

Classification:**OPEN**

Document No.	NLM-SPE-00038
Rev. No.	02
Department/Section:	PREDISPOSAL OPERATIONS
Title: REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES	

Authorization

	NAME	SIGNED
PREPARED	ML VAN STADEN (Senior Scientist: Radwaste)	
CHECKED	L HORDIJK (Waste Specialist: NLM)	
CHECKED	G SCHONKEN (Team Leader: Software Development)	
CHECKED	AA VAN ASWEGEN (Supervisor: Radwaste)	
CHECKED	JH LUBBINGE (Engineer: Radwaste)	
ACCEPTED	ES TSHABALALA (Acting Manager: PDO)	
APPROVED	ZP DLAMINI (Manager: Radwaste)	

Distribution list:

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	2 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

NO.	NAME	NO.	NAME	NO.	NAME
1	NLM QA RECORDS	7	JH LUBBINGE*	13	
2	CJE DE JAGER*	8	ZP DLAMINI*	14	
3	L HORDIJK*	9	AA VAN ASWEGEN*		
4	ML VAN STADEN*	10	MM VAN ZYL*		
5	ES TSHABALALA*	11			
6	G SCHONKEN*	12			

*= Distributed via E-mail

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	3 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

Revisions

This document has been revised according to the following schedule:

Revision	Date Approved	Nature of Revision	Prepared by
00	19/05/2021	First Issue	ML VAN STADEN
01	16/08/2021	Including of barcode readers	ML VAN STADEN
		Changes to incorporate deviations on X-ray URS	
02	See title page	Including of X-ray images into database	ML VAN STADEN
		Removing of requirement specifications that is covered in NLM-SPE-00042	

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	4 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

Contents:

No.	Description	Page
1.0	PURPOSE	6
2.0	DEFINITIONS AND ABBREVIATIONS	6
2.1	DEFINITIONS:	6
2.2	ABBREVIATIONS:	6
3.0	GENERAL OVERVIEW	7
4.0	GENERAL REQUIREMENTS	11
5.0	TECHNICAL REQUIREMENTS	12
5.1	DRUMVIEW / REGISTRATION	15
5.1.1	X-Ray and WSRF Screen	15
5.1.1.1	X-Ray Section	16
5.1.1.2	Segregation Input Section	17
5.1.1.3	Segregation Viewer Section	18
5.1.2	Barcode Reader (BCR)	18
5.1.3	Semi-Automatic Partial and Full Registration	18
5.1.4	X-ray Image Screen	19
5.1.5	IQ3 Results Screen	20
5.1.6	Partial Registration: Flagging of new drums	20
5.2	VRF ACCEPTANCE CRITERIA	21
5.3	WASTE ADMINISTRATION	22
5.3.1	Barcode Reader (BCR) Settings	22
5.3.2	Managing of X-ray database and images	22
5.3.3	Drum Press Batch Process	23
5.3.4	Default Registration Template for Semi-Automatic Population	24
5.3.4.1	Empty Drums	24
5.3.4.2	Liquid Containers	25
5.3.5	Administration Screen for Locations/Buildings	26
5.3.6	Administration Screen for Drum Status	26
5.4	REPORTS	26
5.4.1	Drum General Search	26
5.4.2	Scanner Acceptance Check report	27
5.4.3	Drum Press Barcode Valid	27
5.4.4	Tracking of Segregation and Analysis of new Items	27

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	5 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

5.4.5	X-ray Tracking	28
5.4.6	VRF Tracking	29
5.4.7	Drum Progress Tracking	30
5.5	RECOMMENDATION AND PROGRAMMING OF BARCODE READERS, AND THE INTERFACE WITH WTS	31
5.6	SECURITY	31

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	6 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

1.0 PURPOSE

The purpose of this document is to specify the required changes and upgrades needed on the Waste Tracking System (WTS) as after the rewrite of the current WTS as specified in NLM-SPE-00042: *Requirement Specification for WTS Rewrite*. This program/system is used to manage the Low Level Solid Waste (LLSW) processes of Necsa and consists of various sub program modules. The upgrade needs to incorporate new sub modules to manage (data/information recording and processes) for new processes which are introduced to inspect the content of the drums using an X-ray system and a system (WSRF) to remove any wet waste and/or freestanding liquid identified by the X-ray system.

The WTS uses barcode readers (BCR) as an integral part of the system which is also true for the new processes. Therefore the purpose of this document is also to specify the requirements related to the use of the new BCR(s) for the new processes. . Therefore the requirement for the upgrade also includes:

- Recommendation of minimum requirements of suitable barcode readers
- Programming of the barcode readers if needed
- Programming of the WTS/Barcode reader interface in the WTS

2.0 DEFINITIONS AND ABBREVIATIONS

2.1 DEFINITIONS:

Historic drum	Any drum that is already under the management of PDO at a date to be specified in the WTS.
Original barcode	This is the barcode that was on the waste drum containing the liquid and which was repacked at the WSRF. After repacking this barcode will be physically removed from the drum but it will stay in the WTS to maintain traceability.
Interlinkable	Possibility to track the barcodes of repacked drums/containers from the original barcode as well as to track the repacked drum/containers back to the barcode of the original drum. These links are also available in running queries.

2.2 ABBREVIATIONS:

WTS:	Waste Tracking System
LLSW:	Low Level Solid Waste
PDO:	Predisposal Operations
BNFL:	British Nuclear Fuel Limited (Pty)
SDS:	Segmented Drum Scanner

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	7 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

VRF:	Volume Reduction Facility
IAEA:	International Atomic Energy Agency
WSRF:	Waste Segregation and Repacking Facility
TBI:	To be Investigated
PLC:	Programmable Logic Controller
MS-SQL:	Microsoft Structured Query Language
FTP:	File Transfer Protocol
WSRF	Waste Segregation and Repacking Facility
BCR	Barcode Reader
DTC	Drum Transfer Certificate

3.0 GENERAL OVERVIEW

All the print screens displayed in this section are as from the WTS before the rewrite (see NLM-SPE-00042) and all the new screens needed for the upgrade are only shown as examples and for demonstration purposes.

The WTS is used to track the movement and to specify the current position of each barcoded container with waste in terms of store, row number, block number and pallet height of every waste drum under the management of PDO. The BCR used for the tracking of the movement is a Motorola MM90 terminal (mobile 6 Operating System). The position of the drum is logged by the operator on the BCR before reading the barcode. The barcodes together with the position are then downloaded in the WTS by using the *Download Batch* and *Drum Move* menus (see Figure 1). A report can then be generated of the list of barcodes downloaded. For the *Download Batch* additional information is added to generate the DTC.

