# Axis Series X-Ray Inspection Systems

## Conveyor and Pipeline Models Software Version AXIS X3

# CONTENTS

# THE LOMA GROUP OF COMPANIES

## UK

Loma Systems Limited, Southwood, Farnborough, Hampshire, GU14 0NY, England

Telephone: 01252 893300 Fax: 01252 513322

## CANADA

Loma Canada Limited, 333 Wyecroft Road, Unit 11, Oakville, Ontario, Canada L6K 2H2.

Telephone: 1-800-387-7987 Fax: 905-842-3460

905-842-4581

## NETHERLANDS

Loma Systems BV, Panovenweg 22, 5708 HR, Helmond, Netherlands.

Telephone: 0492 573573 Fax: 0492 573570

## USA

Loma International Inc., 283 East Lies Road, Carol Stream, Illinois 60188, USA.

Telephone: 1-630-588-0900 Fax: 1-630-588-1395

1-800-USA-LOMA Internet address: WWW.LOMA.COM

# THE LOMA GROUP SERVICE CENTRES

## UK

Loma Customer Services Dept., Unit 43 Campus Road, Bradford, West Yorkshire BD7 1HR

Telephone: 01274 378200 Fax: 01274 729716

## MAINLAND EUROPE

Loma Systems BV, Panovenweg 22, 5708 HR, Helmond, Netherlands.

Telephone: 0492 573573 Fax: 0492 573570

## USA and SOUTH AMERICA

Loma International Inc., 283 East Lies Road, Carol Stream, Illinois 60188, USA.

Telephone: 1-800-USA-LOMA / 1-630-588-0900 Fax: 1-630-588-1396

## CANADA

Loma Canada Limited, 333 Wyecroft Road, Unit 11, Oakville, Ontario, Canada L6K 2H2

Telephone: 1-800-387-7987 / 905- 842-4581 Fax: 905-842-3460

## REST OF WORLD

Loma Customer Services Dept., Unit 43 Campus Road, Bradford, West Yorkshire BD7 1HR, UK

Telephone: (44) 01274 378200 Fax: (44) 01274 729716

# CAUTIONARY ADVICE

## CONTENTS

# Safety Warnings

Listed below are all the safety warnings that are used throughout this manual. It is strongly recommended that personnel who are, or will be, responsible for installing, maintaining or operating the equipment described in this manual should read and understand these warnings.

1. **LETHAL HAZARD – ELECTRICAL SUPPLIES**. A current of 100 milli-amps passing through the body for one second can kill. This can occur at voltages as low as 35V ac or 50V dc. The equipment described in this manual uses electrical power which can be lethal. Unless absolutely necessary, cleaning, inspection and maintenance must not be carried out without first isolating the equipment from all electrical supplies.

2. **LETHAL HAZARD** – **RADIATION**. Whilst every precaution has been taken to make sure that all the necessary guards and safety devices have been fitted to the Loma x-ray unit, it is recommended that all operatives are trained in the use of x-ray food inspection machines. Furthermore it is the responsibility of the employer to create a set of local rules (see example at the end of this section) regarding the safe use of x-ray food inspection systems. In the U.K. this is in compliance with the Ionising Radiation's Regulations 1999, users outside of the UK should consult the relevant health and safety executive (see also Radiation Surveys in this manual).

3. **LETHAL HAZARD – COMPRESSED AIR SUPPLIES**. The equipment described in this manual may be supplied with a compressed air supply operating at a pressure, which may be lethal. Unless absolutely necessary, cleaning, inspection and maintenance must not be carried out without first isolating the equipment from all compressed air supplies. In addition, it should be checked that all air pipes are properly connected.

4. **WORKING ON EQUIPMENT**. If it is essential to work on the equipment with electrical and/or compressed air power connected, the work must be undertaken only by suitably qualified and authorised personnel who are fully aware of the danger involved and who have taken adequate safety precautions to avoid contact with dangerous voltages, radiation (see Radiation Surveys) or compressed air supplies.

5. **REJECT DEVICES**. At no time, with compressed air and/or electrical power applied to an automatic reject device, should any part of the body be placed within the operating area of the reject device. In addition no attempt should be made to operate the AXIS x-ray machine without the reject bin or guards in place.

6. **EXCESSIVE NOISE**. When an air blast reject device operates, the noise emitted may constitute a noise hazard. While short exposure to this noise will not normally cause permanent damage to hearing, prolonged exposure may cause some damage. It is recommended that ear defenders are worn by personnel who are regularly exposed to the noise.

7. **HEAVY EQUIPMENT**. The equipment described in this manual is extremely heavy and considerable care must be taken when handling it. Sufficient personnel and a suitable forklift truck or pallet truck must be used to ensure safe handling. In addition attention should be paid to the Axis Lifting Points drawing in the Installation section of this manual.

8. **LIFTING EQUIPMENT**. Use only the correct slings and lifting tackle to move heavy items of equipment described in this manual. Inspect all slings and lifting tackle prior to lifting the equipment to ensure that:

    a) The safe working load will not be exceeded.

    b) There are no frayed or broken strands.

    c) Hooks, rings, etc. are not damaged.

9. **MOVING THE MACHINE**. The centre-of-gravity of the conveyor is high. Care must be taken when moving such equipment on a slope to ensure that it does not topple over. This could result in death or severe injury to an individual and/or severe damage to the machine (refer to Axis Lifting Points in the Installation section of this manual).

10. **CONTAMINANTS**. Oils and greases must always be handled with care. Prolonged bare skin exposure to certain oils and greases can cause skin problems. Always handle oils and greases in accordance with the manufacturer's instructions (for types used see section on routine maintenance).

11. **TRAPPED FINGERS**. Do not place fingers on the underside of the x-ray conveyor belt when the machine is operating. It is possible for fingers to be trapped and subsequently crushed between a moving and fixed component of the machine. Trapped fingers is also to be avoided during pipeline normalisation.

12. **WARNING LABELS**. The Loma AXIS x-ray machine has a number of warning labels and engravings throughout the system. Particular attention should be paid to the location of these warnings and their significance in operating the machine safely. If necessary because of local requirements some labelling may also be provided in a second language.

13. **GUARDS**. No machine is to be run without guards fitted unless for maintenance purposes and only if adequate precautions have been taken. Under no circumstances is any interlock to be defeated. This could lead to serious leakage of radiation if operated with x-rays on in such a manner.

14. **PIPELINE NORMALISATION**. Care is to be taken when carrying this out to ensure correct posture and no over exertion is made.

# Local Rules (UK Example)

### Ionising Radiations Regulations 1999 Local rules

1. **GENERAL**

These rules are provided in compliance with the Ionising Radiations Regulations 1999 (IRR99) (Regulation 17) and the Associated Approved Code of Practice - "Work with Ionising Radiation".

The rules are the general principles and description of the means of complying with the Regulations and should be seen as implementing part of the general safety policy required by Section 2 of the Health and Safety at Work etc. Act 1974.

Aims: to ensure that work with ionising radiations is controlled so that:

1) During normal working, radiation doses to all persons are as low as reasonably practicable,

2) Precautions have been taken to minimise the risk of equipment failure or other occurrence which may result in significant radiation doses to any person, and

3) No doses exceed those specified in the Regulations.

2. **RADIATION PROTECTION SUPERVISOR (RPS)**

[INSERT NAME OF RPS]

The RPS is responsible for ensuring the work is carried out in accordance with requirements of the regulations and for taking all reasonable steps to ensure that these rules are observed. In addition, the RPS should carry out a radiation dose rate survey of the unit at least once a month or after maintenance. Checks should also be made on the operation of any warning lights and door interlocks. A record should be kept of the monitoring results (dose rates should be noted in units of “µSv/h“) and safety system checks.

3. **AUTHORISED STAFF**

Only staff who have been trained in the use of the x-ray unit may operate the equipment. The staff authorised to use the equipment are listed below.

[INSERT NAMES]

4. **DESIGNATION OF AREAS**

No controlled or supervised areas require to be designated in connection with this unit.

## 5. GENERAL PRECAUTIONS

5.1 Any failure of a warning light or interlocks must be reported to the RPS as soon as possible. In the event of a fault resulting in the failure of the door interlock or shielding, the equipment must not be used until it has been repaired. A notice stating that the unit is out of use must be displayed on the unit.

5.2 Before generating any x-rays, check that the warning lights are functioning.

5.3 Before accessing the interior of the unit, e.g. for cleaning, check that the unit is disconnected from the power supply.

5.4 Do not tamper with or attempt to over-ride the door interlock – this could result in exposure to the primary x-ray beam.

5.5 When the equipment is not in use, remove the key to prevent unauthorised use.

## 6. MAINTENANCE

Maintenance will be carried out by appropriately qualified service engineers when necessary. No attempt should be made to repair the x-ray unit without advice from a qualified service engineer.

After maintenance, the unit should be monitored using a suitably calibrated radiation instrument and a record kept of the monitoring results.

## 7. RISK/ HAZARD ASSESSMENT

**Potential hazards are:**

7.1 Failure of an interlock resulting in generation of x-rays while the cabinet door is open.

7.2 Radiation leakage from the cabinet as a result of misplaced shielding following repairs to the unit or non-operation of an interlock. Routine monitoring around the unit following repairs or maintenance should minimise this risk.

7.3 Fire or mechanical damage which may effect the integrity of the shielding.

Under normal operating conditions, the equipment is adequately shielded and doses to operators will be low (< 50 “µSv per year).

## 8. CONTINGENCY PLANS

IMMEDIATE ACTION is necessary to prevent exposure of persons to radiation.

8.1 In the event of a fault, SWITCH OFF the equipment and remove the key from the switch.

8.2 Do not use the equipment again until the fault has been rectified and the absence of any radiation leakage is verified.

8.3 Notify the RPS of the fault.

8.4 In the event that it is suspected that a person has received an over exposure then the RPS must be contacted immediately.

Under these circumstances, the RPS must ascertain if a person has been exposed and the magnitude of the exposure. If investigations determine that an over-exposure has taken place then the Health and Safety Executive must be notified of this forthwith.

# Emergency Shutdown of X-Ray System

Each x-ray system manufactured by Loma Systems is fitted with emergency 'Stop' buttons. These are mounted on the front and sides of the control panel and at the rear of the machine. In the case of a pipeline machine, due to the size and no conveyor present only two emergency stops are required and are situated on the front control panel and the rear door. The buttons are red in colour with a yellow background. In the event of an emergency, which requires the conveyor to be immediately stopped, press the stop button and both x-rays and the conveyor will be stopped.

# Dealing With Fire

In the unlikely event of fire occurring in an item of equipment manufactured by Loma Systems, it is important that a fire extinguisher containing the correct type of extinguishing material is used. Fire on electrical equipment must be extinguished using either a dry powder or carbon dioxide (CO2) extinguisher.

# Audible Warnings

The AXIS x-ray machine is fitted with an alarm, which operates in the event of a fault condition. The maximum volume of the alarm is 116 dB(A) and is adjustable via a potentiometer on the back of the alarm itself.

# Visual Indications

The AXIS x-ray machine is fitted with indicator lamps, which operate to show a particular status or in the event of a fault condition. The machine must not be operated unless all such indicators are fully operational.

# Radiation Levels

Each Loma x-ray inspection machine has a critical examination to ensure that the radiation levels emitted from the system are within the specified allowable limits. In fact at Loma we strive to be well inside the allowable limit to maximise confidence in a safe system. The legislative figure in the UK is 1μ Sv / hour but on the AXIS machine we generally achieve 0.1μSv / hour on average.

In addition when a system is commissioned on a customers premises another critical examination is carried out and the results stored on record at Loma. A copy of which is also provided to the customer (see Radiation Surveys).

# Occupational Safety and Health Administration Warning

"In the United States of America, the Occupational Safety and Health Administration (O.S.H.A.) Acts quite clearly place the burden of compliance on the user of equipment, and the acts are generalised to the extent that determination of adequacy of compliance is a judgement decision on the part of the local inspector. Hence Loma cannot be held responsible for meeting full requirements of O.S.H.A. or O.H.S.A. with regards to any equipment supplied, nor can Loma be held liable for penalty which may be assessed for failure to meet the requirements of the acts as interpreted by an authorised inspector. Loma, however, does act in a responsible manner with regard to safe design of equipment and will always work with customers to assist where possible in the remedy of any violations at a reasonable cost to the buyer."

