

C Communication

C.1 Communication Protocol Overview

C.1.1 Messages Supported by HL7 Interface Protocol

The LIS/HIS communication function of BC-6800 enabled the communication between the analyzer and the PC in laboratory through Ethernet, including sending analysis results to and receiving worklist from lab PC.

This communication protocol is defined based on the HL7 Standards. HL7 is a series of electronic data exchange standards for healthcare industry, which is originally defined by the US and is now adopted worldwide. This protocol is defined based on HL7 v2.3.1. For details of HL7 standards, see *HL7 Interface Standards Version 2.3.1*.

C.1.2 Lower Transmission Layer Protocol

BC-6800 sends messages through TCP connection, and the communication process can be segmented into 3 phases:

Connecting Phase

After the analyzer starts up, it tries to connect to the LIS/HIS server based on its software configuration. If the analyzer fails to connect to the server, will keep retrying until the connection is set up successfully; otherwise, it keeps connected to the server to ensure that data communication can be proceeded at any time. If the analyzer is disconnected from the LIS/HIS server while it is running, it will try to reconnect to the server.

Data Transmission

If the user enabled the auto communication function of analysis results, analysis result data can be transmitted once it is generated in the analyzer, besides being transmitted in batch in the Table Review or QC screen.

The message sending and receiving processes are synchronous in both batch communication and auto communication. The user can configure whether to wait for the acknowledgement message after sending a message. If it is configured to wait for the acknowledgement message, once the acknowledgement message is not received in predefined time (e.g.: 10s), the analyzer will consider the transmission as failed and resend the data. If it is configured not to wait for the acknowledgement message, the analyze will consider the transmission as failed and resend the data once the "Failed to receive" message is received in predefined time (e.g.: 10s); otherwise, it will consider the transmission as succeeded and begin to send the next message.

The bi-directional LIS/HIS inquiry message transmission is different. Before the analyzer enabling/disabling the LIS/HIS communication, saving worklist or starting analysis, it will send an inquiry message including the sample ID. LIS/HIS searches the sample information using

the sample ID, and respond in the form of HL7 message. The analyzer fills up the worklist based on the response or performs sample analysis. If there is no respond in the predefined time (e.g.: 10s) after the bi-directional LIS/HIS inquiry message is sent out, the inquiry will be considered as failed.

Disconnection

The communication is terminated when the operator exits from the BC-6800 software. The connection is also cut off while the communication setup of the software is being edited, and then the analyzer will try to reconnect based on the new settings.

C.1.3 HL7 Message Layer Protocol

HL7 Protocol Overview

■ Message constructing principles

Every HL7 message consists of several segments and ends up with the <CR> (0x0D) character.

Each segment consists of the segment name of three characters and field of changeable characters, and each field consists of the component and subcomponent. For each message, the separators of the field, component and subcomponent are defined in the MSH segment.

For example:

```
MSH|^~\&|Mindray|BC-6800|||20060427194802||ORU^R01^ORU_R01|1|P|2.3.1|||||UNICODE
```

among which:

The five characters following MSH define the separators to distinguish each field, component and subcomponent. Although they can be any non-text characters, HL7 standard recommends the characters in the table below:

Character	Meaning
	Field separator
^	Component separator
&	Subcomponent separator
~	Repetition separator
\	ESC

The first field of MSH includes every separator. Some field behind are empty because they are optional and not used by Mindray HL7 interface. Detailed field definition and selection will be stated in the following sections.

For message of any type, the segments behind MSH appear in the fixed order. The order will be described in the following contents and the grammar is used to organize the segments order.

The segment appeared in [] is optional.

The segment appeared in {} can be repeated once or more.

■ String transferring principles

For the field data of ST, TX, FT, and CF, etc. separators may be contained in the string data like remarks, clinical diagnosis and customized gender etc. When coding, the separators in the original strings shall be transferred into transferred character sequence; then, restore them when decoding. The transferring principles used in the BC-6800 HL7 interface protocol are shown in the table below:

Transferred Character	Original character
\F\	Field separator
\S\	Component separator
\T\	Subcomponent separator
\R\	Repetition separator
\E\	Transferred separator
\.br\	<CR>, i.e. end character of segment

Note: “\” in the transferred character sequence represents the transferred separator. Its value is defined in MSH segment.

HL7 Lower Layer Message Protocol

TCP/IP is a protocol of byte stream. It doesn't provide the message boundary. HL7 of upper layer protocol is based on messages. The function of terminating the message is not provided. In order to determine the message boundary, the lower layer protocol of MLLP is used (such descriptions are also included in *HL7 Interface Standards Version 2.3*).

Communication Layer

Messages are transmitted in the following format:

<SB> dddd <EB><CR>

among which:

<SB> = Start Block character (1 byte)

ASCII <VT>, i.e. <0x0B>. Do not confuse with the SOH or STX character in ASCII.

dddd = Data (variable number of bytes)

dddd is the effective data of HL7 message and expressed in the form of string. For the strings used in the BC-6800 HL7 interface messages, the UTF-8 code is used.

<EB> = End Block character (1 byte)

ASCII <FS>, i.e. <0x1C>. Do not confuse with the ETX or EOT character in ASCII.

<CR> = Carriage Return (1 byte)

ASCII carriage return character, i.e. <0x0D>.

C.2 Duplex Communication

C.2.1 Supported HL7 Messages

Process of Duplex Communication

1. The main unit directly sends the test results (or QC data) to LIS/HIS as Figure 1 shows.

R01 Event: the PC connecting the analyzer actively sends the test results to the LIS. Test results and QC data are all send this way.

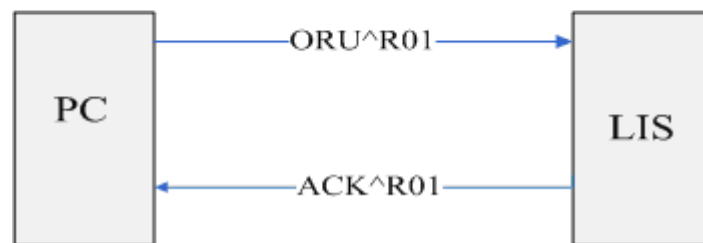


Figure 8 Test results (QC data) communication process

2. Worklist information inquiry.

Worklist belongs to the Order message. Thus, the corresponding HL7 messages: ORM (General Order Message) and ORR (General Order Response Message) can be used. The communication process is shown in Figure 2.