Other information of the drums which is also captured into a database include among others the drum type, the client, the content of the drum (description of waste and a top view photo) and the characterisation information. The user interface containing the modules through which the capturing is performed is shown in Figure 1. The *Drum View/Registration* module as shown in Figure 1 is the module that contains all the information of the drum.

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

Figure 1: Print screen of Drum View/Registration module

As a security measure, specific sub modules and functions are allocated to specific user roles from the list of all the sub modules and functions in the WTS. Every user is given access to a specific user role.

Function	View	Add	Edit	Delete
Barcode Reader Settings	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Barcode Settings	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Can Import from Drum Registration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Close Batch	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Download Batch	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Drum Move	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Drum Streams	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Drum Transfers	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure 2: List of sub modules and functions as used in the WTS

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	9 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

The characterisation (identification and quantification of nuclides) of the drums are done by two gamma-ray scanners namely the BNFL SDS and the IQ3 scanners. The results produced from these two external facilities are logged respectively into each system's database. To incorporate the characterisation results of drums into the WTS -

- The results from the IQ3 scanner are manually transferred to the IQ3 backup database on the server through an administrator function (see Figure 3) from where the operator could import the data to the *IQ3 Results* tab through the *IQ3 Import* function (see Figure 1).

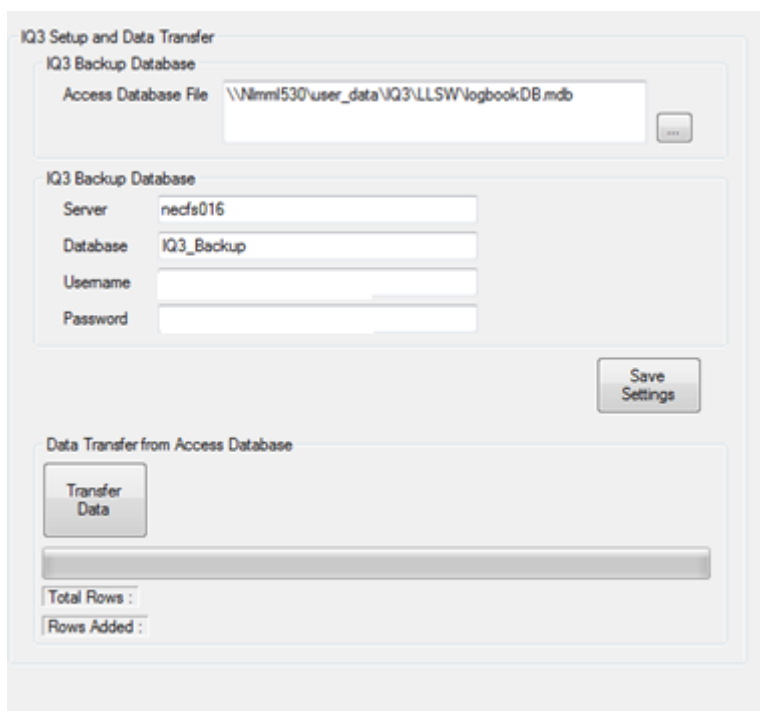


Figure 3: Print screen of the IQ3 Setup and Data Transfer function

- The results from the BNFL scanner are automatically transferred (during the night) to the SDS backup database. The measurement results of the BNFL SDS are not imported into the WTS database, but all the results of a drum are read from the SDS backup database and displayed in the *SDS Results* tab (see Figure 4) of the user interface of the WTS. Although the nuclide data is only read from the SDS backup database, the operation ID of the measurement and the waste class (as calculated from the SDS results) are automatically entered into the *DrumsTable* of the WTS directly after each successful measurement on the BNFL SDS.

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

Parameter	Value
Total U-235(g)	1.19589306811566
Total U(g)	59.806911310688
Drum Weight(g)	25781.25
Total activity(Bq/g)	141.413443012606
Beta/Gamma(Bq/g)	0.0729636209753788
Alpha(Bq/g)	141.34047939163
Ag-108 (Bg/g)	0
Ag-110 (Bg/g)	0
Am-241 (Bg/g)	0
Ba-133 (Bg/g)	0

Figure 4: Print screen of displayed BNFL data

The final step in the conditioning process of a drum containing compressible waste is to compact it at the VRF into a small puck (defined in WTS as a child drum) and to pack about 5 pucks into a 200 litre drum (defined in WTS as a parent drum). Before a drum is compacted at the VRF, the barcode is read by the PLC and sent to the WTS where it is checked and validated against a list of requirements by the WTS to ensure that all the information of the drum is captured and that the characterisation results comply with requirements. The outcome of the validation is then sent back to the VRF as a code which indicates whether the drum complies or not to the VRF acceptance criteria. Appendix 1 lists the codes with the corresponding meaning for each code which is also displayed at the VRF. The requirements include amongst other the waste class, mass of the drum, status of declaration to the IAEA and the waste description.

Since only dry waste is allowed to be stored in Pelstore, a need to inspect the content of the drums more thoroughly arose after liquid was pressed out of the drums during the volume reduction process at the Volume Reduction Facility (VRF). Two new facilities are planned to perform this function:

- The X-ray Facility to do a non-destructive assay of the drum content. New and historic drums will be scanned. Drums not containing liquid comply with the dry waste criteria and will be allowed to be compacted at the VRF. Drums containing liquid need to go, depending on the amount of liquid, to the liquid store or to the WSRF where it will go through a segregation and repacking process to ensure compliance. However, all the information (including characterisation results) as existing in the database for the drums that need to be repacked has to be kept unchanged and available for reference purposes.
- The WSRF where only historic drums containing liquid (as identified by the X-ray) will be segregated and repacked to ensure compliance. The new drums containing liquid have to be

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	11 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

immediately sent back to the waste generator which is responsible for removing the liquid. This implies that the new drums need a flag/indicator to distinguish them from the historic drums till it is proven at the X-ray that they do not contain liquid.