# Advice On Due Diligence

By your selection of a Loma x-ray system you have demonstrated your intention to assure the quality of your products and thereby protect your customers.

The following six simple actions will help you maintain Due Diligence:

1. Once your Loma x-ray system is installed you should contact your local Loma Service Department to have the system commissioned.

2. Check on a daily basis the radiation levels around the x-ray system (<1μSv/hr) using a suitable radiation meter (Details available from Loma Systems Limited) and record the results (see Radiation Surveys).

2. Regularly check the operation of the x-ray unit (once an hour is recommended). Keep accurate records of those tests and the contaminant samples being used, along with the product details.

3. If the x-ray test fails the test, quarantine the product from the last test and re-introduce through the x-ray unit once the equipment is fit for use.

4. Have the equipment supported by a Planned Preventative Maintenance Contract. Details can be obtained from your local Loma Service Department.

5. If you have or intend to have BS EN ISO 9000 accreditation, write a section into your Operating Procedures Manual covering x-ray test procedures and have each x-ray radiation meter regularly calibrated with a certificate issued.

6. Finally, at least on a yearly basis, have your operators, QA and maintenance personnel trained in the use of the equipment. Details of available training can be obtained from your local Loma Service Department.

# RADIATION SURVEYS

## CONTENTS

# Introduction

As with all x-ray machines the LOMA AXIS produces ionising radiation when x-rays are being generated. However, legislation governs the allowable emission levels and safe working practices when using a x-ray machine. With this in mind the AXIS machine has been designed to provide adequate shielding throughout the system, with safety interlocks preventing the guards or access panels from being lifted or removed without x-ray generation being stopped. However, it is recommended, and may be required by your country, state or province, to document a radiation survey of the AXIS machine on the following occasions.

1) Daily.

2) After any maintenance has been performed.

3) After the machine has been moved for any reason (new location etc).

3) After any damage has occurred to the system.

4) As per the regulations of your country, state or province.

A documented survey program assures the system is performing correctly, has not been damaged and provides regular data that the system meets all radiation guidelines.

**Note:** When your AXIS system is commissioned your Loma service engineer will carry out an initial survey report and provide you with a copy. The UK regulations also require that radiological information is provided. This information is given in the Cautionary advice section under Local Rules.

# Radiation Exam

To ensure that maintenance, modification, damage, or distortion of the cabinet, and cowlings etc. do not result in any deterioration of the safety system it is important that regular checks are carried out.

## Interlocks and Emergency Stop Switches

Lids that may need to be opened by operating staff in order to clear obstructions etc. are interlocked to prevent x-rays being generated while the lid is open. Service panels that only need to be opened by trained service personnel are similarly interlocked. The interlocks used are either tongue or magnetic type safety switches, which via safety relays trip the high voltage power supply and stop x-ray generation. The switch is fixed to the frame of the machine and a protective panel, when properly seated, closes the switch. After the high voltage power supply has been tripped it is necessary to re-start the inspection in order to generate x-rays.

The emergency stop switches act in a similar manner to the interlocks. After actuating any emergency stop it has to be manually reset before the x-ray generator can be restarted.

## Radiation Dose Rates

In most if not all countries where ionising radiation is used there will be a maximum allowable emitted dose rate per hour. In addition, the dose measurement must be recorded at a set distance from the machine surface and around the machine at any aperture or discharge conveyor points.

In order to check that the emitted radiation level is within the guidelines a suitable radiation monitor must be used which is regularly calibrated at least once a year.

Please contact your Loma Customer Service office for details on obtaining the correct type of radiation monitor.

## Routine Operational Testing

After the x-ray inspection system has been installed the service engineer will carry out a full radiation and safety survey of the x-ray system.

For assurance that the system remains safe both the emergency shut down system and measurement of the surface dose rates need to be included in a regular test schedule.

The emergency stops provide the means for the operational staff to shut down the system rapidly. Although the stops provided are of proven reliability, it is important that they are tested on a frequent basis.

The test consists of actuating each stop individually while the x-ray generator is operating and noting that the system immediately shuts down. It is also a requirement that when the stop has been manually reset the system does not automatically start up.

The conveyor covers need to be opened to clear blockages, etc. on the conveyor belt and it is important that the safety interlocks immediately shut down the system.

Opening each lid in turn and noting that the system immediately shuts down tests the interlocks. As noted above the system needs to be re-started before x-rays can be generated again.

# External Radiation

Changes in radiation dose rate, either at the surface of the machine or at the infeed and outfeed ports, is most likely to be noted following any material alterations to the system such as a change in the arrangement of the conveyor or lids etc. In addition, if the x-ray tubes operating voltage is raised or lowered, this will affect the reading measured. It is therefore important that a full radiation survey should be carried out following servicing or repair work. Otherwise changes in the dose rate at the surface of the machine in general are unlikely to be noticed.

If changes are observed it will be at either the infeed or the outfeed ports because it is here that product enters and leaves the inspection chamber allowing some x-rays to scatter along the conveyor belt. In view of this the ports are the most important places for routine operational monitoring, but all surfaces should be checked as well.

# Frequency of Monitoring

As noted above the most sensitive area for changes in the dose rate are the ports and as a consequence these should be monitored most frequently. To measure the dose rate at the two ports will take only a few minutes and should be carried out either once per day or once per shift as appropriate.

It is recommended that the dose rate at the ports be measured at the start of each shift or day so that each operating team can feel confident that all is well when they start work. The results should be noted in some form of record so that any longer term trends can be observed.

Radiation shielding of the main beam and elsewhere in the console is intrinsic to the design and where additional shielding is fitted it is mechanically fixed by welding or bolting. As a consequence of this it is reasonable to assume that there will be no changes in dose rates at the surfaces of the machine etc., and routine monitoring of these may therefore be less frequent. In addition to this a full survey should be made following any maintenance that involves removing or changing any internal parts, or following any damage which results in distorted or split housing or panels.

Where lead curtains are fitted, over time these will wear and potentially tear. Visual inspection of these on a daily basis is recommended so that signs of wear are picked up before the curtains become damaged and so prevent the potential of the external dose rate rising above an acceptable level.

# Summary of Test Procedures for Radiation Leakage

**Daily or Shift Checks**

1) Measure and record the radiation dose rate at the infeed and the outfeed port using the radiation monitor. If it is greater than the maximum allowable shut down the system and report it immediately to the supervisor.

2) Check the condition of the lead curtains ensuring no splits or broken segments.

**Weekly Checks**

1) Check the emergency stops. If any of them fail report it immediately to the supervisor.

2) Check the conveyor lid(s). If opening the lid does not immediately shut down the system then use the nearest emergency stop and report the failure to the supervisor.

**Monthly Checks**

1) Carry out a full radiation survey over the accessible surfaces of the machine using the radiation monitor.

**After a Major Service**

1) Carry out a radiation survey over all accessible surfaces and at the openings of the infeed and outfeed ports. Check the emergency stops and the interlocks are operational.

**After a machine has been moved**

1) Carry out a radiation survey over all accessible surfaces and at the openings of the infeed and outfeed ports. Check the emergency stops and the interlocks are operational.

**Note:** When using the radiation monitor it must be moved slowly over the surface that you are measuring. The suggested rate is less than 6 inches per second, however users should refer to the monitor instruction manual and specification.

**It is strongly recommended that persons appointed to carry out radiation surveys have received the necessary radiation awareness training qualification. In some countries this may be mandatory and it is recommended that the user seeks advice from the local health and safety executive.**

# LOMA AXIS

## RADIATION SURVEY REPORT
## X-RAY FOOD INSPECTION UNITS

1. Unit Details:

Model/Type:_____ Customer: _____

Serial No:_____ Address: _____

Year of manufacture:_____ _____

Location of unit:_____ _____

Reason for survey: Installation Post-maintenance Relocation

Other (specify)_____

2. X-Ray Tube Settings:

_____ kV _____mA

3. General Checks:

Adequate guarding fitted …….. Customer information provided ……

'Power On' warning lights labelled, visible from both sides and operate correctly…….

'X-ray On' warning lights labelled, visible from both sides and operate correctly……

'Fault' warning lights labelled, visible from both sides and operate correctly……..

Emergency stops fitted, labelled and operate correctly ……..

Conveyor interlocks fitted and operate correctly …….

X-ray warning labels fitted to infeed and outfeed ..…….

4. Dose Rate Results: (Refer to relevant unit drawing)

For measurement point dose rates see attached Drawing No:_____

External dose rate less than 1µSv/h ……... ☐

5. Radiation Monitor used:

Model/Type:_____ Serial No: _____ Calibration Date: _____

Comments:

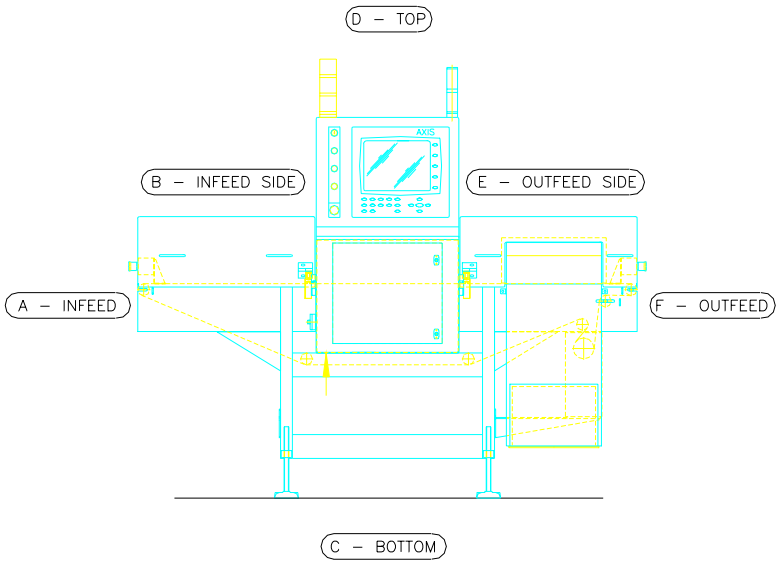
Test conducted by approved Engineer

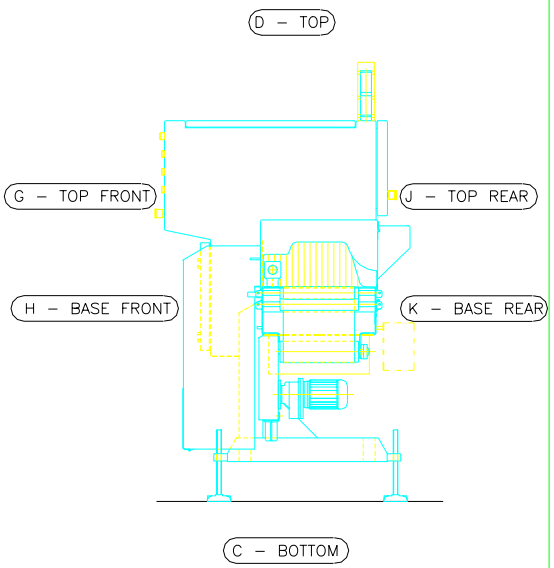
Name:_____ Signature:_____ Date:_____

DRG No. 8900-C4-38729 B

DO NOT SCALE

IF IN DOUBT ASK




| RADIATION READINGS | |
|---|---|
| POSITION | MAX READING uSv/hr |
| A – INFEED | |
| B – INFEED SIDE | |
| C – BOTTOM | |
| D – TOP | |
| E – OUTFEED SIDE | |
| F – OUTFEED | |
| G – TOP FRONT | |
| H – BASE FRONT | |
| J – TOP REAR | |
| K – BASE REAR | |

| | |
|---|---|
| CUSTOMER | |
| MODEL | |
| TYPE | |
| SERIAL No. | |

| ISSUE | MODIFICATION | DRAWN | DATE |
|---|---|---|---|
| B | EXTRA READINGS ADDED | C.B. | 18.04.00 |
| A | FIRST ISSUE | E.D. | 30.9.99 |

