

## *Draft Indian Standard*

# X-RAY BAGGAGE INSPECTION SYSTEM (XBIS)

## 1. SCOPE

This standard defines the requirement of X-Ray Baggage Inspection System (XBIS) for scanning of luggage without physically opening it. It enables security personnel / operator to analyze baggage for threat or suspicious object. It shows scanned images comprising of four colors i.e. orange, green, blue and black. These four colors of scanned baggage are decided by effective atomic number object scanned. Orange, green, blue and black color signify organic, inorganic, thin metal and dense materials respectively. It is used by security personnel at airport, railway stations, metro stations, highly secured govt. offices, R&D labs, shopping mall and hotels etc.

Standard is applicable to 'Single View and Dual View XBIS with dual/multi energy detectors.

Standard is common for XBIS with different tunnel sizes and it can be categorized into 3 types.

- a. Small size : Parcel Scanner
- b. Medium size : Baggage Scanner
- c. Large size : Large Baggage Scanner

## 2. REFERENCES

The Standard given below contain provisions which, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All Standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the Standards indicated below:

IS No.	Title
IEC 61010-1:2010	Safety requirements for electrical equipment for measurement + control + and laboratory use - Part 1: General requirements

## 3. GENERAL REQUIREMENTS

**3.1** The XBIS shall have the ability for real time screening of baggage without stopping the conveyor belt. The aspect ratio of scanned image shall be equivalent to the real baggage and not be deforming from the original shape of the baggage.

**3.2** The physical dimensions of XBIS shall be compatible to security check points. It shall be easy to install, commission and service at the entrance/ exit of the user premises.

**3.3** The XBIS shall display scanned image comprised of at least four colours i.e. orange, green, blue and black signifying organic, inorganic, thin metal and dense materials respectively.

**3.4** The conveyor movement shall be bidirectional for entry and exist gateway of the premises.

**3.5** The real time scanned image shall be provided to enhance the image quality with the help of XBIS software but shall not allow the operator to alter/manipulate the scanned image.

### **3.6 Tunnel Size**

The tunnel size of XBIS denotes the size of entry and exit of the baggage. The XBIS with different tunnel sizes are used in different applications. Based on the tunnel size other parameters of XBIS are decided.

Minimum tunnel size of XBIS may be classified as below.

- a. Small size : 50 cm x 30 cm (WXH)
- b. Medium size : 60 cm x 40 cm (WXH)
- c. Large Size : 100 cm x 100 cm (WXH)

### **3.7 Conveyor Speed**

The conveyor speed decides the shape and image continuity of the scanned object. The conveyor speed shall preferably range from 0.18m/s to 0.3 m/s.

### **3.8 Conveyor load capacity**

Conveyor load capacity (Evenly Distributed) may be classified as below

- a. Small size XBIS: minimum 60 Kg
- b. Medium size XBIS: minimum 165 Kg
- c. Large Size XBIS: minimum 200 Kg

*Conveyor height may vary based on the design i.e Generator at bottom or Top*

*BIS Comment: Conveyor height and Conveyor capacity also may be specified.*

### **3.9 X-Ray Generator voltage**

The emitted X-Ray is proportional to applied X-Ray Generator voltage. X-Ray Generator Voltage defines the other parameter of the XBIS.

*BIS Comments: 160 to 185 kV limit may be specified.*

### **3.10 X-Ray Generator Current**

The emitted X-Ray is proportional to no of electrons released from cathode. The no. of electrons depends on X-Ray generator current.

### **3.11 Cooling**

98% to 99% of electron striking to anode contributes to heat which increases the temperature of X-Ray tube. To compensate this heat cooling mechanism shall be provided.

### **3.12 X-Ray Generator Orientation**

The X-Ray Generator shall be fixed in such a way so that no portion of the scanned image is cut. *X-ray generator duty cycle shall be 100%.*

*X-Ray Generator orientation parameter can be removed since it is design parameter of OEM. For eg. Generator can be placed in the bottom or top. It should be in such a way that total baggage is scanned.*

### **3.13 sDetector Type**

Dual energy/*Multi energy* detectors shall be provided to display scanned images in different colour as per effective atomic number.

### **3.14 Power Supply Input**

The power supply input shall be *230± 10 % VAC, 50 Hz.*

### 3.15 Operating Temperature

The operating shall range from 0-40 °C.

Storage temperature shall range from 0°C to 50°C.

*(These temperature ranges are also part of the MHA specifications.)*

*BIS Comment: Storage temperature may be specified. Members to provide inputs on sub-assembly storage temp. This would be discussed and decided in the next meeting.*

### 3.16 Humidity

The humidity shall be up to 90% non-condensing.