4.0 GENERAL REQUIREMENTS

- The contractor is required to assess the existing/new WTS system. The existing system and the details specified in this document shall be regarded as the specification for the newly to be developed system
- The source code of the current WTS shall be made available to the contractor by NECSA. The original as well as any previous upgrade user specifications shall also be supplied to the contractor.
- A declaration of secrecy must be signed by all potential suppliers before access to the source code and a test database of the current WTS system will be given. Current WTS system's source code shall be accessible from an FTP site.
- The contractor is required to assess the existing system, and add the additional functions as specified. Possible additions shall be made on the existing MS-SQL database to add the required extra functions/data fields. A test database (copy of current database containing minimum data) shall be made available to the contractor.
- All existing data must be migrated to the new database to ensure continuity.
- All the reports must be migrated to either MS-SQL reporting Services or Crystal reports and users must be able to view these as either PDF or Excel files, as specified in Appendix B.
- All files, photos, images, scans and other documents must be saved to the database using a suitable format and user must be able to retrieve these easily.
- No 3rd party add-ins, web services or any other external functionality to be used or included.
- NECSA users will perform end-user testing and supplier shall be responsible for resolving all issues identified during end-user testing.
- A formal handover to NECSA's IT staff of all source code and other development outputs shall be included.
- All source code and development outputs of the upgraded system must be directly accessible and maintainable by NECSA after handover to NECSA.
- All source code and other development outputs of the migrated system shall become Necsa's intellectual property after handover.
- NECSA staff shall deploy the signed-off system to all client computers.
- NECSA shall be responsible for updating the content in all user manuals on the migrated system.
- If required, the supplier's developer can be provided with a work space at NECSA to be in close proximity with the WTS system administrator for faster resolution of queries, etc.

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	12 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

- Contractors must include in their quote a detailed breakdown of development milestones and which percentage each milestone contributes to the total order amount. These shall be as far as possible be based on Necsa verifiable outputs (e.g. completed modules/sub modules/functions)

5.0 TECHNICAL REQUIREMENTS

The drum will be X-rayed (1 to 4 images per drum) at the X-ray Facility where the operator will determine a *Drum Status* for each X-ray image according to different *Drum Status* types that are defined in the X-ray system database for example compressible, non-compressible and back to generator.

If there is any uncertainty about the wet/dry condition of the content in a historic drum the drum will be flagged as such on the X-ray system and it will be sent to the WSRF where the contents will be inspected, segregated and repacked into a new drum (dry content) and into containers (liquid) as needed. Each of the repacked drums/containers will have a unique barcode which have to be interlinkable with the barcode of the original historic drum. The repacked drum also has to go through the X-ray to ensure a final acceptable *Drum Status* (compressible or non-compressible). The empty original (historic) drum will get a new barcode (the original barcode on the drum will be either removed and destructed, or physically made unreadable) and may then be re-used for other waste or the empty drum needs to be characterised by the BNFL before it will be compacted by the VRF.

The current acceptance criteria list for the VRF needs to be updated to include the *Drum Status* as determined by the operator utilising the X-rays of the drum. An additional acceptance list has to be implemented for the compaction of the empty drums which will be compacted on a campaign basis.

The flow diagram of the upgraded process from where the drum is inspected with the X-ray followed by the repacking (if needed), the gamma measurements and the volume reduction processes are shown in Figure 5. The new parameters are indicated in red text in the diagram.

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

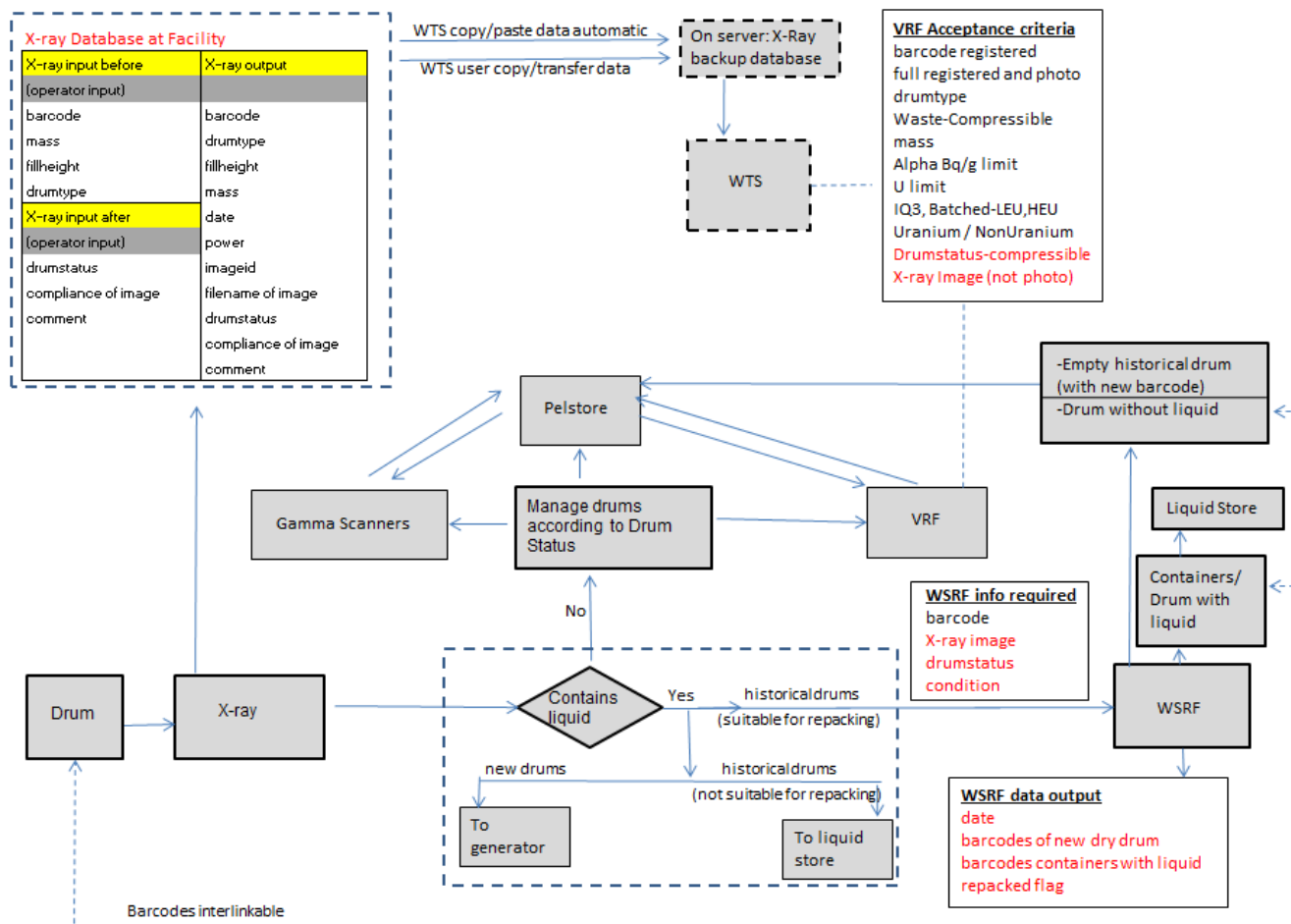


Figure 5: Flow diagram including the X-ray scanning and segregation/repacking processes