SPECIAL INSTRUCTIONS

REMOVE ALL BURRS AND SHARP EDGES

MATERIAL –

PROTECTIVE FINISH –

SURFACE FINISH UNLESS STATED OTHERWISE –



3RD ANGLE PROJECTION

TOLERANCE UNLESS STATED OTHERWISE

MACHINING GENERAL ± 0,2
0,0 ± 0,1
0,00 ± 0,05
ANGULAR ± 0,25°

FABRICATION 0 TO 300 ± 0,5
300 TO 1000 ± 1
1000 TO 3000 ± 2
ANGULAR ± 0,5°

| DRAWN | CHECKED | APPROVED |
|---|---|---|
| E.D. | | |
| SCALE | DATE | DIMENSIONS IN |
| N.T.S. | Sept 30:1999 | Millimeters |

LOMA ENGINEERING LTD.
SUMMIT AVENUE, SOUTHWOOD
FARNBOROUGH, HANTS. GU14 ONY
TELEPHONE (01252 893300)

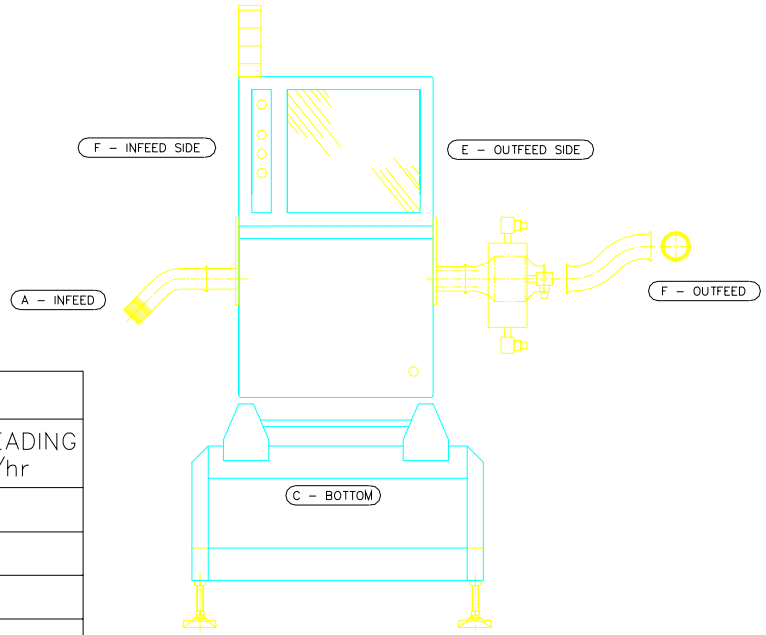
TITLE

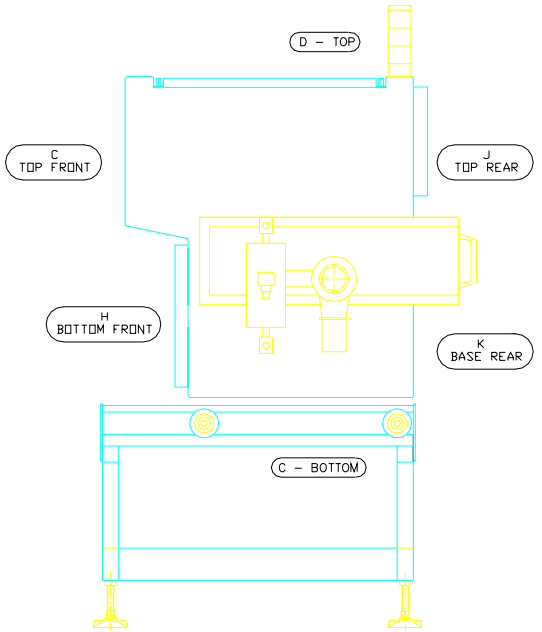
AXIS CONVEYOR MACHINE
RADIATION SURVEY DRAWING

DRAWING No. 8900-C4-38729 B

DRG No. 8900-C4-40658A

DO NOT SCALE | IF IN DOUBT ASK

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| K – BASE REAR | |

| | |
|---|---|
| CUSTOMER | |
| MODEL | |
| TYPE | |
| SERIAL No. | |

| ISSUE | MODIFICATION | DRAWN | DATE |
|---|---|---|---|
| B | REVISED FOR Mk2 VERSION | CB | 22.03.01 |
| A | FIRST ISSUE | CB | 11.05.00 |

SPECIAL INSTRUCTIONS



REMOVE ALL BURRS AND SHARP EDGES

MATERIAL ---

PROTECTIVE FINISH ---

SURFACE FINISH UNLESS STATED OTHERWISE ---

3RD ANGLE PROJECTION

TOLERANCE UNLESS STATED OTHERWISE

MACHINING GENERAL ± 0.2, 0.0 ± 0.1, 0.00 ± 0.05, ANGULAR ± 0.25°

FABRICATION 0 TO 300 ± 0.5, 300 TO 1000 ± 1, 1000 TO 3000 ± 2, ANGULAR ± 0.5°

| DRAWN | CHECKED | APPROVED |
|---|---|---|
| CB | | |
| SCALE | DATE | DIMENSIONS IN |
| N.T.S. | 11.05.00 | Millimeters |

LOMA ENGINEERING LTD.
SUMMIT AVENUE, SOUTHWOOD
FARNBOROUGH, HANTS. GU14 0NY
TELEPHONE (01252 893300)

TITLE

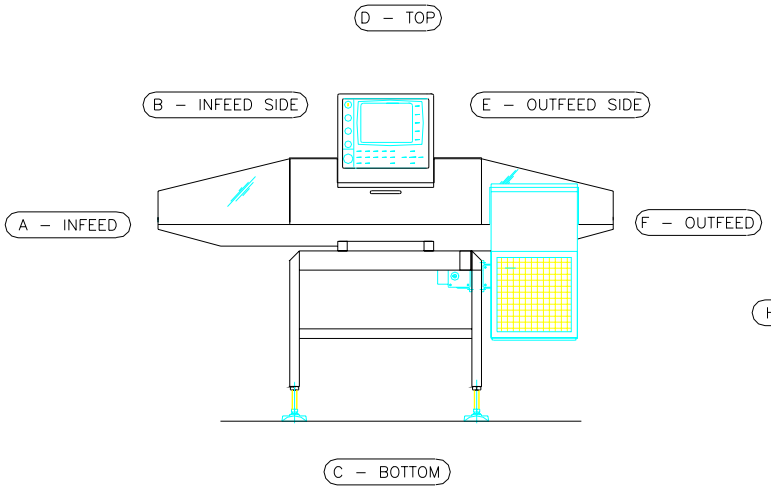
AXIS 3" PIPELINE
RADIATION SURVEY

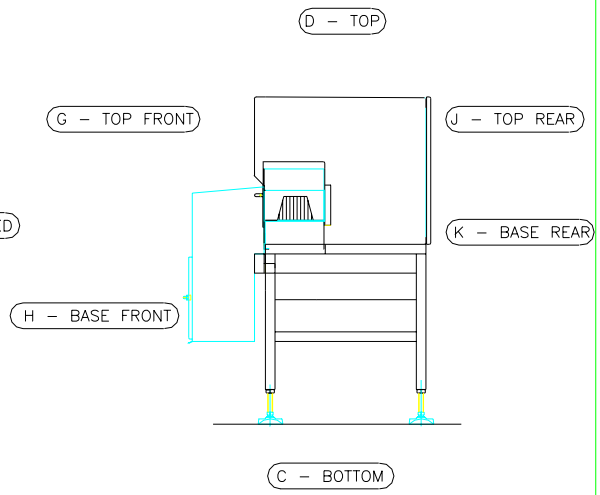
DRAWING No. 8900-C4-40658B

DRG No. 8900-C4-42820 A

DO NOT SCALE

IF IN DOUBT ASK

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| MODEL | |
| TYPE | |
| SERIAL No. | |

| ISSUE | MODIFICATION | DRAWN | DATE |
|---|---|---|---|
| A | FIRST ISSUE | C.B. | 18.9.01 |

SPECIAL INSTRUCTIONS

REMOVE ALL BURRS AND SHARP EDGES

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PROTECTIVE FINISH –

SURFACE FINISH UNLESS STATED OTHERWISE –



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0,0 ± 0,1
0,00 ± 0,05
ANGULAR ± 0,25°

FABRICATION 0 TO 300 ± 0,5
300 TO 1000 ± 1
1000 TO 3000 ± 2
ANGULAR ± 0,5°

| DRAWN | CHECKED | APPROVED |
|---|---|---|
| C.B. | | |
| SCALE: N.T.S. | DATE: Sept 18:2001 | DIMENSIONS IN: Millimeters |

LOMA ENGINEERING LTD.
SUMMIT AVENUE, SOUTHWOOD
FARNBOROUGH, HANTS. GU14 ONY
TELEPHONE (01252 893300)

TITLE
AXIS RAPID CONVEYOR MACHINE
RADIATION SURVEY DRAWING

DRAWING No. 8900-C4-42820 A

# PRINCIPLES OF INSPECTION

## CONTENTS

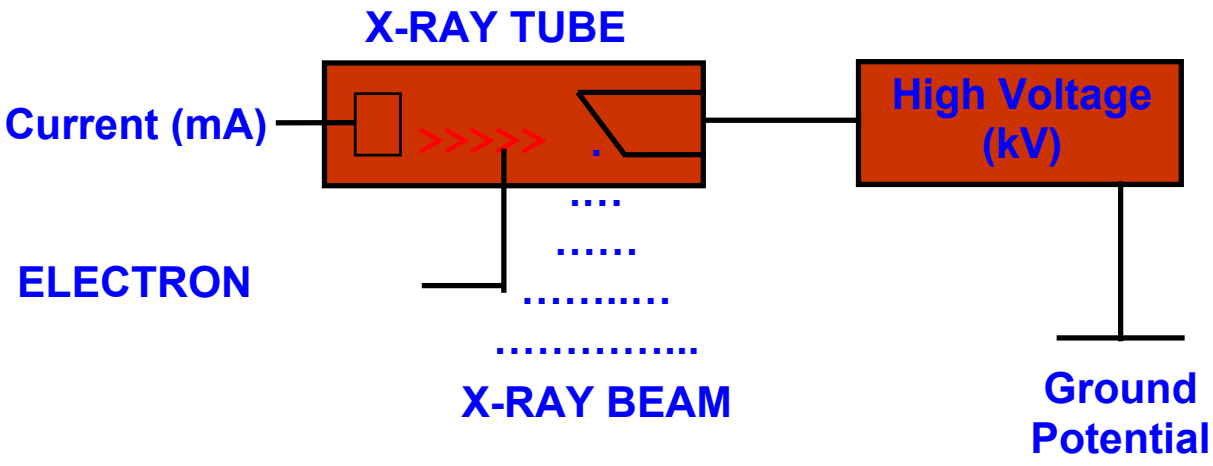
# X-Ray Generation

X-rays are one of many types of electromagnetic radiation that are produced for a particular use. At some time or other most people will have received medical treatment or diagnosis, which will have involved the use of x-rays. Indeed used in the correct manner x-rays can be safely produced and have a number of uses, one of which is for the inspection of food products.

**Note:** X-rays cannot make food products radioactive, as soon as the power source ceases x-ray generation stops and no residual radiation is present.

The principle of x-ray generation is one that is simple to understand and is shown in the diagram below. An evacuated glass tube is used to house a cathode (-ve terminal) and an anode (+ve terminal) which is itself then housed inside a led lined oil filled tank which electrically insulates the tube from the case. In addition the oil is circulated and cooled to dissipate the unwanted heat that is generated when x-rays are produced.

A filament emits electrons inside the tube and a high voltage is then applied which accelerates the electrons towards the target on the anode. When the electrons hit the target x-rays are given off in the form of a conical shaped beam. In effect the voltage controls the brightness and the current the contrast.