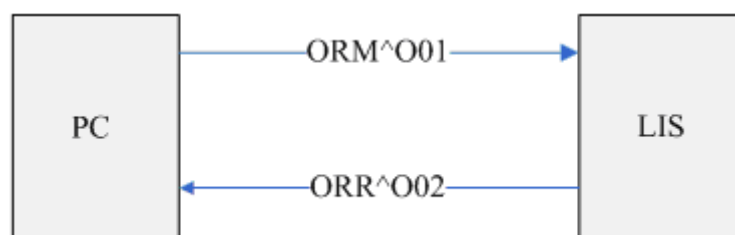


Figure 9 Worklist searching communication process

Note: since the system receiving analysis results and that providing worklist information may be located in different servers, the communication settings of the two functions shall be configured respectively.

Mostly used messages:

ORU^R01 message: it is mostly used for the transmission of the test results and QC

data.

ORU	Observational Results (Unsolicited)	Description
MSH	Message Header, mandatory, including the communication information of message No., sending time, message separator and coding method, etc.	
{		
PID	Patient demographic information, including patient name, gender, patient ID, birthday, etc.	
[PV1]	Patient visit information, including patient type, department, bed No. and charge, etc.	
{		
OBR	sample information, including sample No., operator and run time, etc.	
{[OBX]}	analysis data, including analysis results and work mode, etc.	
}		
}		

ACK^R01 message: it confirms the received ORU^R01 message.

ACK	Acknowledgment	Description
MSH	Message head	
MSA	message acknowledgement, describing whether it has received the communication message	

ORM^O01 message: Common order message, all the actions related to order basically use the message of this type. For example, create a new order or cancel an order. Here, the main unit requests LIS/HIS to re-fill the order message.

ORM	General Order Message	Description
MSH	Message head	
{ORC}	Common message of Order, including the ID information of the sample inquired	

ORR^O02 message: acknowledgement of the ORM^O01 message. Here, returning the completed information of order (i.e. worklist).

ORR^O02	General	Order	Response	Message
	Description			
MSH	Message head			
MSA	Message acknowledgement			
[PID]	patient information			
[PV1]]	patient visit information			
{				
ORC	Common message of Order, including the sample ID			
[

```

        OBR Sample Info.
        {[OBX]}    Data of other sample information, including work
mode, etc.
    ]
}

```

C.2.2 HL7 Segment Definitions

The tables in this section provide detailed definitions of the fields in all the message segments. Each row provides the information of one field, and the content of each column is described as follows:

1. No.: the HL7 message initiates with the segment name of 3 characters followed by the fields which separated by separators. "No." refers to the position of the field in the HL7 message segment.

E.g.:

```

PID      | 1      |      | 7393670^^^MR||Joan^Jlang||19950804000000|F
  ↑      ↑      ↑
Segment name Field1      Field 3

```

Note: for MSH segment, the field separator closely subsequential to the segment name is considered to be the first field, used to describing the field separator values of the whole message.

2. Field name: the logic sense of the field.
3. Data type: the data type based on HL7 standards. See C.1.3for details.
4. Recommended max length: the recommended max length based on HL7 standards. But during the communication process, the data length may be longer than recommended, in which case the fields shall be identified by separators while analyzing the message segment.
5. Note: notes to the value of the field.
6. Samples: samples of the fields.

MSH

The MSH (Message Header) segment contains basic information of HL7 message including separator value, message type and coding method etc. It is the first field of every HL7 message.

Sample message:

```

MSH|^~\&|BC-6800|Mindray|||20080419104618||ORU^R01^ORU_R01|1|P|2.3.1|||||UNICODE
E

```

See Table 1 for definition of each field in MSH segment.

Table 1 MSH Field Definitions

No.	Field Name	Data type	Recomm ended max	Note	Sample

			length		
1	Field Separator	ST	1	Includes the separator of the first field after the segment name; be used to determine the separator's value of the rest parts of the message.	
2	Encoding Characters	ST	4	Includes component separators, repetition separators, transferred separators and subcomponent separators.	^~\&
3	Sending application	EI	180	Application program of sending terminal. If the analyzer sends the message, the value is "BC-6800".	BC-6800
4	Sending Facility	EI	180	Device of sending terminal. The value is "Mindray"	Mindray
7	Date/Time Of Message	TS	26	Created time of message (in the format of YYYY[MM[DD[HH[MM[SS]]]]]); adopts the system time.	20090419104618
9	Message Type	CM	7	Message type; in the format of "message type^event type^message structure name".	ORU^R01^ORU_R01
10	Message Control ID	ST	20	Message control ID; be used to mark a message uniquely.	1
11	Processing ID	PT	3	Message processing ID. Value: "P"- sample and worklist searching information; "Q" – QC results information; In Ack messages, it is consistent with the previously received message.	P
12	Version ID	VID	60	HL7 version No.; the value is "2.3.1".	2.3.1
18	Character Set	ID	10	Character set. The value is "UNICODE", and the message is expressed by UTF-8 string.	UNICODE

MSA

The MSA (Message Acknowledgement) segment contains message acknowledge information.

Sample message:

MSA|AA|1

See Table 2 for field definitions in use.

Table 2 MSA Field Definitions

No.	Field Name	Data type	Recommended max length	Note	Sample
1	Acknowledgment Code	ID	2	Acknowledgement code: "AA"-receive, "AE" – error, "AR"- reject	AA
2	Message Control ID	ST	20	Message control ID; it's consistent with the MSH-10 of the received message.	1
6	Error Condition	CE	100	Error condition (status code), can be selected to transmit, and also contains error condition specification information; see Table 3 for the values.	

Table 3 Error codes of MSA-6 field

Status code (MSA-6)	Status text (MSA-3)	Description/Remark
Succeeded:		AA
0	Message accepted	Succeeded:
Error status code:		AE
100	Segment sequence error	Segment order in the message is wrong, or necessary segment lost
101	Required field missing	Necessary field lost in a segment
102	Data type error	Segment data type error, e.g. numbers are replaced by characters
103	Table value not found	Table value is not found; not used temporarily
Rejection status code:		AR
200	Unsupported message type	Message type is not supported
201	Unsupported event code	Event code is not supported
202	Unsupported processing id	Processing ID is not supported
203	Unsupported version id	Version ID is not supported
204	Unknown key identifier	Unknown key identifier, e.g. transmitting the patient information that is not existed
205	Duplicate key identifier	Repeated key words existed
206	Application record locked	Issues can not be executed at application program saving level, e.g. database is locked

207	Application error	internal	Other interior errors of application program
-----	-------------------	----------	--

PID

The PID (Patient Identification) segment contains the patient basic information.

Sample message:

PID|1||7393670^^^^MR||Joan^Jlang||19950804000000|F

See Table 5 for field definitions in use.