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

Table 1 shows a summary of the changes and additions needed to manage the new processes

Table 1: Summary of required changes		
Group	Screens/Functions	Changes
General	VRF acceptance requirements	<ul style="list-style-type: none"> • Drum Status according to X-ray to be added as an acceptance requirement • Incorporate acceptance requirements specific for empty drums
Drum View / Registration	X-Ray / WSRF Screen	<ul style="list-style-type: none"> • Add X-Ray / WSRF Screen to display the results from the X-ray and to capture the segregation data
	Photo Screen / X-ray Image Screen	<ul style="list-style-type: none"> • Add the PhotoID on the current Photo screen (also populate <i>DrumsTable</i> with PhotoID) • Add new X-ray Image screen to display X-ray Image as well as the links to the X-ray images
	Barcode Reader functionality	<ul style="list-style-type: none"> • Add a function to use a barcode reader to open the drum's info
	IQ3 Results Screen	<ul style="list-style-type: none"> • Add function to populate Review flag from IAEA batch / IAEA batch update • Populate Information of original historic barcode if applicable
	Partial Registration	<ul style="list-style-type: none"> • Add a function to automatically flag a new drum from a location other than NLM facilities
Reports	Drum General Search	<ul style="list-style-type: none"> • Incorporate the reporting of the X-ray Drum Status
	Scanner Acceptance Check	<ul style="list-style-type: none"> • Incorporate the reporting of the X-ray Drum Status
	Drum Press Barcode Valid	<ul style="list-style-type: none"> • Incorporate the check for Drum Status and check X-ray image instead of photo • Incorporate the requirement validation for empty drums
	Tracking of segregation and Analysis of new Items	<ul style="list-style-type: none"> • Add a new report for the tracking of the segregation process and the status of the new items regarding the analysis and the IAEA batching
	X-ray Tracking	<ul style="list-style-type: none"> • Add a new report to track the drums scanned by the X-ray
	VRF Tracking	<ul style="list-style-type: none"> • Add a new report for the tracking of the compacted drums at the VRF
	Drum Progress	<ul style="list-style-type: none"> • Add a new report for tracking the progress of the

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

Table 1: Summary of required changes

Group	Screens/Functions	Changes
	Tracking	drums through the different processes <ul style="list-style-type: none"> • Add a function to upload these results to the BCR
Waste Administration	Locations	<ul style="list-style-type: none"> • Add a new administration screen to add / edit / delete locations in existing Location Table
	Managing of X-Ray database and images	<ul style="list-style-type: none"> • Add an administration screen for managing the transferring of the X-Ray data and images
	Drum Status	<ul style="list-style-type: none"> • Add a new administration screen to add / edit / delete DrumStatus options
	Barcode Reader Settings	<ul style="list-style-type: none"> • Add new administration screen for defining new Barcode Reader settings
	Drum Press Batch Process	<ul style="list-style-type: none"> • Add an option for the empty drums on the current screen to allow for campaign compaction of empty drums • Add an additional acceptance list only applicable to empty drums
	Automatic registration of empty drums	<ul style="list-style-type: none"> • Add function to populate registration fields using a default empty drum registration template
	Automatic registration of WSR liquid containers	<ul style="list-style-type: none"> • Add function to populate registration fields using a WSR liquid container default registration template

5.1 DRUMVIEW / REGISTRATION

All the new screens as displayed in the following paragraphs are only shown for demonstration purposes.

5.1.1 X-Ray and WSRF Screen

Figure 6 is an example of the screen for the new inspection and repacking (segregation) processes. The first screen indicates an example of the original drum containing the liquid after completing the segregation process, while the second screen indicates how the screen for the new items looks after the process.

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

The figure displays two side-by-side screenshots of the WTS application interface, illustrating the X-Ray and WSRF modules.

Left Screenshot (X-Ray Section):

- BCR:** Barcode 000035678, Find by Client Drum No.
- Partial Registration:** Drum Type: SO16_6: 160L metal 0.8mm (Red), Waste Origin: Beva, Client Drum No: PAL 228.
- Current Position:** Building: ORD, Row: 0, Block: ORD, Palette: 0.
- External Dose Rate:** at 50 cm (µSv/h): 0.500000, at contact (µSv/h): .
- Calibration:** Drum ☐ Overpacked ☐ Parent ☐ Reg Date: 2003/05/01.
- Full Reg | SDS Results | IQ3 Results | Drum Photo | Compress | X-ray; WSRF**
- X-Ray Table:**

Date	Image ID	Image link	Status ID	Drum Status	Comment
12/4/2020	1357	C:\.....	2	Need Repacking	
- Drum Status:** Need Repacking (with Edit button).
- WSRF Section:** Date: 15/4/2020, Number new Items: 2.
- SEGREGATION INPUT:**

Barcode	Drum Type
000999051	160L WSR
000999136	5L WSR
- SEGREGATION VIEWER:** Original Barcode, View Selected Barcode.
- Buttons:** Add, Edit, Delete.
- Footer:** New Items Reviewed and Accepted ☒ View Selected Barcode.

Right Screenshot (WSRF Section):

- BCR:** Barcode 000999051, Find by Client Drum No.
- Partial Registration:** Drum Type: SO16_6: 160L metal 0.8mm (Red), Waste Origin: Beva, Client Drum No: PAL 228.
- Current Position:** Building: Pelitore, Row: 20, Block: U, Palette: 2.
- External Dose Rate:** at 50 cm (µSv/h): 0.500000, at contact (µSv/h): .
- Calibration:** Drum ☐ Overpacked ☐ Parent ☐ Reg Date: 2003/05/01.
- Full Reg | SDS Results | IQ3 Results | Drum Photo | Compress | X-ray; WSRF**
- X-Ray Table:** (Empty table with same headers as the left screenshot).
- Drum Status:** (Empty dropdown with Edit button).
- WSRF Section:** Date: 15/4/2020, Number new Items: 2.
- SEGREGATION INPUT:**

Barcode	Drum Type
000999051	160L WSR
000999136	5L WSR
- SEGREGATION VIEWER:** Original Barcode: 000035678, View Selected Barcode.
- Buttons:** Add, Edit, Delete.
- Footer:** New Items Reviewed and Accepted ☐ View Selected Barcode.