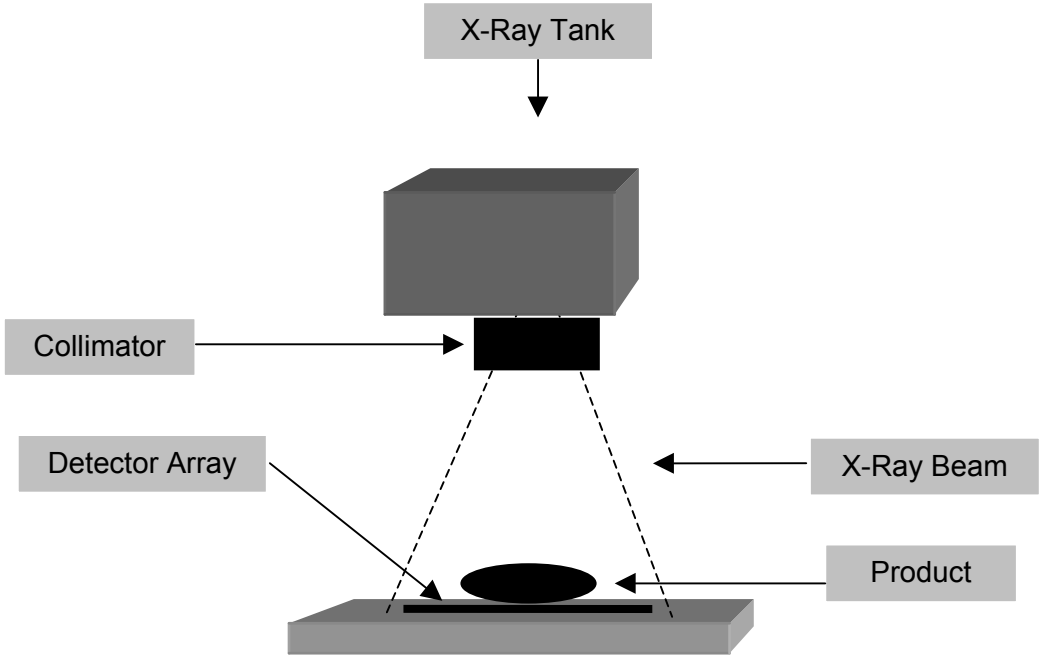



# Detection of X-Rays

Once x-ray generation has taken place and we have the aforementioned conical shaped beam, the next step in the process used on the AXIS machine is to include a device which will receive the x-ray energy and process its signal values.

To do this we first position an assembly directly under the x-ray tank known as the collimator. The collimator in effect allows only the small centre section of the x-ray beam to be emitted approximately one millimeter in thickness. This section of the beam can be considered to be fan shaped and positioned at ninety degrees to the product flow direction as shown in the diagram below

Located on the under side of the centre section of the AXIS machine is a device known as the detector array which is positioned directly in line with the x-ray beam. A line of photosensitive diodes receive the x-ray energy of which the values are then processed in the form of grayscales - 0 (black) to 255 (white) . These scan lines take place at hundreds of scans per second which means a direct relationship between scan rate and belt speed/flow rate exists.



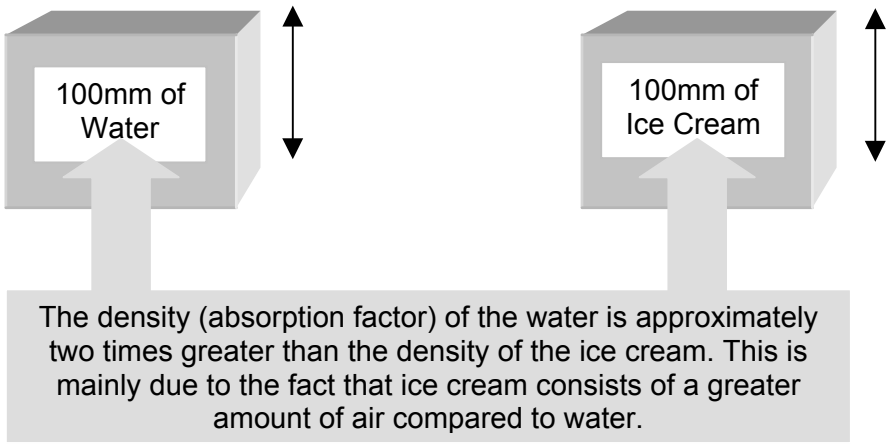

When product is not passing through the x-ray beam the detector array receives 100% of the x-ray energy over the entire length of the array.

When product is introduced through the beam less than 100% of x-ray energy is received of which the signal values will be processed and shown as a grayscale image.

# Product Absorption

When we refer to the product absorption level we mean the amount of x-ray energy that the product will consume (absorb) when x-rays are passed through it. The higher the density of the product passing through the beam, the greater the product absorption factor.

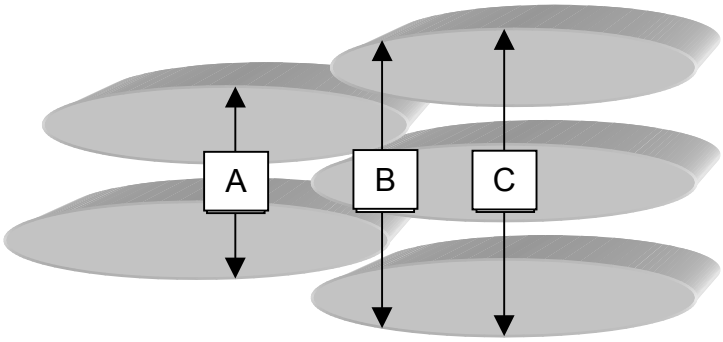
At this stage it is worth noting that just because a product may measure to be higher than another product it does not follow that the greater size is necessarily of a greater overall density. A good example of this is to compare a quantity of water to a quantity of ice cream that measures the same in size. This is shown in the diagram below.




It can therefore be seen that the 100mm of water will absorb a much higher level of x-ray energy than an equivalent quantity of ice cream. In turn the detector array mentioned earlier would receive a lower quantity of x-ray energy through the water compared to the ice cream. The consequence of this is one that generates a lighter grayscale image on the screen in the case of the ice cream.

Further to our examination into product absorption it is important to remember that not all products will have an even absorption factor across its entire area. The 'water' 'ice cream' example shows the density differences assuming both products are homogeneous.

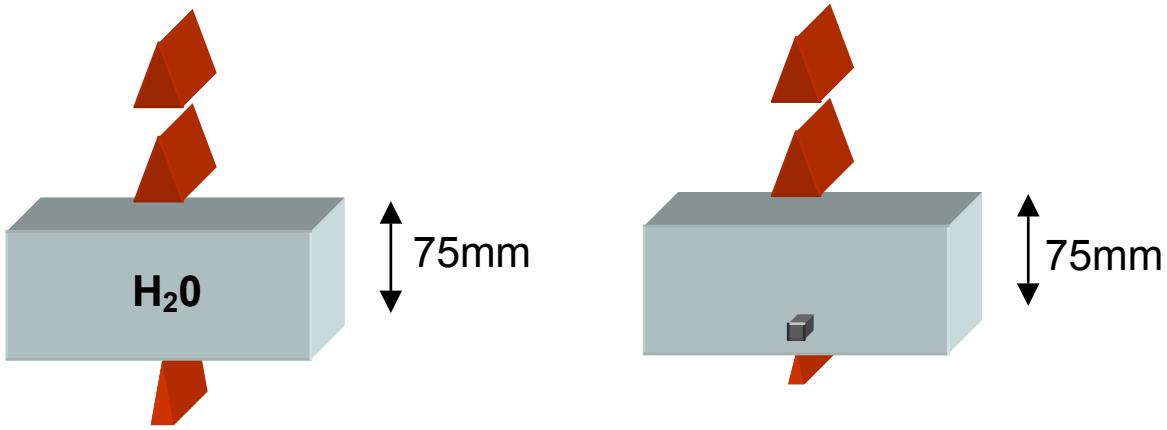
In the case of a particulate product it must be understood that density values will vary across the entire area of the product. Therefore it follows that the level of x-rays reaching the array (detector) will also vary. This will result in an image being shown on the screen of varying grayscale levels. An example is shown below of the effect a particulate product will have in terms of absorption factor.




| |
|---|
| A = 2 x Absorption |
| B = 5 x Absorption |
| C = 3 x Absorption |

When we talk about the absorption factor it is useful to know that the density value is dependant on the specific gravity of the product and that by multiplying the specific gravity value of the product by the height, we can calculate the absorption factor.

## Equating Absorption




Water has an SG (specific gravity) of 1. The relative absorption can be derived from multiplying the product height by the SG.

In the example above the absorption factor is 75 x 1 = 75

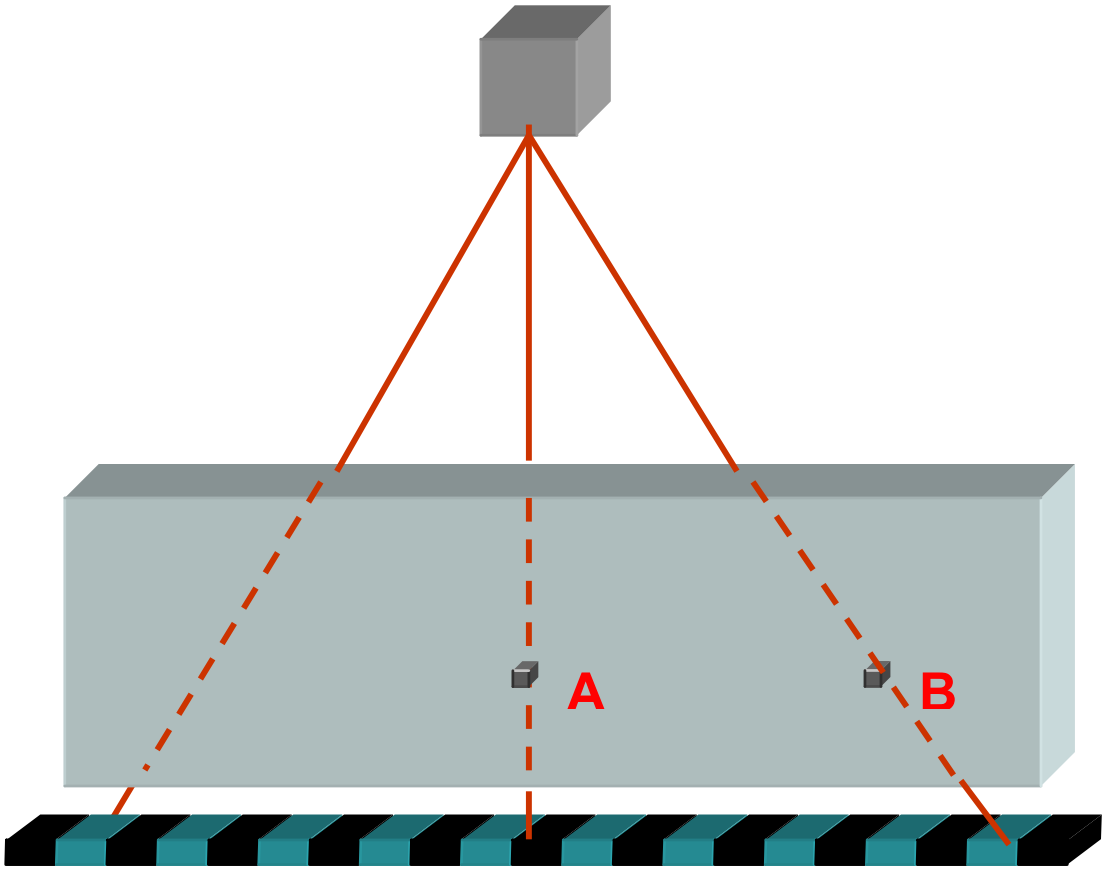
By introducing a 1mm steel contaminate of SG = 8, the absorption of the water has been reduced to 74 x 1 (1mm displacement) but the overall absorption factor has increased.

(74 x 1) + (1 x 8) = 82, a 9% increase

The system detects the density change. If the above example is changed to 5mm high an even larger increase is observed.

5 x 1 = 5 now becomes (4 x 1) + (1 x 8) = 12, a 140% increase

From the following diagram it can be seen that contaminate A is more easy to detect than B. With B the x-ray beam passes through more of the product and therefore has a higher absorbency factor.




## Imaging Software

On the PC mounted in each x-ray machine is loaded software dedicated to the image acquisition, analysis and viewing on the monitor. The version being run on a particular machine is shown in the blue start screen.

Parameter values are then setup to optimize the system performance and requirements suitable for each application.

## Contaminate Detection

The analysis is carried out by comparing each image pixel to a threshold value and rejecting anything below this value i.e. it is denser and hence darker than the product itself. This relationship to density means that if a contaminate is close to water (it floats) then it cannot be detected e.g. insects, wood, hair or paper.