### 3.17 Zoom

Continuous electronic zoom with a minimum value of 16X.

*More zoom will degrade the quality of image and threat identification will be difficult.*

### 3.18 Connectivity requirements (Optional)

Computer of XBIS should have Ethernet connectivity. A client server configuration can be established to network with other of XBIS and its display can be monitored in a central monitoring station.

### 3.19 Baggage Handling:

*Last meeting it was discussed and decided to remove this.*

### 3.20 Film & Food Safety

#### Film Safety:

Food Safety: OEM has to submit a food and drug safety certificate from any NABL accredited lab or from BRIT, Vashi.

### 3.21 Requirement of Video display specifications:

- CPU: Should be able to deliver the output to meet the XBIS specifications.
- Monitor: Minimum 21" monitor with LED back panel. Should be able to display scanned images without corner cut.
- Hard Disk: Minimum 1 TB ,7200 rpm SATA HDD
- Mouse & Keyboard: optical
- Ports: 6 USB port, HDMI, Display port, RJ-45 port.

- CD-R/RW Drive: DVD Writer
- Networking: 10/100/1000 on board integrated network port.

### 3.22 Credential for XBIS software:

Three levels of credentials to be provided by OEM to customer.

- Operator credentials: with limited access.
- Supervisor credentials: with complete access.
- Service Engineer credentials: for maintenance.

Software should be able to recall minimum 15 last scanned images in all credentials.

*BIS Comment: Continuous electronic Zoom may be specified.32X or better.*

*Either Throughput (bags/hour) or conveyor speed may be specified. Refer Item 4.2 of the minutes of the 14<sup>th</sup> meeting of LITD 26. However, the MHA and RDSO technical specifications mention both throughput and conveyor speed. Clarification needed.*

*Sensors may be specified.*

*Connectivity requirements (optional) needs to be incorporated. (Refer Item 4.3 of the minutes of the 14<sup>th</sup> meeting of LITD 26) Ethernet*

*Requirements of baggage handling to be included. (Refer Item 4.4 of the minutes of the 14<sup>th</sup> meeting of LITD 26)*

### 3.20 Threat Image Projection

**3.20.1** TIP software facility shall be incorporated in the offered X-ray machines to assist supervisors in testing the operator alertness and training X-ray screeners to improve their ability in identifying specific threat object. The system will create a threat object and the same will be superimposed on monitor screen while a bag is being screened. To acknowledge that the operator has seen the false object, operator must press the control panel key that will cause the computer generated threat object to disappear from x-rayed bag image on the VDU screen. Each operator's action shall be recorded in the hard disc of the computer for the auditing purpose by the supervisor or other authorized person.

#### 3.20.2 Design of the system

**3.20.2.1** TIP software should be compatible with other X-ray technologies such as automatic reject unit, Dual X-ray screen technologies, automatic threat recognition system etc.

All X-ray image function must be available at the same time along with the TIP.

### **3.20.3 Image Library**

**3.20.3.1** The TIP facility should have an image library. The system shall have facility to expand the library to incorporate additional images by user without assistance of the manufactures as and when required.

**3.20.3.2** The image library should contain images of threats at different orientations – both plane and end-on orientations should be used. Although these will be assigned different file names and references. It must be possible to cross reference these as the same threat. All threat Image Projection images must be realistic. Representative and non-distinguishable from real threat items.

### **3.20.4. Time Interval**

**3.20.4.1** Programming facility shall be available to project threat images in different intervals. The time period for threat image as well as image mix in percentage shall be user programmable e.g. software shall select 40% images of explosive devices, 35% of fire arms & 25% knives or random etc.

**3.20.4.2** Once the screener has responded to identity of the computer generated threat image, it should remain on the screen for a predefined user programmable time for analysis. The image should be highlighted, upon identification, and feedback message shall be visible to the screener.

### **3.20.5. System Administration**

**3.20.5.1** The threat image projection facility shall have details of user data-base such as airport name, screener name, organization, user ID number.

**3.20.5.2** Access to start up menu should be restricted only to the authorized individuals.

A log-in procedure by means of 'password' or 'security key', could achieve restricted access to each of the comment. The log-in procedure should not take longer than 20 second. The system should have facility to by-pass the TIP facility, if programmed so by the system administrator. It is to be ensured that the TIP software shall not be hindrance to normal functioning of X-ray Machines.

**3.20.5.3** When the operator logs-in or log-out, message should be displayed on X-ray BIS VDU Screen to confirm that he/she has been correctly logged-in or logged-out.

