partial Post |
| RBC Agglutination? | RBC Morphology / Partial Post |
| Anisocytosis | RBC Morphology / Partial Post |
| Fragments? | RBC Morphology / Partial Post |
| Macrocytosis | RBC Morphology / Partial Post |
| Turbidity/HGB Interf? | RBC Morphology / Partial Post |
| Iron Deficiency? | RBC Morphology / Partial Post |
| Microcytosis | RBC Morphology / Partial Post |
| Hypocchromia | RBC Morphology / Partial Post |
| Anemia | RBC Morphology / Partial Post |
| Erythrocytosis | RBC Morphology / Partial Post |

1. **Review the PLT parameters:**
2. Perform a platelet and WBC estimate from a stained peripheral smear if there is an PLT flag. Refer procedure 7180-HE-0335 “PLATELET ESTIMATE FROM A STAINED BLOOD SMEAR”. Note your platelet estimate on the printout as you review the smear.
3. Refer to EDTA Platelet Phenomenon procedure 7180-HE-0200 for cases that look like platelet agglutination caused by EDTA.
4. Dilute any PLT > 5000 x 10³/uL. Refer to procedure 7180-HE-0330 “DILUTION OF A HIGH PLT”
5.

|  |  |
| --- | --- |
| **PLT Flag** | **Action** |
| PLT Abn Distribution | PLT Estimate / Partial Post |
| PLT Abn Scattergram | PLT Estimate / Partial Post |
| PLT Clumps? | PLT Estimate / Partial Post |
| Thrombocytopenia | PLT Estimate / Partial Post |
| Thrombocytosis | PLT Estimate / Partial Post |

**Report abnormal platelet morphology in LIS with the manual differential/platelet estimate.**

1. **Review the analyzer printout for flags**:
2. Any **WBC** flags must have a microscopic differential.
3. Any **RBC l** flags must have a stained peripheral smear review for RBC morphology.
4. Any **PLT** flags must have a stained peripheral smear review to verify the platelet count, as in giant platelets, megakaryocytes or platelet clumps, RBC schistocytes or platelet satellitism.

 **5.** **Buffy coat differentials**

 a. Buffy coat differentials do not need to be performed more than one time in a 24 hour period. First time admits with Critical low WBC counts DO need a Buffy coat differential performed. See procedure below for making buffy coat smears.

BUFFY COAT PREPARATIONS*:*

* Order a “Buffy” on the patient’s CBC accession and use those labels for your smears.
* Using a 9” Pasteur pipette, fill a Wintrobe tube with well mixed EDTA blood that has been labeled with the patient’s name written on the Wintrobe tube. Insert the Wintrobe tube into a conical plastic Urinalysis tube. Use another conical tube with an empty Wintrobe tube as the balance and spin at 2900 RPM’s for 9 minutes.
* Remove the spun tubes and with a 9” Pasteur pipette, remove all the plasma down to about 2 lines above the cellular interface. Dispose of the plasma, and using the same pipette, go into the Wintrobe tube and gently aspirate the plasma remaining, the “buffy” layer and a small amout of RBC’s. Mix the sample within your pipette and distribute the drops onto smears (the number of smears depends on the amount of sample you have in your pipette, you should have 2-4 smears).
* Make your smears, they don’t always look as nice as regular peripheral smears. Label, let them dry and stain with Wright-Giemsa stain. If cellular distribution is uneven, use more than one smear to perform your diff.

For those specimens that need microscopic review make one smear using the wedge technique. Label them with an LIS label from the **Y04\_YHemo** printer per procedure 7180-HE-0430 “LABELING SLIDES”. Send the slide through the automated slide stainer. Stained smears are kept for a 1 week period in the slide storage box.

**REPORTING RESULTS**

Report results through the Laboratory Information System. Refer to the LIS Procedure Manual for complete instructions. Use the Result Worklist Template called “DIFF” to do manual diffs and verify all. The LIS has **delta checks** built in the system to monitor system errors**.** The system flags if the MCHC is >36.5 to prevent erroneous resulting. Soft will consider this result “Absurd”, if it remains above 36.5, add a canned message that it has been “rerun and/or verified to the MCHC.

**Calculations**

With plasma replacement procedure due to lipemia - Indices may need to be recalculated. See Procedure 7180-HE-0320.

## XII. REFERENCES

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