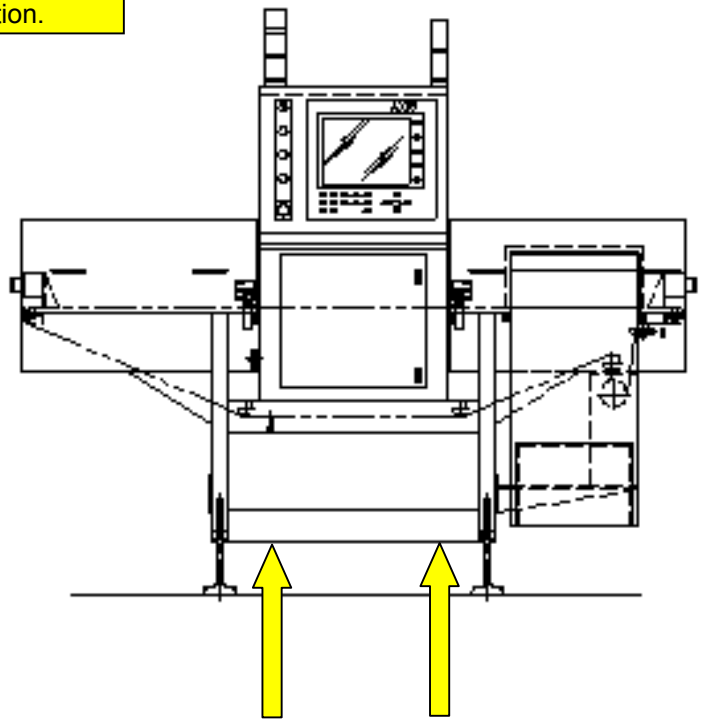
# INSTALLATION

## CONTENTS

# LIFTING AND MOVING AN AXIS MACHINE

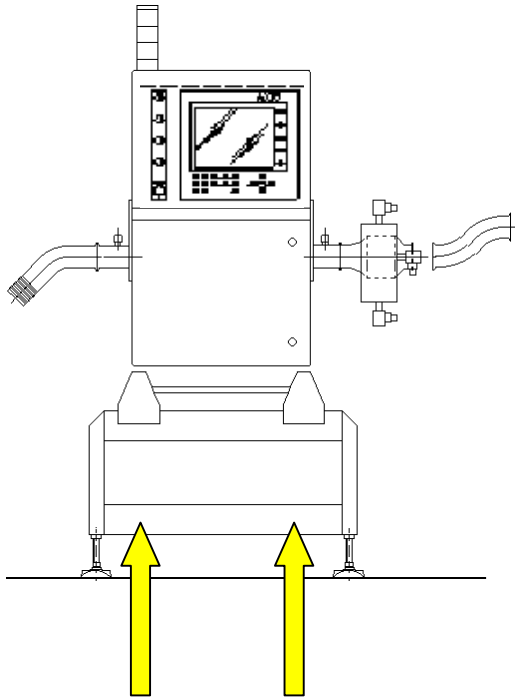
When moving the AXIS conveyor machine place the forks in the indicated position. Care must be exercised when lifting and moving the AXIS making sure that the control unit is not too close to the fork lift face. In addition care must be taken to make sure that the AXIS cannot slip when the forklift is in motion.

**AXIS CONVEYOR INCLUDING RAPID**



**PLACE FORKS HERE**

**AXIS PIPELINE**



**PLACE FORKS HERE**

When moving the AXIS pipeline machine place the forks in the indicated position. Care must be exercised when lifting and moving the AXIS making sure that the control unit is not too close to the fork lift face. Be aware that the centre section must be locked in place before attempting to move the machine. In addition care must be taken to make sure that the AXIS pipeline machine cannot slip when the forklift is in motion.

# Installation - Mechanical

## Pre-Installation Note For Pipeline Machines

**Please note that the infeed and outfeed product pipes need to be fixed to ensure they remain stationary when machine is normalised. These fixings are the responsibility of the user unless supplied with the machine under the agreed machine specification.**

## Preparing to Install the Machine

The system is dispatched from Loma Systems in the following state:

1) Feet are screwed fully in.

2) The X-Ray tank breather screw is in and locked.

3) Delicate items are covered in protective wrapping material and attached or boxed (i.e. lamp stack)

## Space Required for Installation and Maintenance

It is important that sufficient free space is left at the front and back of an AXIS x-ray machine to enable commissioning and maintenance personnel to easily gain access to components. It is recommended that a minimum of 1 metre free space is available at the front and rear of the machine.

## Removal of Packing Materials

1. Remove and discard all packing and protective materials.

2. All AXIS machines are delivered secured to a pallet by 12mm bolts, which are screwed through the feet of the machine. Remove these bolts where fitted.

## Removing the AXIS off the Pallet

**Note:** Refer to LIFTING AND MOVING AN AXIS MACHINE in this section.

### Using a Fork Lift Truck

1. Position the forks beneath the machine at the lifting points indicated so that it does not tilt **(**Refer to LIFTING AND MOVING AN AXIS MACHINE**)**. Raise the lift sufficiently to lift the machine clear of the pallet and any obstacles.

2. Carefully move the machine to the required location following the advice stated in LIFTING AND MOVING AN AXIS MACHINE.

3. Lower the forks and withdraw them from the machine.

## Adjusting/Levelling the Machine

1. Level the machine by adjusting the foot studs. The stud flats are 17mm A/F. Make sure that all feet are firmly on the ground, and are evenly supporting the machine so that it does not rock. If necessary, anchor the machine to the ground using bolts screwed through the feet.

2. Due to the fact that each AXIS machine has an oil filled tank (which the x-ray tube is immersed in) it is necessary to level the machine to ensure that 100% of the x-ray tube is immersed. To this end use a spirit level across the top of the cabinet, in the direction of flow, adjusting the feet until a level condition is achieved.

3. When the height and level is correct, lock the foot stud half-nuts. The lock nut hexagon is 30mm A/F. Failure to do so can have an adverse effect on the components of the AXIS x-ray system.

4. You are recommended to apply silicone sealant around the feet and floor.

## Unlocking the X-Ray Tank Breather

Each AXIS machine is delivered with the x-ray tank breather screw locked. Therefore it follows that this screw needs to be unlocked before powering up the machine.

To do this open the rear access door at the back of the upper rear cabinet. The breather screw is easily located on the top of the x-ray tank filler plug. Loosen the screw by two or three turns anti-clockwise and close access doors.

It should be noted that conveyors fitted with other forms of cooling other than a vortex may require the complete top lid to be removed to gain access.

# Installation - Electrical

## Connecting Electrical Supplies

The supply voltage for the system is indicated on the identification/rating plate that is mounted on the frame. The maximum line current is also shown

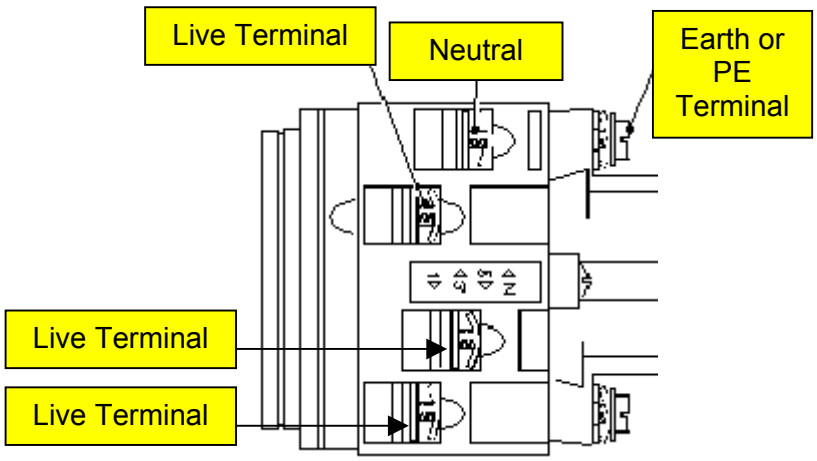
1. Open the door on the front of the centre section cabinet to access the electrical services area.

2. The isolator switch is located at the bottom left hand side of the cabinet. Beneath it on the bottom of the cabinet is the cable gland access for the power cable.

3. The system-input power will depend on the country and system type that has been delivered. For details refer to the rating plate mounted on the frame of the AXIS machine in conjunction with the wiring diagrams delivered with the user manual.

4. Split the cable inside the box and cut the wires to suitable lengths. An armoured/braided cable is recommended when cable conduit is not used. A suitable earth conductor is also to be fitted.

5. Refer to Figure below for isolator switch wiring details. Make the connections to the isolator switch as specified in Table 1.




**Isolator Switch Terminals**

| European | Colour | North America | Colour | Terminal |
|---|---|---|---|---|
| LIVE | Brown or black | HOT | Black | 1/3/5 |
| NEUTRAL | Blue | NEUTRAL | White | N |
| EARTH | Green/Yellow | GROUND | Green | E |
| SCREEN | - | SCREEN | - | E |

**Table 1 Electrical Supply Connections**

6. Check that all connections are secure then close and lock the door.

# Installation - Pneumatics

## Connecting the Air Supply

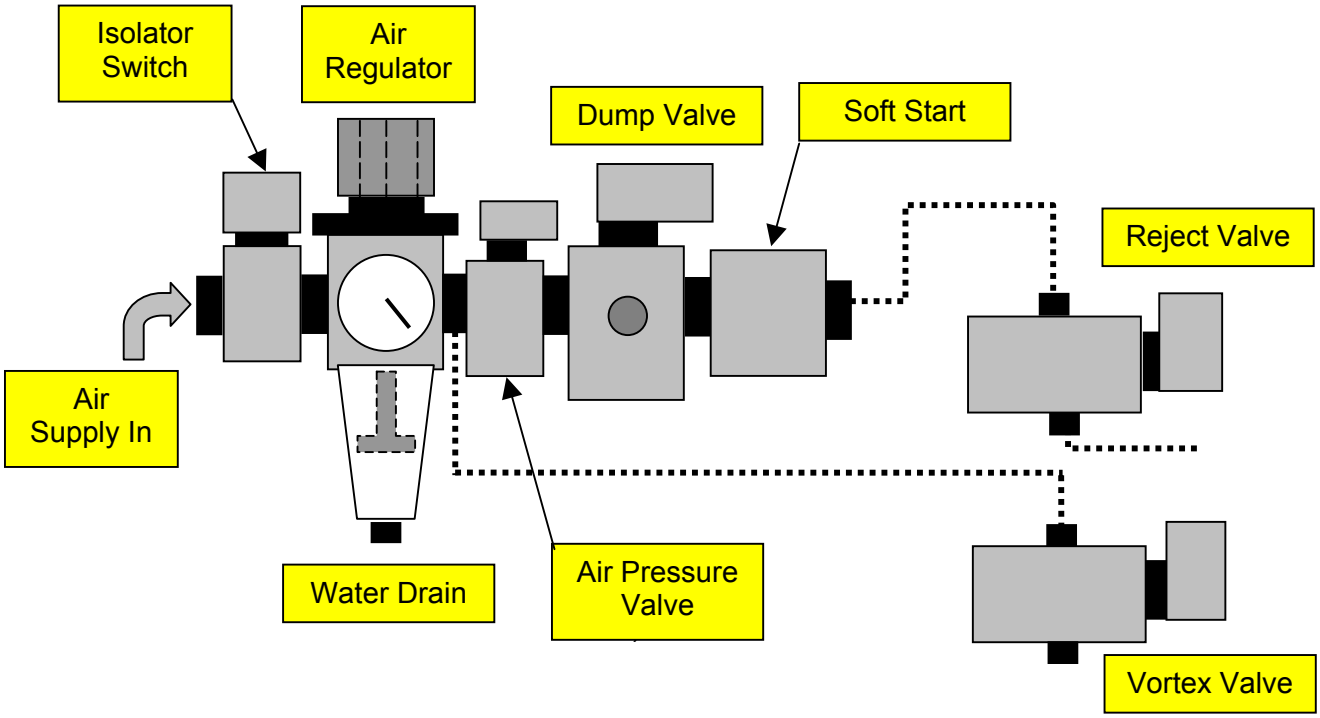
All AXIS x-ray systems require a compressed air supply, primarily to operate the automatic reject system. In addition the standard AXIS conveyor model requires a further air supply to feed the vortex cabinet cooler situated on the top of the central cabinet. In this situation when a reject occurs operation of the vortex is inhibited to allow maximum air to the reject mechanism. It is therefore essential that the air supply is robust enough for correct operation of the Axis machine when either the reject or vortex operate.