Figure 6: Possible screen to be used for the X-ray and repacking processes

5.1.1.1 X-Ray Section

- The X-ray data is read and listed for all the X-ray measurements of the barcode from the specified X-ray database on the NLM server. (All the images are stored with the barcode as part of the filename).
- Convert the names of the X-ray images to links from where the images are viewable as full screen images (The links for the last 4 scanned images are also listed on the X-Ray Image Screen –see paragraph 5.1.4).
- The final *Drum Status* as automatically displayed beneath the table could be only Compressible if all the entries of *Drum Status* for the last 4 X-ray images are Compressible, otherwise the final *Drum Status* is the *Drum Status* other than Compressible. The options for the *Drum Status* as defined in the X-ray database are also defined in the WTS through an administration function (see paragraph 5.3.6) for managing the WSRF section and the acceptance of the drum at the WSRF. Only a final *Drum Status* of Compressible will be accepted by the VRF.
- The final *Drum Status* can be manually edited by using a dropdown menu (by specified user roles) which will overwrite the automatically populated final *Drum Status*.

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	17 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

- The *Drum Compliance* box is automatically populated using the format, *barcode_C1C2C3C4*, with C1, C2, C3 and C4 the compliances (Y/N) of the last 4 scanned images (if available in the X-ray database it may be used). Possible to open the combined image as a full screen image from this screen.
- The final *Drum Status* and the *Drum Compliance* (as in Figure 6) must be populated in the *DrumsTable* of the WTS database.
- The *Segregation Input* section is disabled by default and will only become activated/enabled for specific final *Drum Status* options (see paragraph 5.3.6) as specified.

5.1.1.2 Segregation Input Section

- After completion of the segregation and repacking process, the operator needs to activate an *Acceptance Flag* for accepting the information of the new items as correct.
- Original drum contents could be packed in up to 7 other containers, each having a unique barcode. Barcodes of new items are entered by using a pop-up window and a Barcode Reader to read and capture the barcode of the new item in the WTS. However, it must also be possible for the operator to enter the barcode manually. The *Drum Type* of each new item is also needed to be specified by the operator from the pop-up window using a dropdown menu. Only drum types containing a specified phrase (for example “WSR”) are available in the drop down menu.
- Only possible to capture barcodes if not already registered. Display an error message if a barcode already exists.
- Possible to edit or delete the information of a new item before the *Acceptance Flag* is activated
- As soon as the *Acceptance Flag* is activated the following actions are automatically performed on the original barcode:
 1. The date of repacking is automatically populated
 2. The number of new items is automatically populated
 3. The address in the *Partial Registration* section is changed as follows- Building –ORD; Row(X)-0; Block(Y)-ORD; Palette(Z)-0
 4. *Barcode Status* is indicated as “WSRF : Historic drum” by populating the current *Status* column in the *DrumsTable*
 5. Change all the info of the drum to be only viewable, except for the *View Selected Barcode* button of the *Segregation Input* section which needs to be still active for opening the new items from the original barcode
 6. The barcodes of the new items as in the *Segregation Input* section as well as the original barcode needs to be populated in the *Segregation Viewer* section of each of the new items respectively (barcodes 1 to 7 as shown in Figure 6).

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	18 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

7. Possible to open barcodes of new items (drums/containers) from the original barcode.
- As soon as the *Acceptance Flag* is activated the following actions are automatically performed on the *Drum View/Registration* module of the barcodes of the new items (drums/containers):
 1. Registering of barcode and corresponding drum type (as specified in the pop-up window during the capturing of the barcodes for the new items)
 2. Populate the *Waste Origin* field with the same *Waste Origin* as the original barcode
 3. Populate the *Client Drum No.* field with the same *Client Drum No.* as the original barcode
 4. Automatically populate the rest of the partial and full registration parameters for the liquid containers as specified in the *Default Registration-Liquid Containers* template (see paragraph 5.3.4.2).
 5. Populate *IQ3 Results* screen as specified in paragraph 5.1.5

5.1.1.3 Segregation Viewer Section

- Barcodes of new items as automatically copied from the *Segregation Input* Section of the original barcode
- Data not editable
- All the barcodes (original and new items) have to be interlinkable (original drum numbers to repacked drum/container numbers; and repacked drum/containers back to original drum number) – through the *View Selected Barcode* button

5.1.2 Barcode Reader (BCR)

- Add an option to scan the drum's barcode to populate the barcode field for opening the drum's information (see Figure 6)

5.1.3 Semi-Automatic Partial and Full Registration

- Add a function to populate the partial and full registration of empty metal drums (current 100 and 160L drums) according to the parameters as specified in the *Default Registration-Empty Drum* administration screen (see Figure 11a) as soon as the operator selects the *Drum Type* specified for empty drums during partial registration.
- Add a function to populate the partial and full registration of liquid containers (used for the liquid removed from the drum) according to the parameters as specified in the *WSRF Default Registration-Liquid Containers* administration screen (see Figure 11b) as soon as the operator at the WSRF activates the *Acceptance Flag* to indicate that the information of the new items are accepted.

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	19 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

5.1.4 X-ray Image Screen

- Add a new X-ray Image Screen (Figure 7) to display the X-ray images (including the composite images) that were automatically imported into the database as soon as it is available after the drum is X-rayed. Images to be used during the segregation and repacking process (if needed) and the validation of the VRF acceptance requirements.
- List links for all the X-ray images available for the barcode (including the combined images) for viewing on full screen (new window).
- Add a function to delete selected older X-ray images from the screen in cases where a drum is X-rayed more than once

Figure 7: Print screen of the X-ray images with list of links

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	20 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

5.1.5 IQ3 Results Screen

- If the IQ3 results of the original barcode were already IAEA batched with a LEU-, HEU-, DU- or NU- number, the IQ3 results screen of the new items needs to be automatically populated with the original drum's barcode and Batch number in non-editable fields. This information has to be available in the IQ3 results table in the database.
- Add a function to populate the *Released Flag* for a batch of drums specified in terms of location, batch number or individually selected barcodes through the *IAEA Batch* modules/functions and which start with LEU-, HEU-, DU-, NU- or ZU- (this is a gap in the current system and plays no role in the new processes).