### **3.20.6. Feed Back Report**

**3.20.6.1** The threat image Projection should be capable of giving feedback HIT, MISS or FALSE ALARM message. No message will be presented if a screener correctly passed as clear bag.

**3.20.6.2** A 'HIT' message to be presented when a screener has correctly identified a Threat Image Projection image. A 'MISS' message shall be presented when screener fails to identify the TIP image A 'False Alarm' message shall be given when screener incorrectly indicate TIP image when in fact no threat image projection is present. The feedback should clearly indicate in a screen that a TIP object has been correctly identified / TIP object has been missed / no TIP object was present. Information should be recorded in the database.

**3.20.6.3** Different colour coding shall be used for feedback to the screener. It is recommended that colour code 'Red for MISS', Green for 'HIT' and 'yellow to False Alarm or Interrupt' be used.

**3.20.6.4** The system shall automatically prepares the daily log of events for each shift and for each screener performance. TIP log shall include particulars of

**3.20.6.5** Airport, XBIS, Name of Screener, Time & data of threat image, weather threat image was successfully identified or missed etc.

**3.20.6.6** The report on Threat Image Projection system may have date and time (From-To) as per requirement, Screener particulars, and decision /outcome i.e. MISS, HIT or False Alarm in percentage as well in absolute numbers, number of bags screened, categories such as explosive devices knife or weapon etc.

**3.20.6.7** As a standard practice, daily/ weekly/monthly report shall be retrieved. Report shall be for any given time and period, as per command.

**3.20.6.8** All data should be stored on the system for a minimum of two months after it has been down loaded. No individual, regardless of access rights to the Threat Image Projection components would delete or amend any of threat Image Projection data or time i.e. Threat Image Projection data on the actual X-ray machine will be read only file.

**3.20.6.9** Automatic tray retrieval system with reject lane and recheck station with multiple divestment stations may be installed by airport operators to increase throughput, wherever required.

**3.20.6.10** X-BIS shall have automated online framing of suspicious martial (e.g. Explosives, high density material, narcotics etc.) for operator. This feature should be in real time requiring no operator involvement.

**3.20.6.11** All the system should be maintained by the OEMs or entities certified by them, by whatever arrangements airport operators opt for.

**3.20.6.12** The system should not be connected or accessed through internet by the OEM for any purpose including remote diagnosis.

**3.20.6.13** A non-disclosure agreement (NDA) is to be signed by the airport operators (Buyer) with OEM (Supplier) to affect the confidentiality of the information pertaining to the system.

**3.20.6.14** Service Engineer of Indian origin will only be deputed by the OEM or entities authorized by them to maintain the system. Non-Indian Engineers may be deputed for major breakdowns under supervision.

BIS Comments: Following Image parameters may be incorporated:

- a. Machine should be capable for recalling 15 or more previous images,
- b. It should have the capability of archiving 50,000 or more images with date & time stamp.
- c. Facility of image enhancement should be available,
- d. Facility for variable contrast must be incorporated to allow enhancement lighter and darker portion of the image,
- e. Machine should have online recording facility and images can be recorded on a mass storage device and should be able to view images so recorded on a stand-alone PC,
- f. The machine should have features of Multi-energy X-ray imaging facility where materials of different atomic number will be displayed in different colours to distinguish between organic and inorganic materials.
- g. Continuous Electronic Zoom facility should be available to magnify the chosen area of an image eight times (8X) or more. Image features shall be keyboard controllable.

#### **4. Performance Requirements**

The CTP (Combined Test Piece) shall be used to ensure that the performance requirements for XBIS set out are met and maintained. The CTP shall contain samples of organic and inorganic material; materials for resolution and penetration tests. The X-Ray Baggage Inspection machine shall comply with the following requirements:





Fig. Combined Test Piece

#### 4.1 Single Wire Resolution

Wire resolution defines the minimum gauge of the wire detected using XBIS. Wire resolution depends on applied Kilo volt to the X-Ray tube of XBIS.

A set of un-insulated tinned copper wires of size 26, 30, 35, 38, 40 and 42 SWG or corresponding AWG wires are placed on Perspex sheet. The wires are laid out in 'S' shaped curves. The wires are placed behind varying thickness of aluminium. A quarter of the length of each wire is uncovered whilst the remaining 3 quarters are covered by 3 wedges of aluminium of 4.8mm (3/16"), 7.9mm (5/16") and 11.1mm (7/16") thickness. Metallic marker is provided using high-density material, so that SWG/AWG numbers are clearly visible on the display. The X-BIS machine shall be able to display single un-insulated tinned copper wire of 38 AWG. **Minimum guaranteed wire resolution is 36 AWG.**

#### 4.2 Multi Energy X-Ray

With multi-energy X-Ray, it should be possible to distinguish between materials of different average atomic number. The use of sugar and salt samples encapsulated on the test piece of CTP will check the material discrimination facility. The sugar is displayed in orange color and salt in green color.