The AXIS pipeline machine also requires an additional air supply for the operation of the shutter piston located by the side of the collimator. The minimum air pressure must not fall below 65psi (4.5 bar) when the reject operates on all models.

In the case of a pusher reject, a dump valve is also fitted in order to protect an operator in case of an emergency. As soon as an emergency stop is activated the mains air supply is shut off and all air is exhausted from the system.

In addition for failsafe reasons an air pressure switch is fitted in order to alert the operator that the air supply is low and shut down the system generating a fault condition.

The mains air supply is to be connected as shown below to the input side of the air regulator and should be set to 5.5 bar (80 psi).




**Pneumatic assembly** (pipeline shutter valve not shown)

# Checking Guards

1. Check that all guards and interlocks are securely fastened in place.

2. Check that the infeed and outfeed of the system are clear of obstructions.

# Powering Up the System

### WARNINGS

1. **LETHAL HAZARD – ELECTRICAL AND COMPRESSED AIR SUPPLIES.** This equipment uses electrical and compressed air supplies that can be lethal. Unless absolutely necessary, work must not be carried out without first isolating the equipment from all electrical and compressed air supplies.

2. **LETHAL HAZARD** – **RADIATION**. Whilst every precaution has been taken to make sure that all the necessary guards and safety devices have been fitted to the Loma x-ray unit, it is recommended that all operatives are trained in the use of x-ray food inspection machines. In addition users must adhere to the necessary requirements required by their country, state or province. Furthermore it is the responsibility of the employer to create a set of local rules (see example in Cautionary Advice) regarding the safe use of x-ray food inspection systems. In the U.K. this is in compliance with the Ionising Radiation's Regulations 1999, users outside of the U.K. should consult the relevant health and safety executive (see also Radiation Surveys).

3. **WORKING ON EQUIPMENT.** If it is essential to work on the equipment with electrical and/or compressed air power connected, the work must be undertaken only by qualified and authorised personnel who are fully aware of the danger involved and who have taken adequate safety precautions to avoid contact with dangerous voltages, compressed air supplies or radiation.

4. Each x-ray system manufactured by Loma Systems is fitted with emergency 'Stop' buttons. These are mounted on the front and sides of the control panel and at the rear of the machine. In the case of a pipeline machine, due to the size and no conveyor present only one emergency stop is required and this is situated on the front control panel. The buttons are red in colour with a yellow background. In the event of an emergency, which requires the machine to be immediately stopped, press the stop button and both x-rays and the conveyor will be stopped. In addition an alarm will sound and an amber lamp will be illuminated.

5. Before powering up any AXIS machine for the first time, a suitably qualified person should be present to carry out a critical examination (see Radiation Surveys). For advice please contact your local Loma Service office.

6. Switch on the compressed air supply to the system and open air isolator switch.

7. At the bottom left hand side of the central electrical services cabinet switch on the mains isolator. The system automatically boots up in a failsafe fault condition with the alarm sounding and the amber fault lamp on.

8. Press the amber fault reset button, the alarm should stop and then again to clear the amber fault lamp.

9. On fixed speed conveyor models only operate the green 'Start' switch located on the system control panel. Check that the Conveyor belt runs in the correct direction. If incorrect swap two of the phase cables over in the incoming supply. Variable speed conveyors will be correct and not need adjustment.

10. At this stage contact an authorised key holder to insert the key into the x-ray key switch and switch to the on position. Refer to operators guide and setup section for further details.

# Checking Belt Tracking

The belt must be checked for correct tracking before running the conveyors for any length of time. The tracking adjusters are found adjacent to the end rollers of the AXIS conveyor machine.

If belt tracking needs to be reset, carry out the belt tracking procedure described in the section titled Routine Maintenance (Weekly/Monthly) in the Maintenance section of this manual.

# Setting Up Reject

### WARNING

**REJECT DEVICES. At no time, with air and/or electrical power applied to an automatic reject device, should any part of the body be placed within the operating area of the reject device.**

### General

The system is normally supplied with the reject mechanism correctly set up for at least one product. If the Reject Delay and Dwell times need to be adjusted for further products, these are set up via the user interface. Refer to the sections titled Reject Setup in the operators guide.

**Pusher and Plough Rejects**

The system is supplied with the reject cylinders already set, and normally no further adjustment should be necessary.

In certain instances Loma may supply a Reject Device only, and the end user supplies the Reject Catchment Device, Bin / Table, etc. The safety of the Reject Device is therefore a function of the design of the User's Reject Catchment Device. It becomes the User's responsibility to ensure the safety of the complete Reject System.

In most instances the product is delivered onto the system by conveyors. The System has to have entry and exit points. There is a possible hazardous area at the transfer between the conveyors. Loma rely on the total line being made safe by the End User.

## WARNING

**The internal cabinet areas of the machine contain electrical devices which are at 240V, 220V or 110V potential depending on the supply voltage. These voltages may cause injury or death on contact. Work in this area should only be carried out by a qualified Technician with the Isolator switched off. (The Isolator is located at the bottom left-hand side of the Electrical Services Box).**

Diagnostic work should not be undertaken unless the Technician has been Loma trained.

## WARNING

**For fixed speed conveyors and pipelines located in a wet environment a Ground Fault Interrupter or RCCB must be used. This is not recommended for variable speed conveyors as the inverter may cause the device to trip.**

# ATTENTION

## IT IS IMPERATIVE THAT THIS MACHINE IS CORRECTLY EARTHED.

## PLEASE CHECK SUPPLY VOLTAGE BEFORE SWITCHING ON.

## Errors will affect Loma warranty

## For Axis fixed speed conveyor machine

# ATTENTION

## IT IS IMPERATIVE THAT THIS MACHINE IS CORRECTLY EARTHED.

## THIS MACHINE SHOULD NOT BE SUPPLIED VIA AN EARTH LEAKAGE CIRCUIT BREAKER (RCD)

## PLEASE CHECK SUPPLY VOLTAGE BEFORE SWITCHING ON.

## Errors will affect Loma warranty

## For Axis variable speed conveyor machine

# ATTENTION

## IT IS IMPERATIVE THAT THIS MACHINE IS CORRECTLY EARTHED.

## PLEASE CHECK SUPPLY VOLTAGE BEFORE SWITCHING ON.

## Errors will affect Loma warranty

## THIS MACHINE WILL EMIT X-RAYS IF NOT CONNECTED USING OFFSET FEED PIPES OR IN A PIPELINE & SHOULD NOT BE

## ENERGISED UNTIL CORRECTLY INSTALLED.

## For Axis pipeline machine

# PRODUCT DESCRIPTIONS

## CONTENTS

# Technical Specification

X-ray unit……..Loma AXIS

Case Material .....Stainless steel 304L, fabricated

Case Finish .....Bead blasted

Environmental Protection .....Dust and waterproof to IP66 level (Nema 4x)

Control Unit .....Loma AXIS

Computer.....933 MHz (minimum)

Monitor ..... 15” nominal (CRT), VGA

LCD Screen (Rapid Only) ..... 12.1 TFT

Mounting.....On adjustable feet

Power Requirements

Supply voltages..... 220v/1ph/ 50Hz, 380v / 3ph / 50Hz, 415v / 3ph / 50Hz

.....220v / 3ph / 60Hz, 110V /1ph / 60Hz

Load Current (typical) .....Conveyor - 110V / 11A, 230V / 6A

..... ……. Pipeline - 110V / 5A, 230V / 2A

.....……. Rapid - 110V / 5A, 230V / 2A

Environment

Operating Temperature..... +2º to +40ºC

Relative Humidity .....90% non-condensing (maximum)

Nominal line height.....900mm ± 100mm

Air supply.....5 to 8 bar / 80 to 100 psi at a volume of 25 cfm

Weight ..... … Conveyor - approximately 550 kilograms

.....……. Pipeline - approximately 350kilograms

..... ……. Rapid - approximately 250kilograms

# X-Ray Subsystem

The x-ray components and control system are contained inside the central stainless steel cabinet.

## X-Ray Tank

The x-ray tube is mounted inside an oil-cooled tank connected to a mains driven pump and a fan cooled radiator. In order to stop the x-ray tube from overheating the oil passing through the radiator is cooled and re-circulated through the x-ray tank. The oil used is a mineral based transformer oil and should be treated as a such when considering handling and disposal requirements.

## High voltage PSU

The x-ray power is supplied by a high voltage power supply, which controls the power level (kV) ranging from 20 to 75 kV depending on the model (low or high power).

## Filament PCB

The current (mA) supplied to the filament in the tube is regulated via a separate PCB known as the filament board.

## Detector Array

The detector array comprises of a line of photosensitive diodes (the number varies depending on width of conveyor - 256 diodes for 200mm wide, 384 diodes for 300mm wide, 640 diodes for 500mm wide and 768 diodes for 600mm wide - which receive the x-ray energy emitted from the x-ray tube. The detector scans at a rate of hundreds per second (typically 620) depending on the belt/product speed. Both serial and parallel connections go directly to the PC, the parallel connections providing the image data and the serial connection allowing full control of the sensor by the PC. The PLC provides timing signals in the form of the 'scan' and 'acquire' signals.

## PLC

The PLC has a number of functions. Two of which controls and monitors both the power level and the current supply to the x-ray tube. In addition monitoring and control functions of the various systems is also undertaken. This includes the reject signal and serial communication to the PC.

## PC (Computer)

The PC is also located in the centre section of the AXIS machine and is where the control software, image processing software and hardware are located. Data is received from the detector, analysed and then displayed on the monitor. The PC also communicates with the PLC. When power is removed from the system e.g. due to a power failure the PC operating system will still shut down in an orderly manner due to a small internal UPS which maintains power for at least the duration of this process.

### User Interface

The user interface is a display monitor, which is fitted behind a clear polycarbonate panel. Down the right hand side and below are a number of membrane switches which are used in conjunction with the screen information. Down the left hand side are the control switches. For more information see the Operators Guide User Interface Section.

### X-Ray PC Software

This software is used to provide for the operator interface to the system, gather and display image information of product passing through the machine and communicate with the PLC.

### CONFIGURATION (Conveyor model)

One of two power levels are provided on each unit and are as follows:

a) 100 Watt System, Tube voltage (max) = 50 kV Tube current = 1.0 to 2.0mA

b) 400 Watt System, Tube voltage (max) = 75 kV Tube current = 1.0 to 5.0mA

In addition to the two power levels available the detector array is selectable dependant on the width of the conveyor. Two variations are available.

a) 205mm (for a 200mm wide Rapid conveyor)

b) 307mm (for a 300mm wide conveyor)

c) 512mm (for a 500mm wide conveyor)

d) 614mm (for a 600mm wide conveyor)

e) 666mm (for a 650mm wide conveyor)

### CONFIGURATION (Pipeline model)

The pipeline is provided with only one power level as follows:

a) 100 Watt System, Tube voltage (max) = 50 kV Tube current = 1.0 to 2.0mA

The detector array is supplied in the 307mm wide unit only.

## Conveyors

A 370 watt 0.5hp (187W for the Rapid) motor drives the conveyor which is as standard is fixed speed but if specified can be variable speed via an inverter. In addition the conveyor is fitted with a suitable reject system that will best ensure that contaminated product is successfully placed in a suitable container e.g. reject bin.

The non-crack surface makes it easier to clean and in addition is non-absorbent. The standard belt supplied is PU but Intralox belt may be supplied if required. The conveyors are supplied in the following standard sizes:

| | |
|---|---|
| Nominal line height: | 900mm ± 100mm |
| Belt widths: | 200mm (Rapid), 300mm, 500mm and 600mm |
| Typical Lengths: | 1900mm (Rapid), 2100mm (Standard) and 2800mm (Bulk Flow) |

# Safety Guards / Devices

## Guarding

As with any x-ray machine the use of guarding is extremely important in order to shield operators from the ionising radiation present when x-rays are on. Legislation sets very specific demands with regards to radiation limits surrounding a x-ray machine. Radiation levels must not be greater than 1.0μSv per hour. The level emitted from the Loma AXIS machine is much less, on average not greater than 0.1μSv per hour. This is achieved by engineering and design. The stainless steel construction creates most of the shielding required with the addition of four lead loaded curtains. These are fitted at each side of the internal x-ray cabinet and at both ends of the conveyor for the infeed and outfeed of the machine. For high power units two curtains are fitted at each of the four locations; the two curtains are staggered to ensure that the fingers of each curtain overlap. For these applications it is important that if for any reason the curtains are removed that this overlap is maintained. In certain bulkflow applications the curtains may not be fitted and protection is provided by the fact that access cannot be obtained via the infeed and outfeed apertures.