Table 4 PID Field Definitions

No.	Field Name	Data type	Recommended max length	Note	Sample
1	Set ID - PID	SI	4	Sequence NO.; it is used to mark the different PID segments of a message.	1
3	Patient Identifier LIS/HIS	CX	20	To be used as the patient ID in the message of the sample test results, in the form of "Patient ID^^^^MR". To be used as QC lot No. in the message of QC.	7393670^^^^MR
5	Patient Name	XP	48	Patient name (divided into two parts: "FirstName" and "LastName"), e.g. "LastName^FirstName".	Joan^Jlang
7	Date/Time of Birth	TS	26	To be used as date of birth in the message of sample results In the form of YYYY[MM[DD[HH[MM[SS]]]]] To be used as expiration date in QC messages.	19950804000000
8	Sex	IS	1	Gender, string.	F, M, O, U stand for Female, Male, Other and Unknown respectively.

PV1

The PV1 (Patient Visit) segment contains the patient visit information.

Sample message:

PV1|1||DEPT^^BEDN11

See Table 6 for field definitions in use.

Table 5 PV1 Field Definitions

No.	Field Name	Data type	Recommended max length	Note	Sample
1	Set ID - PV1	SI	4	Sequence NO.; it is used to mark the different PV1 segments of a message.	1
2	Patient Class	IS	1	Patient type, string, content not defined	B, E, I, O, P and R stand for Obstetrics, Emergency, Inpatient, Outpatient, Preadmit, and Recurring patient respectively.
3	Assigned Patient Location	PL	80	Patient location information; in the form of "Department^ ^Bed No."	Internal Medicine
20	Financial Class	FC	50	Charge, string, content not defined	Own expense

OBR

The OBR (Observation Request) segment contains the test report information.

Sample message:

OBR|1||20090807011|00001^Automated Count^99MRC||20090807080000|20090807160000|||Mindray|||cold|20090807083000||||||||HM|||||||Mindray

See Table 7 for field definitions in use.

Table 6 OBR Field Definitions

No.	Field Name	Data type	Recommended max length	Note	Sample
1	Set ID - OBR	SI	4	Sequence NO.; it is used to indicate the different OBR segments of a message.	1
2	Placer Order Number	EI	22	To be used as sample ID in the message of worklist searching response, i.e. ORC^O02	
3	Filler Order Number +	EI	22	To be used as sample ID in the message of test results To be used as file No. in the QC message	20090807011
4	Universal Service ID	CE	200	Universal service ID, to identify different types of test results. See configuration files for the values.	00001^Automated Count^99MR C
6	Requested Date/time	TS	26	Requested Date/time To express the sampling date and time.	20090807140600
7	Observation Date/Time #	TS	26	Run Time	20090807150616
10	Collector Identifier *	XCN	60	Sample collector To indicate the deliverer	Mindray
13	Relevant Clinical Info.	ST	300	Relevant clinical information. It can be used as the clinical diagnostic information in the patient info.	Cold
14	Specimen Received Date/Time *	TS	26	Sample received time To express the delivery time.	20090807150000
15	Specimen Source *	CM	300	Sample source Values in BC-6800 messages: "BLDV"- Venous blood "BLDC"- Capillary blood	
22	Results Rpt/Status Chng - Date/Time +	TS	26	Results report/Status Change - Date/Time To be used as validating time.	
24	Diagnostic Serv Sect ID	ID	10	Diagnostic ID, the value is "HM", means Hematology.	HM
28	Result	XCN	150	Result copies to	

	Copies To			To indicate the validator.	
32	Principal Result Interpreter +	CM	200	Principal result interpreter To be used as operator in the sample message To be used as "Operator" in the QC run message	Mindray

OBX

The OBX (Observation/Result) segment contains the parameter information of each test result.

Sample message:

OBX|6|NM|6690-2^WBC^LN||4.63|10\S\9/L|11.00-12.00|L||F||E

See Table 8 for field definitions in use.

Table 7 OBX Field Definitions

No.	Field Name	Data type	Recommended max length	Note	Sample
1	Set ID - OBX	SI	10	Sequence NO.; it is used to mark the different OBX segments of a message.	6
2	Value Type	ID	3	Data type of test results; the values can be "ST", "NM", "ED" and "IS", etc.	NM
3	Observation Identifier	CE	590	Test item identifier Form: "ID^Name^EncodeSys", where "ID" is the test item identifier; "Name" the description information of the test item; "EncodeSys" is the coding system of the test item. See configuration files for values of different test items. Note: "ID" and "EncodeSys" are used to identify a unique parameter, but "Name" is used for description rather than identification.	6690-2^WBC^LN
5	Observation Value	*	65535	Test results data. It can be numbers, strings, enumeration values and binary data, etc. See related sections for the values (Binary data like histogram or	4.63

				scattergram are transferred using the Base64 coding method.).	
6	Units	CE	60	Units of test items. Expressed in ISO standard units.	10\S\9/L
7	References Range	ST	60	Reference range; in the form of "lower limit-upper limit", "< upper limit" or "> lower limit".	11.00-12.00
8	Abnormal Flags	ID	5	Result flags. Values shown as follows: "N"- Normal "A"- Abnormal "H"- higher than upper limit "L"- lower than lower limit Note: The flag for normal or abnormal and that for high or low result may appear in this field at the same time. In this case, the two types of flags should be connected with a "~", e.g.: "H~A"	L
11	Observ Result Status	ID	1	Test result status. The value is "F" - (Final Result); it means the final result.	F
13	User Defined Access Checks	ST	20	Customized contents. It stands for reagent expiration mark, modification mark, etc. Form: "mark1~mark2". There are 3 types of marks: O – Expired reagent E – Active editing e – Passive editing	E

ORC

The ORC (Common Order) segment contains the common information of order.

Sample message:

ORC|RF||SampleID||IP

See Table 9 for definition of each field.

Table 8 ORC Field Definitions

No.	Field Name	Data type	Recommended max length	Note	Sample
-----	------------	-----------	------------------------	------	--------

1	Order Control	ID	2	Order control word In the ORM message the value is "RF" which means "re-fill the order request". In the ORR message the value is "AF" which means "affirm the re-filled order".	RF
2	Placer Order Number	EI	22	Placer order number. In the ORM message the value is empty ; in the ORR message the value is the sample ID.	
3	Filler OrderNum	EI	22	Filler Order Number. In the ORM message the value is the sample ID; in the ORR message the value is empty.	SampleID
5	Order Status	ID	2	Order status. In the ORM worklist inquiry communication message, the value is always "IP" which means "order is being processed, but results are not obtained"; in the ORR message the value is empty.	IP

C.2.3 Complete Sample Message

The following 2 sections show the whole process of sample data communication.