#### 4.3 Steel Penetration

Steel penetration defines thickness of steel which the X-Ray from XBIS is able to penetrate. It depends on applied Kilo volt to the X-Ray tube of XBIS. Steel penetration is the parameter where lead strip placed behind steel step wedge of varying thickness should be visible while scanning.

- a. Small size XBIS: minimum 14 mm
- b. Medium size XBIS: minimum 28mm
- c. Large Size XBIS: minimum 28mm

*BIS Comment: Test to be explicitly mentioned.*

#### **4.4 Spatial Resolution**

Spatial Resolution defines the ability of the system to distinguish and display objects which are close together. The minimum spatial resolution that the XBIS shall be able to distinguish is 1mm. Minimum spatial resolution shall be 1 mm

The CTP has copper plate with two sets of gratings (1.0mm and 1.5mm). Each set consists of a horizontal group and a vertical group. The requirement is that a vertical and horizontal grating can be seen.

*BIS Comment: Test to be explicitly mentioned.*

#### **4.5 Thin Metal Imaging**

This is to test the ability of XBIS to display thin metal. This involves three thin squares of steel of 0.05mm, 0.10mm and 0.15mm thickness placed in row and the requirement is to image steel strip of 0.1 mm thickness.

*It is a part of CTP. CTP should have a thin metal strip of varying thickness of 0.05 mm, 0.1 mm and 0.15 mm. The dimension of the full strip is ~ 1.5 cm X 11 cm ( WxL)*

*BIS Comments: Test to be mentioned explicitly.*

*Video display specifications may be specified.*

*Food safety and Film safety for high speed films (up to ISO 1600) may be specified. Film safety (ISO 3200)inputs needed from bel, vehant, Krystal vision, ecil. Vehant to share test reports of BARC for ISO 3200.*

### **5. Safety Requirements**

Radiation emission leakages must be below the required regulatory limits with less than 1 $\mu$ Sv/hr at 5cm from all surfaces of XBIS. The XBIS must comply with all applicable Atomic Energy Regulatory Board (AERB) requirements under section-16 of the Atomic Energy Act, 1962, as well as EN standard 61010-1:2010, AMD1:2016.

*Provision of – (to be added)*

- *Fuses for over load protection: refer EN 61010-1:2010 , clause no. 9.4.*
- *Lock & Key switch for power supply. : Provision for lock and key for the system is required to restrict unauthorized operation.*
- *Safeties inter locks for Array Box and side panels.: provision for safety interlock to be provided at the panel and diode array box panel. Removal of any of the panel prevents the generation of X-Rays.*
- *X-Ray On indication and Emergency Stop on front panel, rear panel & control desk.: provision for Emergency Stop should be there to switch off the power in case of emergency condition. X-Rays ON warning indication located at the entrance and exit of the inspection tunnel and control panel to indicate that the X-ray generator is switched on.*
- *Lead coated curtains on both front and back: Lead impregnated curtains at the entrance and exit of the XBIS to reduce leakage radiation less than 1 $\mu$ Sv/hr.*
- *Lead shielding material on cabinet: Lead shielding is to be done on the surface of XBIS tunnel.*
- *Warning Signs: Permanently affixed warning sign at entry and exit of the tunnel of XBIS.*

### **5.1 EMI/EMC Requirements:**

The EMI/EMC requirement for various test parameters shall be as given in below table;