Figure 8: Print screen of the IQ3 Results screen with the Released field flagged

5.1.6 Partial Registration: Flagging of new drums

- Any new drum (registered after a date as specified – see paragraph 5.3.2) and which was received from a location other than a NLM facility will be considered as new. It has to be flagged with a populated field in the *DrumsTable* in the database together with a visible indicator (for example a red colour of the Full Registration (*Full Reg*) tab which will alert the operator that it is a new drum.
- The flag (populated field and the visible indicator) has to stay active until the *Drum Status* field in the *DrumsTable* is populated with a compressible or non-compressible status. As soon as the *Drum Status* field is populated with one of these two, the populated field in the *DrumsTable* needs to be deleted automatically and the visible indicator has to be changed back to normal.

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	21 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

5.2 VRF ACCEPTANCE CRITERIA

The requirements as specified in the current system can be viewed in Appendix 1. It has to be changed to incorporate new requirements following from the X-ray process without the necessity of adding new reason codes -

- Add to the current acceptance requirement list for the VRF the Drum Status as determined from the X-ray images. To be accepted by the VRF the Drum Status has to be compressible. If the drum does not comply due to this criteria the reason code 0041 has to be allocated.
- Ensure that the current photo requirement is replaced with the requirement for the existence of X-ray images
- The waste class (determined from BNFL measurements) with colour code 0000030400 (Possible clear waste) to be added by current list of acceptable waste classes (identified as a gap in the current system)

However, another requirement list has to be created for the empty drums originated from the WSRF which could not be re-used for waste. This list needs to be only applied for batches of empty drums (as specified on the *Drum Press Batch Process* administration screen). The empty drum has to comply with the following requirements:

1. Valid barcode (empty drum with a new unique registered barcode and not the same barcode as the original drum, thus Barcode status (just below the barcode –see Figure 6) not populated with “Repacked due to liquid”)
2. Drum fully registered (photo or X-ray not required)
3. Container type “Allowed to Compress” (as specified on *Drum Type* administration screen)
4. *Waste Description* has to be “allowed to Compress” (as specified on *Waste Description* administration screen)
5. Drum characterised by SDS/BNFL
6. BNFL measured U235 mass < 200g
7. Alpha activity < 400 Bq/g
8. The waste class (determined from BNFL measurements) to be LLW with colour code 0102030000 (previously LILW-SL), Possible LLW with colour code 0102030005 (previously Possible LILW-SL) or Possible clear waste with colour code 0000030400.
9. Mass of drum < 160 kg

The validation process for the acceptance requirement list of the empty drums needs to be incorporated into the existing WTS in such a way that no need is required for any program changes at the VRF. The following parameters with reason codes as from the list in Appendix 1 are applicable:

0022	Drum Invalid	Not Fully Registered
0041	Drum Invalid	Drum Type or Waste Description*

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

0051	Drum Invalid	Drum Weight
0052	Drum Invalid	Drum Weight Null
0061	Drum Invalid	No BNFL/ISOCS results
0071	Drum Invalid	Waste Class or AlphaActivity or U235 not Valid
0072	Drum Invalid	Color Code empty
0140	Drum Valid	Process Waste Origin = Drum Waste Origin

5.3 WASTE ADMINISTRATION

5.3.1 Barcode Reader (BCR) Settings

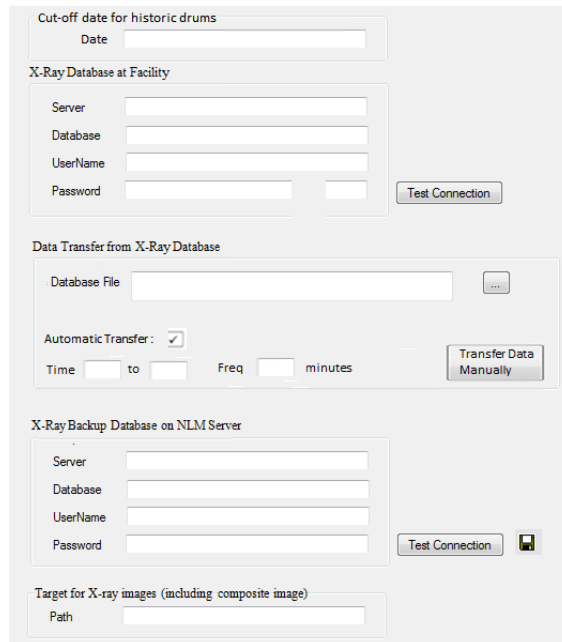
- Add new sections on the existing *Barcode Reader Settings* administration screen to incorporate and specify the parameters needed to connect to the WTS for
 - 1) The barcode reader used to read and open the information of the barcode of the original drum (paragraph 5.1.2)
 - 2) The barcode reader used to read and allocate the barcodes of the new items to the corresponding original barcode (paragraph 5.1.1.2)

5.3.2 Managing of X-ray database and images

- Add a function (administration screen –Figure 9) to specify the parameters needed to transfer (copy and add) the new data and X-ray images (manually and automatically) from the X-ray facility to the X-ray database and the X-ray image directory on the NLM server respectively. The specified directory of X-ray images will also be used for the required image links
- The automatic transfer will be performed at a specified time frequency (in minutes) starting from a specified time of the day.
- Add a section to specify a cut-off date that will be used to separate historic drums from new drums (see paragraph 5.1.6). This date will be used to determine if the drum needs to be flagged as a new drum.

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	23 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES



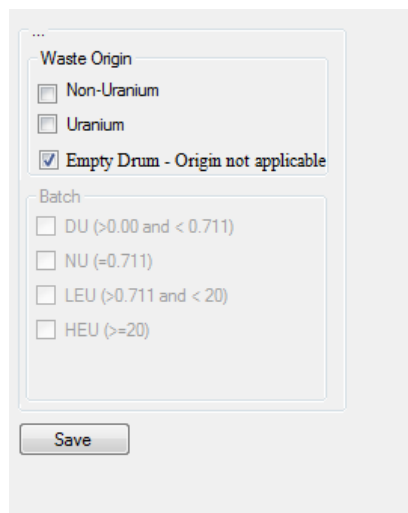
The screenshot shows a web application interface with the following sections:

- Cut-off date for historic drums:** A date input field.
- X-Ray Database at Facility:** Fields for Server, Database, UserName, and Password, with a 'Test Connection' button.
- Data Transfer from X-Ray Database:** A 'Database File' input field, an 'Automatic Transfer' checkbox (checked), and a 'Transfer Data Manually' button.
- X-Ray Backup Database on NLM Server:** Fields for Server, Database, UserName, and Password, with a 'Test Connection' button and a save icon.
- Target for X-ray images (including composite image):** A 'Path' input field.