Sample Response Message

Every time a sample result is sent, a sample response message composed of two message segments (MSH and MSA) may be received. To send a correct response message, take into consideration that: the MSH-9 field should be ACK^R01 which indicates that it is a sample response message; If the value in the MSA-2 field is the same with the MSH-10 value of the analysis result, it indicates that this response message is corresponding to the sent analysis result. The MSA-2 value in the following example is 1

```
MSH|^~&|LIS/HIS|||20080419104633||ACK^R01^ACK_R01|1|P|2.3.1|||UNICODEMSA|AA|1
```

Note: If a response of sample transmission error is received from LIS/HIS, the sample data shall be resent. If no response is sent back, the data transmission will be considered as succeeded.

QC Message

The content of the QC message differs from that of the sample analysis result: the MSH-11

value of the QC message is Q which indicates that it is a QC message; each QC message is corresponding to one QC point in the IPU software which may contain several analysis results. For example, there is one analysis result in an L-J QC message, while there are two analysis results and one mean calculation result in an X-R QC message.

A QC message is composed of an MSH message head and several analysis results, each of which contains the PID and OBR segments as the head of the sample message, as well as several OBX segments to carry parameters and other information. The OBR-4 field of each analysis result indicates the type of the result See Appendix: Message coding definition for details.

An example of the L-J QC message is shown as follows:

```
MSH|^~\&|BC-6800|Mindray|||20081120171602||ORU^R01^ORU_R01|1|Q|2.3.1|||||UNICODE
E
PID|1||QC|||20091000235959||
OBR|1||6|00006^LJ QCR^99MRC|||20080807142518|||||||||||||HM|||||R&D Engineer
OBX|1|IS|05001^Qc Level^99MRC||H|||||F
OBX|2|IS|08001^Take Mode^99MRC||C|||||F
OBX|3|IS|08002^Blood Mode^99MRC||Q|||||F
OBX|4|NM|6690-2^WBC^LN||0.00|10*9/L|||||F
OBX|5|NM|704-7^BAS#^LN||***.**|10*9/L|||||F
OBX|6|NM|706-2^BAS%^LN||**.**|%|||||F
OBX|7|NM|751-8^NEU#^LN||***.**|10*9/L|||||F
OBX|8|NM|770-8^NEU%^LN||**.**|%|||||F
OBX|9|NM|711-2^EOS#^LN||***.**|10*9/L|||||F
OBX|10|NM|713-8^EOS%^LN||**.**|%|||||F
OBX|11|NM|731-0^LYM#^LN||***.**|10*9/L|||||F
OBX|12|NM|736-9^LYM%^LN||**.**|%|||||F
OBX|13|NM|742-7^MON#^LN||***.**|10*9/L|||||F
OBX|14|NM|5905-5^MON%^LN||**.**|%|||||F
OBX|15|NM|789-8^RBC^LN||0.02|10*12/L|||||F
OBX|16|NM|718-7^HGB^LN||0|g/L|||||F
OBX|17|NM|787-2^MCV^LN||***.**|fL|||||F
OBX|18|NM|785-6^MCH^LN||***.**|pg|||||F
OBX|19|NM|786-4^MCHC^LN||***|g/L|||||F
OBX|20|NM|788-0^RDW-CV^LN||**.**|%|||||F
OBX|21|NM|21000-5^RDW-SD^LN||***.**|fL|||||F
OBX|22|NM|4544-3^HCT^LN||0.0|%|||||F
OBX|23|NM|777-3^PLT^LN||4|10*9/L|||||F
OBX|24|NM|32623-1^MPV^LN||***.**|fL|||||F
OBX|25|NM|32207-3^PDW^LN||**.**|%|||||F
OBX|26|NM|10002^PCT^99MRC||.***|%|||||F
OBX|27|NM|10003^GRAN-X^99MRC||6|||||F
OBX|28|NM|10004^GRAN-Y^99MRC||32|||||F
OBX|29|NM|10005^GRAN-Y(W)^99MRC||20|||||F
OBX|30|NM|15051^RBC Histogram. Left Line^99MRC||10|||||F
```


OBX|31|NM|15052^RBC Histogram. Right Line^99MRC||250|||||F

QC Response Message

The only difference between the QC response message and the analysis result response message is that the MSH-11 value of the QC response message is Q.

An example of the ACK X-R QC message is shown as follows:

MSH|^~\&|LIS/HIS||||20081120171602||ACK^R01|1|Q|2.3.1|||||UNICODEMSA|AA|1

Bidirectional LIS/HIS Inquiry Message

A bidirectional LIS/HIS inquiry message contains a sample ID. After the LIS/HIS received the inquiry message, it will search for the corresponding patient and sample information to provide a response.

The inquiry message is composed of two message segments: MSH and ORC. The MSH segment is almost the same with that of the analysis result, except that the MSH-9 value is ORM^O01. The ORC-3 field should be filled with the receiver code (in this case, the sample ID; where in the following sample, it is SampleID1). Note that in the autoloading analysis, if there is a barcode scan error while sending an inquiry message, the sample ID will be "Invalid".

An example of the inquiry message is shown as follows:

MSH|^~\&|BC-6800|Mindray||||20081120174836||ORM^O01^
ORM_O01|4|P|2.3.1|||||UNICODEORC|RF||SampleID1||IP

Bidirectional LIS/HIS Inquiry Response Message

When the LIS received an inquiry message, it needs to send back an inquiry response message. The first two message segments of the inquiry response message are MSH and MSA. The MSH-9 field (indicating the type of the segment) is filled with ORR^O02, while the MSA segment should be filled up as shown in the following example of the inquiry response message. If the LIS/HIS gets searching results for the inquiry, there will be PID, PV1, ORC, OBR and OBX message segments after the two heading segments to provide the patient and sample information, in the same way as the sample data message does. The ORC segment is indispensable for an inquiry response message with searching results, in which the ORC-1 value is AF, and ORC-2 is the filter (the sample ID). Note that the OBR-2 field indicates the sample ID, which should be the same as in the ORC-2 field; otherwise, the message will be regarded as incorrect.