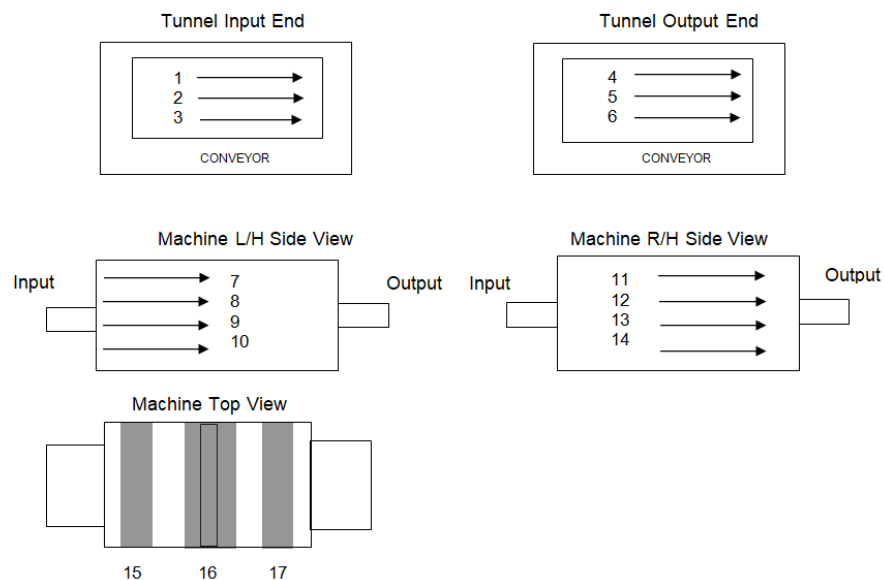
Sr. No.	Name of the test	Standard
1.	Conducted Emissions	CISPR 11
2.	Radiated Emissions	CISPR 11
3.	Radiated RF EM field Immunity	IEC 61000-4-3:2020
4.	Electrical Fast Transient / Burst immunity	IS 14700 (Part 4/Sec 4):2018/ IEC 61000-4-4:2012
5.	Surge Immunity	IS 14700 (Part 4/Sec 5):2019/ IEC 61000-4-5:2017
6.	Conducted disturbance, induced by RF Field	IS 14700 (Part 4/Sec 6):2016/ IEC 61000-4-6:2013
7.	Power Frequency Magnetic Field Immunity	IS 14700 (Part 4/Sec 8):2018/ IEC 61000-4-8:2009
8.	Voltage Dips, Short Interruptions & Voltage	IS 14700 (Part 4/Sec 11):2021/

	Variations Immunity	IEC 61000-4-11:2020
9.	Electrostatic Discharge Immunity	IS 14700 (Part 4/Sec 2):2018/ IEC 61000-4-2:2008

## 6. Other Important Tests:

### 6.1 Radiation Emission check:

Leakage Radiation measurement shall be measured at the various points of the XBIS when X-Rays being generated. A calibrated pressurized ion chamber radiation survey meter is used for the measuring leakage radiation. Leakage measurement has to be done as per the following points.



The leakage radiation must be less than 1 $\mu$ Sv/hr at 5cm from all surfaces of XBIS.

### 6.2 High Temperature Test:

*The XBIS system shall be kept in a high temperature oven at 42°C for 4 hrs. After the test the XBIS should work as per its specifications.*

### 6.3 Humidity Test:

*The XBIS system shall be kept at 40°C @ 93% RH for 48 hrs. After the test, the XBIS shall work as per its intended specifications.*

*These tests will be covered in the qualification of 3.15, 3.16*

#### **6.4 Durability of marking test:**

All system markings shall remain clear and legible under conditions of normal use and shall resist the effects of the cleaning agent. Conformity is checked by performing this test for durability of markings on the stickers mentioned above. The markings are rubbed by hand, without undue pressure, for 30s with a cloth soaked with 70% of isopropyl alcohol.

*BIS Comments: Durability of marking is not defined in IEC 61010-1:2010. To clarify.*

*Would durability of marking be tested by bump test? Generally bump test is used for testing for mechanical hazards.*

#### **6.5 Temperature monitoring Test:**

The XBIS shall be subjected to temperature monitoring test in accordance with EN 61010-1:2012, applicable clause no. is 10.1. This test is conducted to monitor temperature at different points of XBIS Surface for protection against burns.

*BIS Comments: Clause number of concerned test of IEC 61010-1:2017 to be mentioned Qualifying criteria also to be mentioned.*

#### **6.6 Conveyor Belt Load test:**

The XBIS shall be subjected to conveyor belt load test in accordance with IEC 61010-1:2017. The load shall be placed on the conveyor belt. Conveyor belt should withstand and be able to scan optimum load in reverse and forward direction.

*BIS Comments: Clause number of concerned test of IEC 61010-1:2017 to be mentioned. Qualifying criteria also to be mentioned. IEC Reference is not available.*

### **7. Marking:**

**7.1.** Each XBIS shall be legibly and indelibly marked with the following information:

- a) Manufacturer's name or trade-mark (if any);
- b) Model designation and serial no. ;
- c) Month and Year of manufacturing
- d) Country of manufacture;
- e) Input supply voltage and frequency;
- f) Power consumption;

#### **7.2. BIS Certification Marking:**

The XBIS may also be marked with standard mark.

**7.2.1** The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulation made thereunder. The details

of conditions under which a license for the use of the Standard Mark may be granted to manufacturers and/or producers may be obtained from the Bureau of Indian Standards.