Figure 9: Possible screen for the managing of the X-ray database and images

5.3.3 Drum Press Batch Process

- Add an option on the current administration screen Drum Press Batch Process (Figure 10) for compacting empty drums. The Batch section is disabled for empty drums and only the shortened list of acceptance requirements (paragraph 3.2) is applicable to the empty drum batch.



The screenshot shows a web application interface for the Drum Press Batch Process with the following sections:

- Waste Origin:** Checkboxes for 'Non-Uranium', 'Uranium', and 'Empty Drum - Origin not applicable' (checked).
- Batch:** Checkboxes for 'DU (>0.00 and < 0.711)', 'NU (=0.711)', 'LEU (>0.711 and < 20)', and 'HEU (>=20)'.
- Save:** A button at the bottom.

Figure 10: Print screen of the Drum Press Batch Process with the empty drum option included

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	24 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

5.3.4 Default Registration Template for Semi-Automatic Population

5.3.4.1 Empty Drums

- Add a *Default Registration-Empty Drum* template (administration screen-Figure 11a) to specify the parameters needed to populate the registration of drum types containing the word *empty* in the description field automatically. Registration information will be dependent on the drum type.

Figure 11a: Possible screen for the automatic population of empty drums

- List all the drum types with the word “empty” included in the name in the dropdown. The drum type (as selected by the operator when registering the drum) will be used to indicate which default template to use for the automatic population of the full registration of the drum.
- Allocate the following registration parameters as specified per drum type-
 1. Client Drum No
 2. Waste Origin as selected from dropdown menu
 3. External Dose Rate
 4. Default Position
 5. Waste Description as from dropdown menu
 6. Waste Characteristic

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	25 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

7. Waste Stream from dropdown menu
8. Fill Height
9. Gross Mass

- The template will be completed in the same way as for the normal partial and full registration (the current *Drum Press Default* screen is the template used for the automatic registration for parent drums at the VRF)
- For the *Client Drum No* only the default part will be specified (for example WSRF) on the template. An index number will be added automatically every time an empty drum is added to the system.

5.3.4.2 Liquid Containers

- Add a *Default Registration-Liquid Containers* template (administration screen- Figure 11b) to specify the parameters needed to populate the registration of drum types containing the word *WSR* in the description field automatically. Registration information will be dependent on the drum type.

Figure 11b: Possible screen for the automatic population of liquid containers

- List all the drum types with the word “WSR” included in the name in the dropdown. The drum type (as selected by the operator when registering the drum) will be used to indicate which default template to use for the automatic population of the full registration of the container.
- Allocate the following registration parameters as specified per drum type-

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	26 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

1. External Dose Rate
2. Default Position
3. Waste Description as from dropdown menu
4. Waste Characteristics
5. Waste Stream from dropdown menu

5.3.5 Administration Screen for Locations/Buildings

Add an administration screen to manage (add/edit/delete) the locations/buildings (gap identified in current system) as listed in the Building dropdown list of the Current Position Block during partial registration (the building parameters are populated in the *Location* table in the database).

5.3.6 Administration Screen for Drum Status

Add an administration screen to manage (add/edit/delete) the *Drum Status* options and to specify which *Drum Status* options will activate/enable the *Segregation Input* section (see paragraph 5.1.1.1) on the X-ray and WSRF screen. Only drums with a final *Drum Status* that will activate the *Segregation Input* section will be accepted at the WSRF, all other drums will be rejected.

5.4 REPORTS

All the reports (new and existing) must be migrated to either MS-SQL reporting Services or Crystal reports and users must be able to view these as either PDF or Excel files, as specified in Appendix 2.

5.4.1 Drum General Search

- Change current report to incorporate *Drum Status* (as determined from the X-rays) of the drum as well as to use the *Drum Status* as a filter.

Figure 12: Print screen of the current *Drum General Search* report including the *Drum Status*

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

5.4.2 Scanner Acceptance Check report

- Change current report to incorporate the *Drum Status* of the drum as determined from the X-rays.

Figure 13: Print screen of the current *Scanner Acceptance Check* report including the *Drum Status*

5.4.3 Drum Press Barcode Valid

- Change current report to incorporate the new acceptance requirement for the final *Drum Status* as determined from the X-ray. This status has to be displayed in the table. The validation of the acceptance requirements for empty drums also needs to be incorporated into the report for validation.

Figure 14: Print screen of the current *Drum Press Barcode Valid* report including the *Drum Status*

5.4.4 Tracking of Segregation and Analysis of new Items

- Add a new report for the tracking of the segregation process and the status of the new items regarding the analysis and the IAEA batching.

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	28 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

Tracking of Segregation

☐ Dates included Date Range From: 01/01/2000 To: 30/12/2020

Filter Original Barcode

Drum status

Store

IAEA Batch

Row Count 0

Original Drum				New Items										
Barcode	IAEA Batch	Number new Items	Date	Barcode	IAEA Batch	Drum Status	Store	X	Y	Z	Drum Type	IQ3 date	BNFL date	WQM

Figure 15: Possible screen for the *Tracking of Segregation and Analysis of new Items* report

The following information for the original drum has to be reported:

1. Barcode
2. IAEA Batch
3. Number new Items
4. Date of repacking

The following information for the new items has to be reported:

5. Barcode
6. IAEA Batch
7. Drum Status as determined from X-rays
8. Location in terms of Store, Row(X), Block(Y) and Palette(Z)
9. Drum Type
10. IQ3 and BNFL dates (analysis of new drum)
11. Waste Quantification Method used for liquid container (up to two methods are possible) – both must be displayed if applicable

5.4.5 X-ray Tracking

- Add a new report to track the drums scanned by the X-ray

X-Ray Tracking

☐ Dates included Date Range From: 01/01/2000 To: 30/12/2020

Filter Drum Status

Row Count 0

Barcode	Date	Drum Status	Store	X	Y	Z
---------	------	-------------	-------	---	---	---

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	29 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