An example of the inquiry response message with searching results is shown as follows:

MSH|^~\&|LIS/HIS||||20081120174836||ORR^O02^
ORR_O02|1|P|2.3.1|||||UNICODEMSA|AA|4PID|1||ChartNo^^^MR|^FName||19810506|NTP
V1|1|E|nk^^Bn4|||||||||NewChargeORC|AF|SampleID1|||OBR|1|SampleID1|||20060506|||t
ester|||Diagnose

```
content....|20060504||||||20080821||HM||||Validator||||OperatorOBX|1|IS|08001^Take
Mode^99MRC||A|||||FOBX|2|IS|08002^Blood    Mode^99MRC||W|||||FOBX|3|IS|08003^Test
Mode^99MRC||CBC|||||FOBX|4|IS|01002^Ref
Group^99MRC||XXXX|||||FOBX|5|NM|30525-0^Age^LN||1|hr||||FOBX|6|ST|01001^Remark^9
9MRC||remark content....|||||F
```

An example of the inquiry response message with no search result is shown as follows, in which the MSA-2 field indicates the result of the response. In this example, the MSA-2 value is "AR", indicating the inquiry was rejected; if it is "AE", then there is an error in the inquiry process.

```
MSH|^~&|LIS/HIS||||20081120175238||ORR^O02^
ORR_O02|1|P|2.3.1|||||UNICODEMSA|AR|9
```

C.3 Exception Handling

C.3.1 Sample Data Output

- Get no response in predefined time (e.g.: 10s) after sending the sample data:
Considered as successful data transmission, and continue to send the data of next sample.
- Get 3 or more (configurable) error feedbacks for the same sample data that has been sent:
Report the error and try to send the data of next sample.
- Network connection error:
Try to reconnect. If it fails to set up the connection for 3 times (configurable), report the error and stop the transmission of the sample data; in the instant sample data transmission mode, the analyzer will try to set up the network connection while sending the data of next sample.

C.3.2 Bi-Directional LIS/HIS

- Get no response in predefined time (e.g.: 10s) after sending the worklist inquiry message:
Resend the worklist inquiry message for predefined times (e.g.: 3 times). Report the error if there is still no response.
- Get the feedback of incorrect message after sending the worklist inquiry message:
Resend the message for predefined times (e.g.: 3 times). Report the error if the same feedback is got.
- Get the feedback of message not supported after sending the worklist inquiry message:
Report error and recommend the operator check whether the worklist inquiry server is working properly.

C.4 HL7 Data Type Definitions

CE - Code Element

<identifier (ST)> ^ <text (ST)> ^ <name of coding system (ST)> ^ <alternate identifier (ST)> ^ <alternate text (ST)> ^ <name of alternate coding system (ST)>

CM - Composite

The format is defined by the corresponding field.

CX - Extended composite ID with check digit

<ID (ST)> ^ <check digit (ST)> ^ <code identifying the check digit scheme employed (ID)> ^ < assigning authority (HD)> ^ <identifier type code (IS)> ^ < assigning facility (HD)>

ED – Encapsulate Data

<source application (HD)> ^ <type of data (ID)> ^ <data sub type (ID)> ^ <encoding (ID)> ^ <data (S)>

EI - Entity Identifier

<entity identifier (ST)> ^ <namespace ID (IS)> ^ <universal ID (ST)> ^ <universal ID type (ID)>

FC – Financial Class

<financial class (IS)> ^ <effective date (TS)>

HD - Hierarchic designator

<namespace ID (IS)> ^ <universal ID (ST)> ^ <universal ID type (ID)>

Used only as part of EI and other data types.

FT - Formatted text

This data type is derived from the string data type by allowing the addition of embedded formatting instructions. These instructions are limited to those that are intrinsic and independent of the circumstances under which the field is being used.

IS - Coded value for user-defined tables

The value of such a field follows the formatting rules for an ST field except that it is drawn from a site-defined (or user-defined) table of legal values. There shall be an HL7 table number associated with IS data types.

ID - Coded values for HL7 tables

The value of such a field follows the formatting rules for an ST field except that it is drawn from a table of legal values. There shall be an HL7 table number associated with ID data types.

NM - Numeric

A number represented as a series of ASCII numeric characters consisting of an optional

leading sign (+ or -), the digits and an optional decimal point.

PL - Person location

<point of care (IS)> ^ <room (IS)> ^ <bed (IS)> ^ <facility (HD)> ^ < location status (IS)> ^ <person location type (IS)> ^ <building (IS)> ^ <floor (IS)> ^ <location description (ST)>

PT - Processing type

<processing ID (ID)> ^ <processing mode (ID)>

SI - Sequence ID

A non-negative integer in the form of an NM field. The uses of this data type are defined in the chapters defining the segments and messages in which it appears.

ST – String**TS - Time stamp**

YYYY[MM[DD[HHMM[SS[.S[S[S[S]]]]]]][+/-ZZZZ] ^ <degree of precision>

XCN - Extended composite ID number and name

In Version 2.3, use instead of the CN data type. <ID number (ST)> ^ <family name (ST)> & <last_name_prefix (ST) ^ <given name (ST)> ^ <middle initial or name (ST)> ^ <suffix (e.g., JR or III) (ST)> ^ <prefix (e.g., DR) (ST)> ^ <degree (e.g., MD) (ST)> ^ <source table (IS)> ^ <assigning authority (HD)> ^ <name type code (ID)> ^ <identifier check digit (ST)> ^ <code identifying the check digit scheme employed (ID)> ^ <identifier type code (IS)> ^ <assigning facility (HD)> ^ <name representation code (ID)>

XPN - Extended person name

In Version 2.3, replaces the PN data type. <family name (ST)> ^ <given name (ST)> & <last_name_prefix (ST)> ^ <middle initial or name (ST)> ^ <suffix (e.g., JR or III) (ST)> ^ <prefix (e.g., DR) (ST)> ^ <degree (e.g., MD) (IS)> ^ <name type code (ID) > ^ <name representation code (ID)>

VID - Version identifier

<version ID (ID)> ^ <internationalization code (CE)> ^ <international version ID (CE)>

C.5 Message Coding Definitions

1. In HL communication messages, the OBR-4 (Universal Serview ID) field, in the form of "ID^Name^EncodeSys", is used to identify the type of the analysis result (e.g. sample analysis result, microscopic examination result, QC result, etc.). Table 17 below lists all the code values of this field.

Table 9 OBR-4 Codes

Data	Code (ID)	Name	EncodeSys
Analysis result	00001	Automated Count	99MRC
Microscopic examination result	00002	Manual Count	99MRC
LJ QC result	00003	LJ QCR	99MRC
X QC result	00004	X QCR	99MRC
XB QC result	00005	XB QCR	99MRC
XR QC result	00006	XR QCR	99MRC
X QC result mean	00007	X QCR Mean	99MRC
XR QC result mean	00008	XR QCR Mean	99MRC

2. Each OBX segment contains one test parameter or information of other data and consists of the following fields: OBX-2, indicating the type of the HL7 data contained; OBX-3 (Observation Identifier), the identifier of the data in the form of "ID^Name^EncodeSys"; OBX-5, containing the value of the data; OBX-6, containing the unit for the parameter, (in the ISO standard unit). Table 19 lists the HL7 type and code identifier of each communication data item. Table 20 lists all the parameter units in the communication.