## Interlock switches

In addition to the shielding of the guards, each machine is fitted with interlock switches on all access panels that would allow access to the radiation areas. When opened x-rays will switch off and a fault condition is generated. There is no residual radiation present when x-rays are off.

## Safety Relay and Circuits

As safety is paramount, two (one on a pipeline) failsafe relays are fitted to ensure that if a contact of the interlocks were to fail the safety relay will automatically detect the fault and therefore shut down x-rays and activate a fault condition.

The conveyor safety relays work as follows. The infeed cover, outfeed cover and the rear panel interlocks are connected in series and monitored by the safety relay ES1. A contact of ES1 and the remaining emergency stops, back door, lower panel and lid interlocks are in series and monitored by safety relay ES2. The 'Tank Over temperature' switch, ES1 and ES2 then control the 'Mains Voltage' relay RL1. Both this circuit and safety relays status are monitored by the PLC. The PLC programme utilizes these signals to generate the 'X-Ray Enable' output which tells the PC to generate x-rays or not. A contact from ES2 also switches the main contactor which controls the inverter and the motor circuit.

## Reject Types

Loma x-ray machines are supplied with the following reject types:

- Air Blast reject;
- Pusher reject;
- Ball valve (pipeline only)

Alternatively, a conveyor or pipeline can be supplied without a reject device with a 'Signal Only' output. On detection of a contaminant in the product, the control unit provides an output signal only. This can be used for wiring into other equipment such as a PLC.

## Air Blast Reject

An air blast reject is pneumatically operated. On detection of a contaminant a high-pressure blast of compressed air is directed from the air blast reject device to the product, causing the contaminated product to be blown off the belt into the reject bin.

## Pusher Reject

A pusher reject is pneumatically operated. On detection of a contaminant the compressed air supply activates the pusher, causing it to push the contaminated product off the belt into the reject bin.

## Pneumatic Specification for reject type

### Pusher

Optimum supply pressure…….5.5 Bar (80 psi)

Minimum supply pressure……..4.5 Bar (65 psi)

Maximum supply pressure…… 6.0 Bar (90 psi)

Capacity (Litres/second at 100 psi)…….……10

### Air Blast

Optimum supply pressure……6.8 Bar (100 psi)

Minimum supply pressure……5.5 Bar (80 psi)

Maximum supply pressure……..8.0 Bar (120 psi)

Capacity (Litres/second at 100 psi)……20

# Electrical Services

Electrical services to the x-ray machine are inside the main x-ray cabinet with mains cable entry points in the bottom. The conveyor contactor and overload are also located inside the main x-ray cabinet. For conveyor motors controlled by an inverter no overload is fitted.

The isolator is used for isolating the electrical power to the machine and is located at the lower left-hand side of the x-ray cabinet.

### Safety Devices

Each x-ray machine is fitted with emergency 'Stop' buttons and cover/panel interlocks. These when operated, switch x-rays off and exhausts air out of the reject device (where applicable).

# Other Standard Equipment

### Air Pressure Switch

An air pressure failure switch is fitted to both the conveyor (excluding the Rapid) and pipeline models. The switch is set by Loma to operate if the pressure of the compressed air supply to the machine falls below approximately 3 bar (42 psi). The conveyor then stops x-rays switch off and the fault alarm and lamp are activated. In the case of the pipe line all above will take place and the reject will stay open for failsafe operation.

### Product Registration Photo-Electric Cell

The Loma AXIS conveyor model is supplied fitted with a photoelectric Cell (PEC) as standard. The PEC is mounted on the side of the conveyor just prior to the x-ray beam. It is used to register the position of the products on the conveyor. As an option, the PEC may be mounted directly above the belt. This is particularly suitable for the registration of products that have very little depth (flat).

Bulkflow machines are not fitted with a PEC.

### Internal cabinet thermostat / cooler

A thermostat is normally fitted to guard against system overheat. Pipelines and some low power conveyors may not require cooling. If the internal temperature of the cabinet should reach the set limit the thermostat will switch on a solenoid valve which in turn activates the cooler (type will vary depending on application) to cool the internal temperature. This is set at manufacture and should not be changed.

### Vortex Cooler

In order to keep the internal temperature of the x-ray cabinet down to an acceptable level, a method of cooling is installed. It should be noted that in some applications no cooling is fitted. For those with cooling a vortex cooling unit is the standard method used (see optional equipment for other methods). Air flows through the vortex cooler and is discharged into the main x-ray cabinet at a much-reduced temperature. The vortex does not operate all the time but only if necessary and operators should be made aware that it may operate at anytime when the machine is running. It should be noted that the operation of the vortex will be inhibited if there is a reject. This is to ensure that there is a full supply of air available to the reject mechanism.

### Indicator lamp Stack

In addition to the indicator lamps on the control panel a lamp stack is also fitted on the top of the x-ray cabinet to indicate power on (white), x-rays on (red) and fault (amber). In some cases an additional lamp stack is fitted at the front of the cabinet. This is done to ensure all round visibility of the indictors e.g. when an air conditioning unit is fitted.

### Audible Alarm

An audible alarm is fitted to the x-ray cabinet to alert the operator that the fault condition is active and the conveyor has stopped.

### X-Ray tank sensors

In addition to the internal temperature of the cabinet two extra thermostats are fitted to the x-ray tank itself. In the event of an overheat condition the first sensor will signal to the control unit, which in turn will activate a fault condition and the second as a failsafe will automatically cut the power to the x-ray power supply.

## Optional Equipment

### Reject confirmation PEC

This device is normally fitted across the aperture of a reject bin directly in the path of the rejected product. If the rejected product does not break the photocell beam in a given time a fault condition is activated. The conveyor will then stop and the operator will be alerted by means of an audible alarm and lamp. The fault will be displayed on the front screen.

### Bin full PEC

This device is normally fitted near to the top of the reject bin. If the bin should fill up with rejected product there is a danger that further rejected product could be deflected back on to the conveyor and into the good product path. If a bin full photocell is fitted, the rising product will break the photocell beam and will activate a fault condition. The conveyor will then stop and the operator will be alerted by means of an audible alarm and lamp. The fault will be displayed on the front screen.

## Overhead PEC

The Loma AXIS x-ray machine as standard has a product registration photocell fitted to the side of the conveyor. However if the product to be inspected is extremely flat there is a possibility that the side mounted version could not register positively. In this case an overhead photocell would be required.

## Communications Package

The AXIS machine also has the facility to send reports back to a central computer (LOMANET) to collate and archive for later reference. Another option that can be supplied is a connection to a printer (remote hand held or desktop). This is via a serial link port at the rear of the machine. The printer needs to be set at rate 9600 Baud.

## Encoder Reject

This option synchronises the reject timing with the speed of the conveyor. The standard system operates a timed reject, which does not compensate for any changes in the conveyor belt speed. An encoder is therefore fitted on variable speed applications.

## Cooling Methods

A heat exchanger can be selected to replace the vortex. The unit is an air to air heat exchanger that uses ambient air to cool the cabinet air via two isolated cooling circuits. For environments where high ambient temperatures are expected a heat exchanger is used but in addition is fitted with peltier semiconductor coolers to provide additional cooling. An air conditioning unit may also be fitted instead of the vortex.

## Multilane Reject

For some conveyor applications a dual lane system is fitted or multilane reject for bulkflow systems. The dual lane system divides the conveyor width into two and product is passed down in two rows. Multilane reject systems consist of up to 8 reject flaps across the width of the belt; so that in bulkflow mode only the minimum product is rejected when necessary.

## Mass Measurement / Missing Product

These are two special functions incorporated into the software if requested. Also separate rejects in addition to the contaminate can also be incorporated if required.

## Variable Speed

Due to production constraints a variable speed conveyor may be necessary. This is done by controlling the motor via an inverter instead of direct on line.

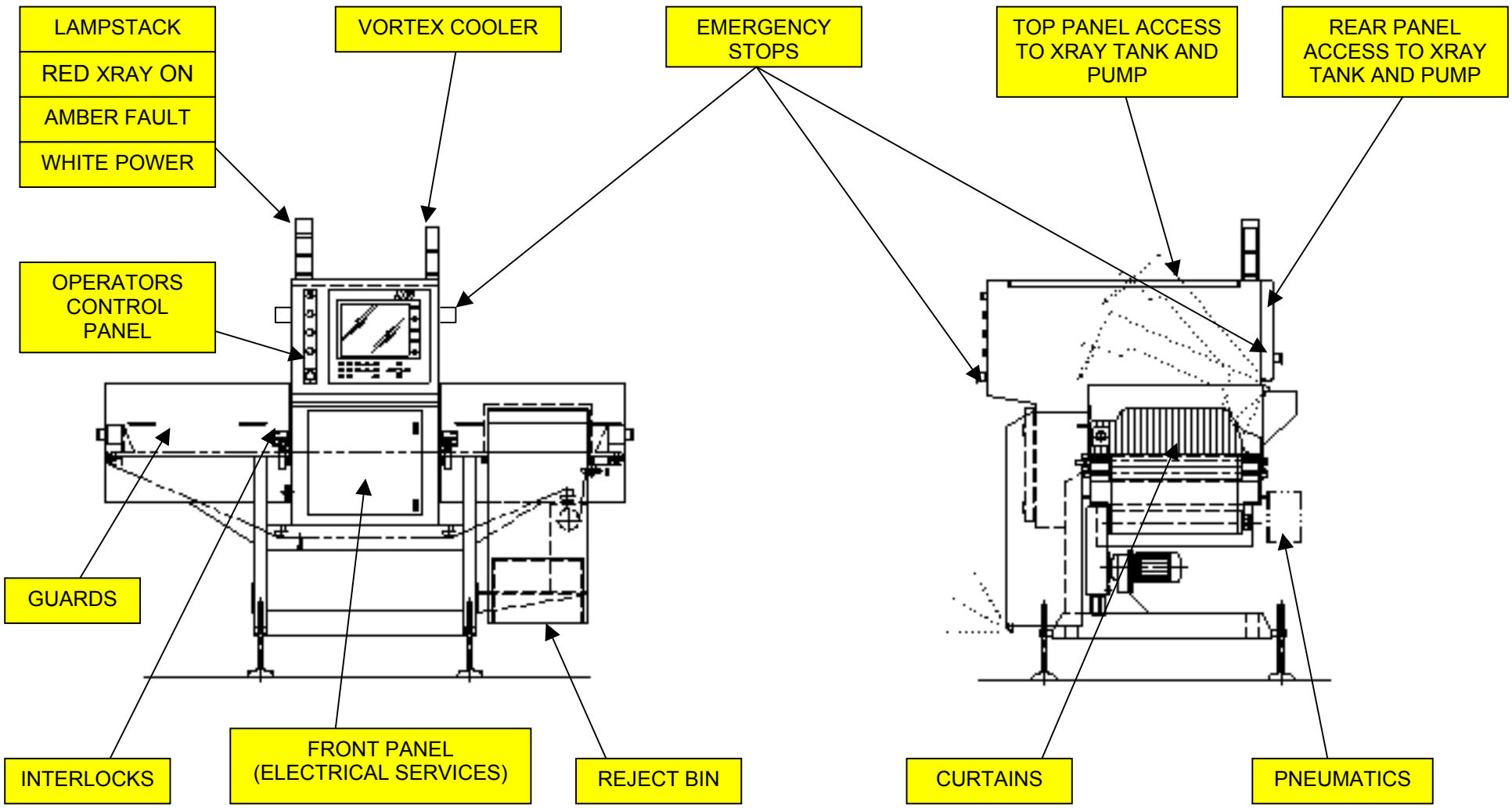
## Roller Track Reject

This is fitted instead of the reject bin. Reject conformation and bin full PECs may also be fitted if required.