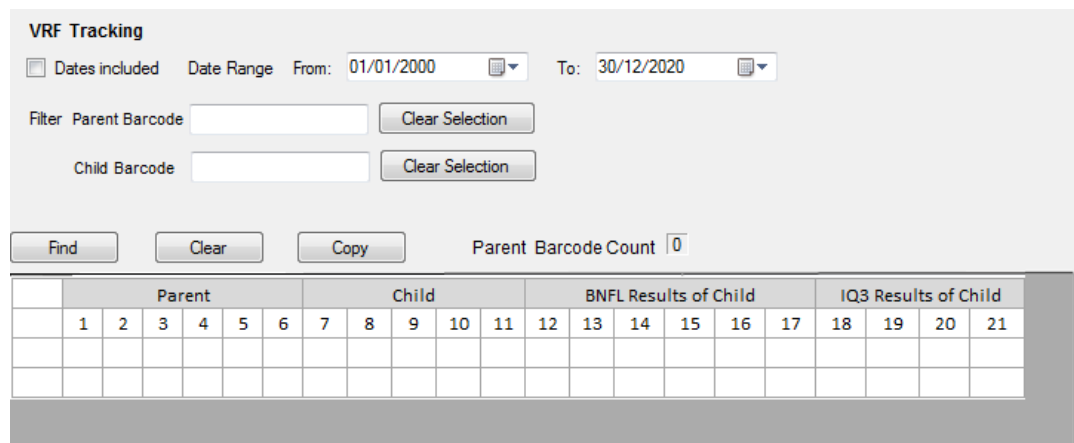
Figure 16: Possible screen for the Tracking of X-ray scanning report

The following information has to be reported:

1. Barcode
2. Date
3. Drum Status
4. Location in terms of Store, Row(X), Block(Y) and Palette(Z)

5.4.6 VRF Tracking

- Add a new report to track the drums compacted at the VRF



VRF Tracking

☐ Dates included Date Range From: 01/01/2000 To: 30/12/2020

Filter Parent Barcode

Child Barcode

Parent Barcode Count 0

Parent						Child					BNFL Results of Child					IQ3 Results of Child				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

Figure 17: Possible screen for the Tracking of drums compacted at the VRF (column numbers refer to detail information below)

The following information has to be reported for the Parent:

1. ParentDrumID
2. Barcode
3. ClientDrumNo
4. Gross Mass
5. ActiveFillHeight
6. Location in terms of Store, Row(X), Block(Y) and Palette(Z)

The following information has to be reported for the Child:Barcode

7. Barcode
8. Compacted height
9. ChildPosition

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	30 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

10. Date Added
11. Gross Mass

The following information has to be reported for the child regarding BNFL results

12. SDS OperationID
13. ColorCode
14. U235Mass (=U235DrumMassBest)
15. TotAlpha (=DrumTotAlphaBest)
16. TotBeta (=DrumTotBetaGamBest)
17. DrumWeight

The following information has to be reported for the child regarding IQ3 results

18. U235Mass
19. U238Mass
20. MGAU
21. IAEABatch

5.4.7 Drum Progress Tracking

- Add a new report to track the progress of the drums through all the different processes.
- Add a function to upload information (from the report output) to the BCR as specified by the operator to be displayed on the BCR when the barcode of the drum is scanned.

Figure 18: Possible screen for the Tracking of the progress of drums through the different processes

The following information has to be reported:

1. Barcode
2. Location in terms of Store, Row(X), Block(Y) and Palette(Z)

Doc. No.:	NLM-SPE-00038
Rev. No.:	02
Page No.:	31 of 33

REQUIREMENT SPECIFICATION FOR WTS UPGRADE TO INCLUDE X-RAY AND WSRF MODULES

3. Gross Mass
4. FillHeight
5. X-rayed (✓ / ✗)
6. Drum Status (see figure 6 paragraph 5.1.1)
7. WSRF (✓ / ✗)
8. BNFL (✓ / ✗)
9. IQ3 (✓ / ✗)
10. IAEA Batch (see figure 8)
11. Any Other Waste Quantification Methods (✓ / ✗)
12. WQM used (up to two methods are possible) – both must be displayed if applicable

5.5 RECOMMENDATION AND PROGRAMMING OF BARCODE READERS, AND THE INTERFACE WITH WTS

- Add a new module on the Barcode Readers (used for the *Drumload Batch* and *Drum Move* menus) to display the progress of processes as specified and uploaded by the operator by using the upload function on the *Drum Progress Tracking* report in the WTS (see paragraph 5.4.7) Recommend barcode readers that will be compatible with the WTS and which will be capable to perform the following functions:
 - 1) The opening of the original drum's information when scanning the barcode on the drum at WSRF (see paragraphs 5.1.2 and 5.3.1). Display the *X-ray Image* screen by default when opening the drum's information.
 - 2) The capturing of the barcodes of the new items (drums/containers) used during repacking in the WSRF (see paragraphs 5.1.1.2 and 5.3.1)
- Program the barcode readers to perform the functions as described.
- Change or redevelop the existing WTS-Barcode interfacing to ensure that all the BCRs will retrieve and download the required information between the WTS and BCR

5.6 SECURITY

Add all the new screens and new functions in the permission list as shown in Figure 2.

APPENDIX 1: Reason Codes used for validation of VRF acceptance requirements.

0021	Drum Invalid	No Photo
0022	Drum Invalid	Not Fully Registered
0041	Drum Invalid	Drum Type or Waste Description*
0051	Drum Invalid	Drum Weight
0052	Drum Invalid	Drum Weight Null
0061	Drum Invalid	No BNFL/ISOCS results
0071	Drum Invalid	Waste Class or AlphaActivity or U235 not Valid
0072	Drum Invalid	Color Code empty
0081	Drum Invalid	No IQ3 results
0091	Drum Invalid	IAEA Batch is Null
0092	Drum Invalid	IAEA Batch is blank
0101	Drum Invalid	IAEA Released = No
0102	Drum Invalid	IAEA Released blank
0131	Drum Invalid	Process Waste Origin NOT Drum Waste Origin
0140	Drum Valid	Process Waste Origin = Drum Waste Origin
0150	Drum Valid	Selected Batch process = drum batch
0151	Drum Invalid	Selected Batch process NOT drum batch

APPENDIX 2: Specified Output Formats of the Different Reports

REPORTS	FORMAT
Drum Move Report (generated from the <i>Drum Move</i> function)	PDF (Portable Document Format)
Drum Transfer Certificate (generated from the <i>Download Batch</i> function)	PDF (Portable Document Format)
Store Inventory	Excel
Drum Transfers	Excel
Drum Received	Excel
Drum Tracking	Excel
Drum General Search	Excel
Drum Count per Location	Excel
Drum Press Barcode Valid	Excel
Scanner Acceptance Checks	Excel
Tracking of Segregation and Analysis of New Items	Excel
X-Ray Tracking	Excel
VRF Tracking	Excel
Drum Progress Tracking	Excel; Uploading to BCR as specified