Table 10 Data Type and Encodesys

Data	HL7 Type (OBX-2)	Code (ID)	Name	EncodeSys	Example of OBX-3 Field
Other Data					
Presentation mode	IS	08001	Take Mode	99MRC	08001^Take Mode^99MRC
Sample mode	IS	08002	Blood Mode	99MRC	08002^Blood Mode^99MRC
Analysis mode	IS	08003	Test Mode	99MRC	08003^Test Mode^99MRC
Age	NM	30525-0	Age	LN	30525-0^Age^LN
Remarks	ST	01001	Remark	99MRC	01001^Remark^99MRC
Reference Group	IS	01002	Ref Group	99MRC	01002^Ref Group^99MRC
Level of control	IS	05001	Qc Level	99MRC	05001^Qc Level^99MRC

Analysis Result Data					
WBC	NM	6690-2	WBC	LN	6690-2^WBC^LN
BAS	NM	704-7	BAS#	LN	704-7^BAS#^LN
BAS_PER	NM	706-2	BAS%	LN	706-2^BAS%^LN
NEU	NM	751-8	NEU#	LN	751-8^NEU#^LN
NEU_PER	NM	770-8	NEU%	LN	770-8^NEU%^LN
EOS	NM	711-2	EOS#	LN	711-2^EOS#^LN
EOS_PER	NM	713-8	EOS%	LN	713-8^EOS%^LN
LYM	NM	731-0	LYM#	LN	731-0^LYM#^LN
LYM_PER	NM	736-9	LYM%	LN	736-9^LYM%^LN
MON	NM	742-7	MON#	LN	742-7^MON#^LN
MON_PER	NM	5905-5	MON%	LN	5905-5^MON%^LN
RBC	NM	789-8	RBC	LN	789-8^RBC^LN
HGB	NM	718-7	HGB	LN	718-7^HGB^LN
MCV	NM	787-2	MCV	LN	787-2^MCV^LN
MCH	NM	785-6	MCH	LN	785-6^MCH^LN
MCHC	NM	786-4	MCHC	LN	786-4^MCHC^LN
RDW_CV	NM	788-0	RDW-CV	LN	788-0^RDW-CV^LN
RDW_SD	NM	21000-5	RDW-SD	LN	21000-5^RDW-SD^LN
HCT	NM	4544-3	HCT	LN	4544-3^HCT^LN
PLT	NM	777-3	PLT	LN	777-3^PLT^LN
MPV	NM	32623-1	MPV	LN	32623-1^MPV^LN
PDW	NM	32207-3	PDW	LN	32207-3^PDW^LN
PCT	NM	10002	PCT	99MRC	10002^PCT^99MRC
RET	NM	14196-0	RET#	LN	14196-0^RET#^LN
RET_PER	NM	4679-7	RET%	LN	4679-7^RET%^LN
IRF	NM	33516-6	IRF	LN	33516-6^IRF^LN
LFR	NM	10015	LFR	99MRC	10015^LFR^99MRC
MFR	NM	10016	MFR	99MRC	10016^MFR^99MRC
HFR	NM	10017	HFR	99MRC	10017^HFR^99MRC
NRBC	NM	30392-5	NRBC#	LN	30392-5^NRBC#^LN
NRBC_PER	NM	26461-4	NRBC%	LN	26461-4^NRBC%^LN
P_LCR	NM	10014	PLCR	99MRC	10014^PLCR^99MRC
P_LCC	NM	10013	PLCC	99MRC	10013^PLCC^99MRC
IMG	NM	51584-1	IMG#	LN	51584-1^IMG#^LN
IMG_PER	NM	38518-7	IMG%	LN	38518-7^IMG%^LN
RBC-O	NM	10018	RBC-O	99MRC	10018^RBC-O^99MRC
PLT-O	NM	10019	PLT-O	99MRC	10019^PLT-O^99MRC
HNLC	NM	10020	HNLC#	99MRC	10020^HNLC#^99MRC
HNLC_PER	NM	10021	HNLC%	99MRC	10021^HNLC%^99MRC
PLT-I	NM	10022	PLT-I	99MRC	10022^PLT-I^99MRC
WBC-O	NM	10023	WBC-O	99MRC	10023^WBC-O^99MRC
WBC-D	NM	10024	WBC-D	99MRC	10024^WBC-D^99MRC

WBC-B	NM	10025	WBC-B	99MRC	10025^WBC-B^99MRC
WBC-N	NM	10026	WBC-N	99MRC	10026^WBC-N^99MRC
BASO-N	NM	10027	BASO-N#	99MRC	10027^BASO-N#^99MRC
BASO-N_PER	NM	10028	BASO-N%	99MRC	10028^BASO-N%^99MRC
LYM-N	NM	10029	LYM-N#	99MRC	10029^LYM-N#^99MRC
LYM-N-PER	NM	10030	LYM-N%	99MRC	10030^LYM-N%^99MRC
Intermediate Data of Analysis Results (histogram and scattergram data of WBC, RBC, and PLT)					
RBC histogram binary data	ED	15050	RBC Histogram. Binary	99MRC	15050^RBC Histogram. Binary^99MRC
RBC histogram left discriminator	NM	15051	RBC Histogram. Left Line	99MRC	15051^RBC Histogram. Left Line^99MRC
RBC histogram right discriminator	NM	15052	RBC Histogram. Right Line	99MRC	15052^RBC Histogram. Right Line^99MRC
RBC histogram metadata length	NM	15053	RBC Histogram. Binary Meta Length	99MRC	15053^RBC Histogram. Binary Meta Length^99MRC
RBC histogram left discriminator adjusted mark	IS	15054	RBC Histogram. Left Line Adjusted	99MRC	15054^RBC Histogram. Left Line Adjusted^99MRC
RBC histogram right discriminator adjusted mark	IS	15055	RBC Histogram. Right Line Adjusted	99MRC	15055^RBC Histogram. Right Line Adjusted^99MRC
RBC histogram bitmap data	ED	15056	RBC Histogram. BMP	99MRC	15056^RBC Histogram. BMP^99MRC
PLT histogram binary data	ED	15100	PLT Histogram. Binary	99MRC	15100^PLT Histogram. Binary^99MRC
PLT histogram left discriminator	NM	15111	PLT Histogram. Left Line	99MRC	15111^PLT Histogram. Left Line^99MRC
PLT histogram right discriminator	NM	15112	PLT Histogram. Right Line	99MRC	15112^PLT Histogram. Right Line^99MRC
PLT histogram	NM	15113	PLT	99MRC	15113^PLT Histogram.

metadata length			Histogram. Binary Meta Length		Binary Meta Length^99MRC
PLT histogram left discriminator adjusted mark	IS	15114	PLT Histogram. Left Line Adjusted	99MRC	15114^PLT Histogram. Left Line Adjusted^99MRC
PLT histogram right discriminator adjusted mark	IS	15115	PLT Histogram. Right Line Adjusted	99MRC	15115^PLT Histogram. Right Line Adjusted^99MRC
PLT histogram bitmap data	ED	15116	PLT Histogram. BMP	99MRC	15116^PLT Histogram. BMP^99MRC
DIFF 2D scattergram bitmap data	ED	15200	WBC DIFF Scattergram. BMP	99MRC	15200^WBC DIFF Scattergram. BMP^99MRC
Diff scattergram metadata length	NM	15203	WBC DIFF Scattergram. Meta len	99MRC	15203^WBC DIFF Scattergram. Meta len^99MRC
Diff scattergram Fcs dimension	NM	15205	WBC DIFF Scattergram. Fsc dimension	99MRC	15205^WBC DIFF Scattergram. Fsc dimension^99MRC
Diff scattergram Ssc dimension	NM	15206	WBC DIFF Scattergram. Ssc dimension	99MRC	15206^WBC DIFF Scattergram. Ssc dimension^99MRC
Diff scattergram FL dimension	NM	15207	WBC DIFF Scattergram. FL dimension	99MRC	15207^WBC DIFF Scattergram. FL dimension^99MRC
Diff scattergram binary data	ED	15201	WBC DIFF Scattergram. BIN	99MRC	15201^WBC DIFF Scattergram. BIN^99MRC
Baso 2D scattergram bitmap data	ED	15250	Baso Scattergram. BMP	99MRC	15250^Baso Scattergram. BMP^99MRC
Baso scattergram binary data	ED	15251	Baso Scattergram. BIN	99MRC	15251^Baso Scattergram. BIN^99MRC
Baso scattergram	NM	15253	Baso Scattergram.	99MRC	15253^Baso Scattergram. Meta

metadata length			Meta Len		Len^99MRC
Baso scattergram Fcs dimension	NM	15255	Baso Scattergram. Fsc dimension	99MRC	15255^Baso Scattergram. Fsc dimension^99MRC
Baso scattergram Ssc dimension	NM	15256	Baso Scattergram. Ssc dimension	99MRC	15256^Baso Scattergram. Ssc dimension^99MRC
Baso scattergram FL dimension	NM	15257	Baso Scattergram. FL dimension	99MRC	15257^Baso Scattergram. FL dimension^99MRC
RET 2D scattergram bitmap data	ED	15300	RET Scattergram. BMP	99MRC	15300^RET Scattergram. BMP^99MRC
PLT-O 2D scattergram bitmap data	ED	15301	PLT-O Scattergram. BMP	99MRC	15301^PLT-O Scattergram. BMP^99MRC
RET-EXT 2D scattergram bitmap data	ED	15302	RET-EXT Scattergram. BMP	99MRC	15302^RET-EXT Scattergram. BMP^99MRC
RET scattergram Fcs dimension	NM	15303	RET Scattergram. Fsc dimension	99MRC	15303^RET Scattergram. Fsc dimension^99MRC
RET scattergram Ssc dimension	NM	15304	RET Scattergram. Ssc dimension	99MRC	15304^RET Scattergram. Ssc dimension^99MRC
RET scattergram FL dimension	NM	15305	RET Scattergram. FL dimension	99MRC	15305^RET Scattergram. FL dimension^99MRC
RET scattergram binary data	ED	15306	RET Scattergram. BIN	99MRC	15306^RET Scattergram. BIN^99MRC
RET scattergram metadata length	NM	15307	RET Scattergram. Meta Len	99MRC	15307^RET Scattergram. Meta Len^99MRC
NRBC 2D scattergram	ED	15350	NRBC Scattergram.	99MRC	15350^NRBC Scattergram.

bitmap data			BMP		BMP^99MRC
NRBC scattergram Fcs dimension	NM	15351	NRBC Scattergram. Fsc dimension		15351^NRBC Scattergram. Fsc dimension^99MRC
NRBC scattergram Ssc dimension	NM	15352	NRBC Scattergram. Ssc dimension	99MRC	15352^NRBC Scattergram. Ssc dimension^99MRC
NRBC scattergram FL dimension	NM	15353	NRBC Scattergram. FL dimension	99MRC	15353^NRBC Scattergram. FL dimension^99MRC
NRBC scattergram binary data	ED	15354	NRBC Scattergram. BIN	99MRC	15354^NRBC Scattergram. BIN^99MRC
NRBC scattergram metadata length	NM	15355	NRBC Scattergram. Meta Len	99MRC	15355^NRBC Scattergram. Meta Len^99MRC
Abnormal Flag Messages					
WBC Scattergram Abn.	IS	12000	WBC Abnormal scattergram	99MRC	12000^WBC Abnormal scattergram^99MRC
WBC Histogram Abn.	IS	12001	WBC Abnormal histogram	99MRC	12001^WBC Abnormal histogram^99MRC
Leucocytosis	IS	12002	Leucocytosis	99MRC	12002^Leucocytosis^99MRC
Leucopenia	IS	12003	Leucopenia	99MRC	12003^Leucopenia^99MRC
Neutrophilia	IS	12004	Neutrophilia	99MRC	12004^Neutrophilia^99MRC
Neutropenia	IS	12005	Neutropenia	99MRC	12005^Neutropenia^99MRC
Lymphocytosis	IS	12006	Lymphocytosis	99MRC	12006^Lymphocytosis^99MRC
Lymphopenia	IS	12007	Lymphopenia	99MRC	12007^Lymphopenia^99MRC
Monocytosis	IS	12008	Monocytosis	99MRC	12008^Monocytosis^99MRC
Eosinophilia	IS	12009	Eosinophilia	99MRC	12009^Eosinophilia^99MRC

Basophilia	IS	12010	Basophilia	99MRC	12010^Basophilia^99MRC
WBC Abn.	IS	12011	WBC Abnormal	99MRC	12011^WBC Abnormal^99MRC
Left Shift?	IS	17790-7	WBC Left Shift?	LN	17790-7^WBC Left Shift?^LN
Immature Granulocyte?	IS	34165-1	Imm Granulocytes?	LN	34165-1^Imm Granulocytes?^LN
Abn./Atypical Lymph?	IS	15192-8	Atypical Lymphs?	LN	15192-8^Atypical Lymphs?^LN
RBC Lyse Resist?	IS	34525-6	rstRBC	LN	34525-6^rstRBC^LN
Erythrocytosis	IS	12012	Erythrocytosis	99MRC	12012^Erythrocytosis^99MRC
RBC Distribution Abn.	IS	12013	RBC Abnormal distribution	99MRC	12013^RBC Abnormal distribution^99MRC
Anisocytosis	IS	15150-6	Anisocytosis	LN	15150-6^Anisocytosis^LN
Macrocytosis	IS	15198-5	Macrocytes	LN	15198-5^Macrocytes^LN
Microcytosis	IS	15199-3	Microcytes	LN	15199-3^Microcytes^LN
Dimorphologic	IS	10379-6	RBC Dual Pop	LN	10379-6^RBC Dual Pop^LN
Anemia	IS	12014	Anemia	99MRC	12014^Anemia^99MRC
Hypochromia	IS	15180-3	Hypochromia	LN	15180-3^Hypochromia^LN
HGB Abn./Interfere?	IS	12015	HGB Interfere	99MRC	12015^HGB Interfere^99MRC
Platelet Distribution Abn.	IS	12016	PLT Abnormal Distribution	99MRC	12016^PLT Abnormal Distribution^99MRC
Thrombocytosis	IS	12017	Thrombocytosis	99MRC	12017^Thrombocytosis^99MRC
Thrombopenia	IS	12018	Thrombopenia	99MRC	12018^Thrombopenia^99MRC
Platelet Clump?	IS	7796-6	Platelet Clump?	LN	7796-6^Platelet Clump?^LN
Right Shift	IS	12020	Right Shift	99MRC	12020^Right Shift^99MRC
Asp. Abn./Sample Abn.	IS	12021	Sample Abnormal	99MRC	12021^Sample Abnormal^99MRC

RBC Agglutination?	IS	12022	RBC Clump	99MRC	12022^RBC Clump^99MRC
Small Platelet	IS	32208-1	Platelets.small all	LN	32208-1^Platelets.small ^LN
RBC or HGB Abn.	IS	12023	RBC HGB Abnormal	99MRC	12023^ RBC HGB Abnormal^ 99MRC
Iron Deficiency	IS	12024	Iron Deficiency	99MRC	12024^Iron Deficiency^99MRC
RBC or HGB Abn.?	IS	12025	RBC HGB doubt	99MRC	12025^ RBC HGB doubt^99MRC
DIFF Data Collection Error	IS	12026	DIFF Sampling Error	99MRC	12026^DIFF Sampling Error^99MRC
DIFF Data Analysis Error	IS	12027	DIFF-CH Error	99MRC	12027^DIFF-CH Error^99MRC
Blast cell	IS	44017-2	Blasts	LN	44017-2^Blasts^LN
NRBC /PLT Clump?	IS	12028	NRBC /PLTClumps	99MRC	12028^NRBC /PLTClumps^99MRC
RBC Data Collection Error	IS	12029	RBC Sampling Error	99MRC	12029^RBC Sampling Error^99MRC
RBC Data Analysis Error	IS	12030	RBC-CH Error	99MRC	12030^RBC-CH Error^99MRC
RBC Agglutination?	IS	50670-9	RBC Agglutination ?	LN	50670-9^ RBC Agglutination?^LN
HGB Abn.	IS	12031	HGB Defect	99MRC	12031^HGB Defect^99MRC
PLT Data Collection Error	IS	12032	HGB Sampling Error	99MRC	12032^HGB Sampling Error^99MRC
PLT Data Analysis Error	IS	12033	PLT-CH Error	99MRC	12033^PLT-CH Error^99MRC
BASO Data Collection Error	IS	12034	BASO Sampling Error	99MRC	12034^BASO Sampling Error^99MRC
BASO Data Analysis Error	IS	12035	BASO-CH Error	99MRC	12035^BASO-CH Error^99MRC
Leucocytosis (BASO)	IS	12036	Leukocytosis (BASO)	99MRC	12036^Leukocytosis(BASO)^99MRC
Leucopenia (BASO)	IS	12037	Leukopenia(BASO)	99MRC	12037^Leukopenia(BASO)^99MRC
RET Data Collection	IS	12038	RET Sampling	99MRC	12038^RET Sampling Error^99MRC

Communication

Error			Error		
RET Data Analysis Error	IS	12039	RET-CH Error	99MRC	12039^RET-CH Error^99MRC
RET Scattergram Abn.	IS	12040	RET Abn Scattergram	99MRC	12040^RET Abn Scattergram^99MRC
Reticulocytosis	IS	12041	Reticulocytosis	99MRC	12041^Reticulocytosis^99MRC
NRBC Data Collection Error	IS	12042	NRBC Sampling Error	99MRC	12042^NRBC Sampling Error^99MRC
NRBC Data Analysis Error	IS	12043	NRBC-CH Error	99MRC	12043^NRBC-CH Error^99MRC
NRBC Scattergram Abn.	IS	12044	NRBC Abn Scattergram	99MRC	12044^NRBC Abn Scattergram^99MRC
Nucleated Red Blood Cell	IS	34188-3	NRBC present	LN	34188-3^NRBC present^LN

C.6 Base64 Encoding Process

1. Select the 3 adjacent bytes (i.e. 24 bit) from the data stream to be encoded; from left to right, divide them into 4 groups of 6-bit; and then, the ASCII string is obtained by mapping as per Table 14 below:

Raw data:	15H	A3H	4BH
Binary data	00010101	10100011	01001011
6-bit groups obtained after dividing	000101	011010	001101 001011
Corresponding codes	5H	1AH	0DH 0BH
Corresponding characters	F	a	N L

Table 11 Base64 Mapping

Value/Code	Value/Code	Value/Code	Value/Code
0 A	17 R	34 l	51 z
1 B	18 S	35 j	52 0
2 C	19 T	36 k	53 1
3 D	20 U	37 i	54 2
4 E	21 V	38 m	55 3
5 F	22 W	39 n	56 4
6 G	23 X	40 o	57 5
7 H	24 Y	41 p	58 6
8 I	25 Z	42 q	59 7
9 J	26 a	43 r	60 8
10 K	27 b	44 s	61 9
11 L	28 c	45 t	62 +
12 M	29 d	46 u	63 /
13 N	30 e	47 v	
14 O	31 f	48 w	(pad) =
15 P	32 g	49 x	
16 Q	33 h	50 y	

2. Repeat step 1 continuously till the whole data stream is encoded.

When the data left is less than 3 bytes, 0 is added to the right to complement. If the all the 6-bit groups obtained is composed of 0, then it is mapped to the “=” character. When there is the last one byte left, there will be two “=” characters in the obtained coding string; when two bytes are left, then the obtained coding string consists of one “=” character. See the two examples below:

① Raw data 0AH
 00001010

Data obtained after complementing	00001010	00000000	00000000
6-bit groups obtained after dividing	000010	100000	000000 000000
Corresponding codes	02H	20H	00H 00H
Corresponding characters	C	g	= =

② Raw data 0AH 0BH
 00001010 00001011

Data obtained after complementing	00001010	00001011	00000000
-----------------------------------	----------	----------	----------

Communication

6-bit groups obtained after dividing	000010	100000	101100	000000
Corresponding codes	02H	20H	2CH	00H
Corresponding character	s	C	g	s
				=