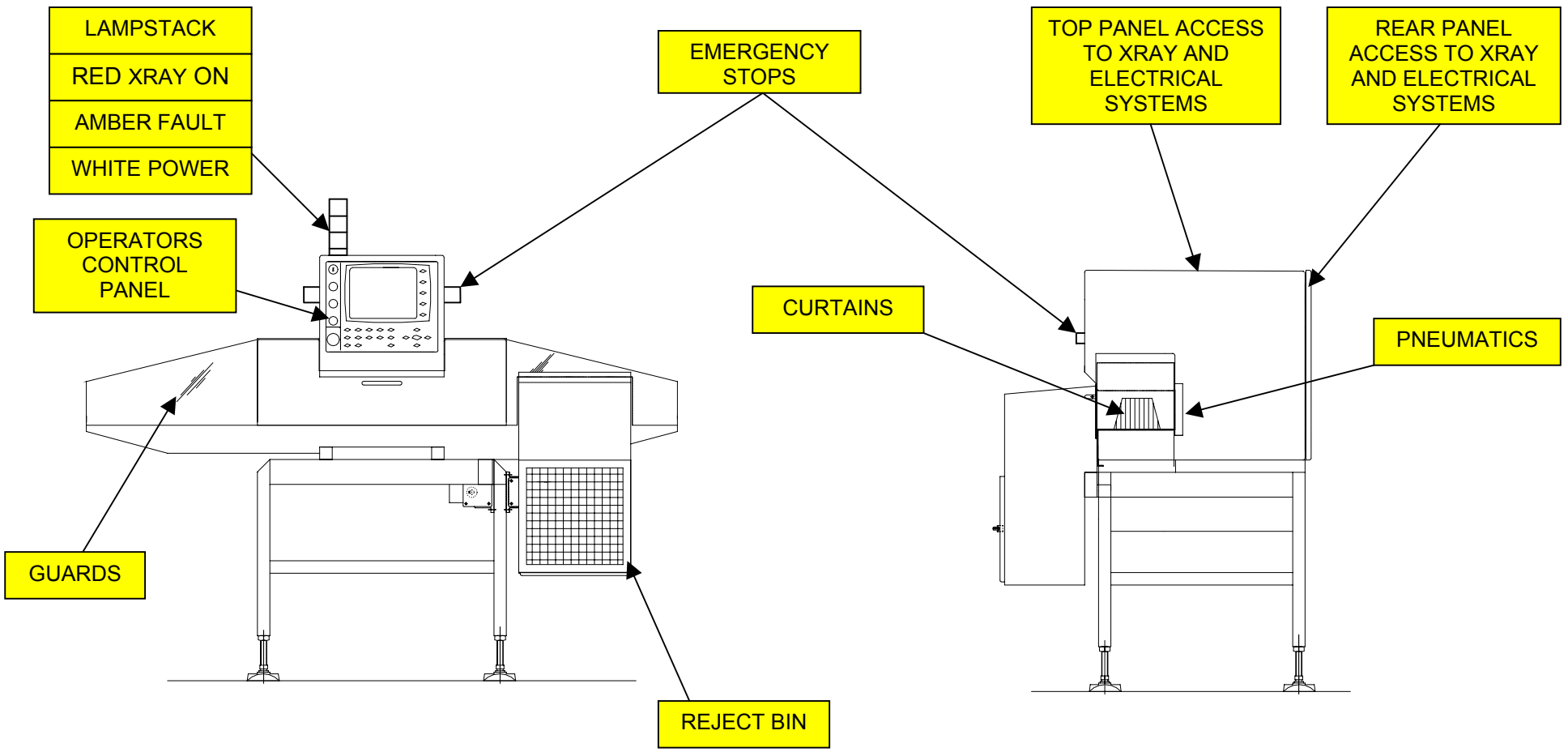
# OPERATORS GUIDE AND SETUP

## CONTENTS

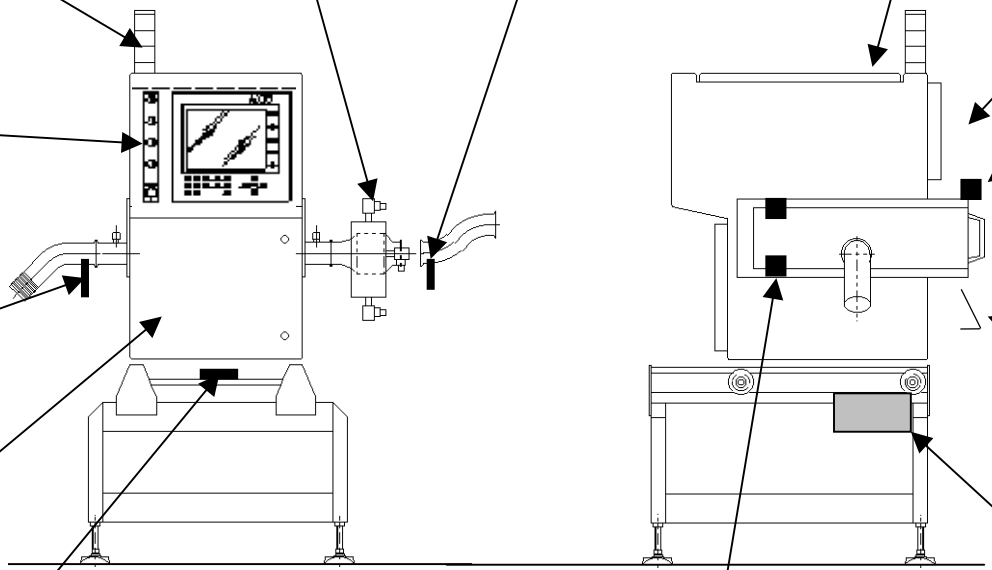
# AXIS CONVEYOR LAYOUT DRAWING



# AXIS RAPID LAYOUT DRAWING



# AXIS PIPELINE LAYOUT DRAWING



LAMPSTACK
RED XRAY ON
AMBER FAULT
WHITE POWER

REJECT VALVE (LEE BALL) AS STANDARD OPTION

OUTFEED SAFETY INTERLOCK

REAR PANEL ACCESS TO XRAY TANK AND PUMP

TOP PANEL ACCESS TO XRAY TANK AND PUMP

SAFETY INTERLOCKS (CENTRE PIPE ACCESS)

OPERATORS CONTROL PANEL

DIRECTION OF TRAVEL FOR CENTRE PIPE ACCESS

INFEED SAFETY INTERLOCK

VENTING DUCTS

FRONT PANEL (ELECTRICAL SERVICES)

RELEASE CATCH AND PULL CENTRE SECTION FORWARD TO NORMALISE

RELEASE KNOBS TO ACCESS PRODUCT PIPE CENTRE SECTION

PNEUMATICS ASSEMBLY PLATE LOCATION DEPENDANT ON M/C HANDING

# Description of Analysis Modes and Parameters

The Loma AXIS range of machines has been designed to incorporate a number of inspection modes. This enables the user to optimise the system and choose the best mode of operation that suites the product and line conditions.

The following pages will describe the different analysis modes and parameters, which will aid the user in setting up the AXIS machine for optimum performance. The user should also refer to the relevant menu map for their machine and descriptions in the Glossary of Parameters.

### The Analysis Modes are in the following order:

1) Auto (Conveyor model)

2) Auto with Bone Filter (Pipeline and conveyor bulkflow models)

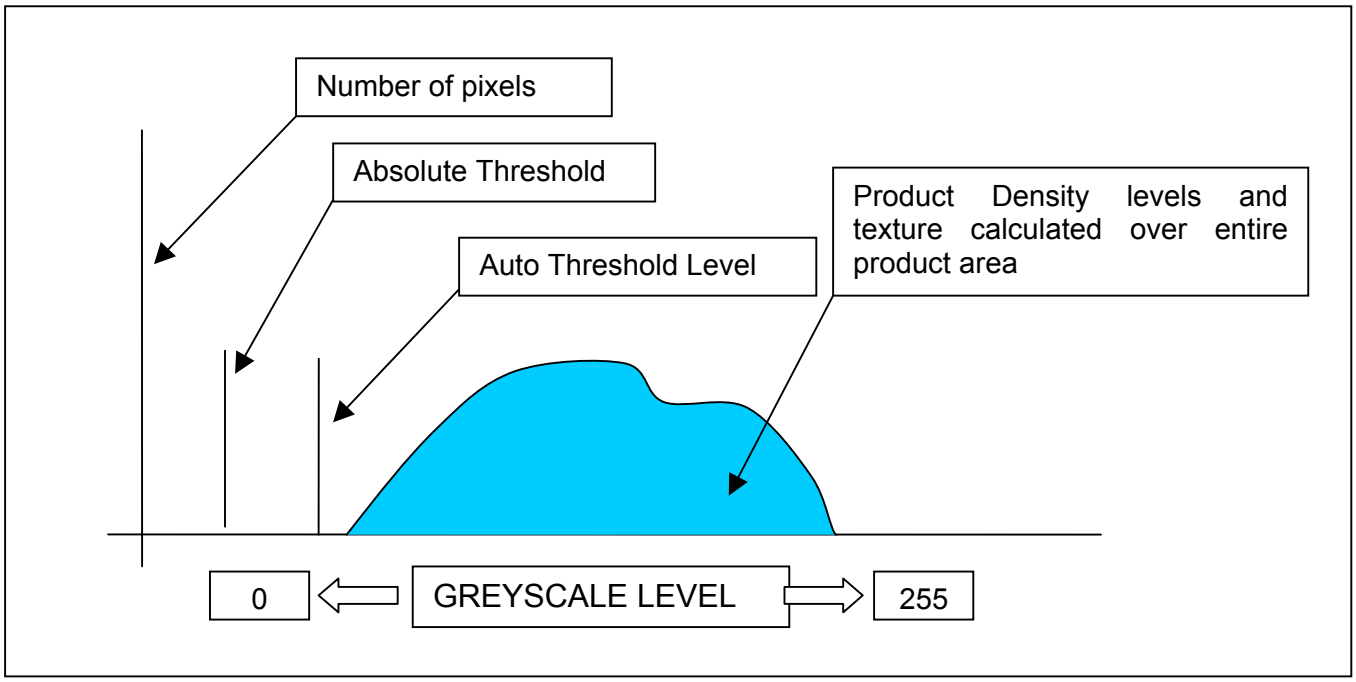
3) Explorer (Conveyor, Pipeline and bulkflow models)

**AUTO (Conveyor Model)**

This mode of analysis is standard on all machines. The inspection is carried out in the following way:

1) Inspection is started when the PEC is triggered by the product.
2) The system captures an image the length of which is determined by the **PRODUCT LENGTH**. The **PRODUCT LENGTH** must be correctly entered otherwise not all the product will be analysed.
3) The system examines the image and looks for the product by locating the first row of data that is darker than the set figure in the **PRODUCT LOCATOR** entry box.
4) The whole of the greyscale area is then examined so as to calculate its greyscale distribution and texture level whereupon an Auto threshold (reject point) will be set. In addition to the calculated Auto threshold we can manually increase or decrease sensitivity by adjusting the **AUTO SENSITIVITY**.
5) The system will then check the contam size count whereby if it is higher than the manually set **CONTAM SIZE** and lower than the **AUTO THRESHOLD** value a reject will be registered. In addition the contaminant will be highlighted in red on the image.
6) The **CONTAM THRESHOLD** allows the user to set an absolute reject point regardless to whether it is product or contaminant. This is useful to guard against the possibility of a very large lower density contaminant being factored into the histogram.
7) **Window Top** and **Window Bottom** is set to limit the inspection width. This may be set to exclude fixed objects (such as product guides) from the analysis area.

The diagram below is a representation of the histogram that will be seen when in **PRODUCT SETUP** screen.




Two further parameters are located and used in the **AUTO** analysis mode of which are described below:

**ERODE TOP / BOTTOM**

This parameter should be used when the leading and trailing edge of a box or container is thick enough to cause a dense area to be registered which may cause false rejects. The setting of this will in effect mask out the offending edges in pixel count. However care must be taken not to mask out the product in certain applications.

**ERODE LEFT / RIGHT**

This parameter (similar to the last) is used in the case of a product having a dense edge on the sides. It can be used independently or in conjunction with **ERODE TOP/BOTTOM**. It is particularly used to stop the possibility of false rejects in a round product. The setting of this will in effect reduce the area to be inspected by pixel count. As mentioned earlier care must be taken not to reduce or mask the product area.

## AUTO Mode with BONE FILTER (Pipeline and Conveyor Bulkflow Models)

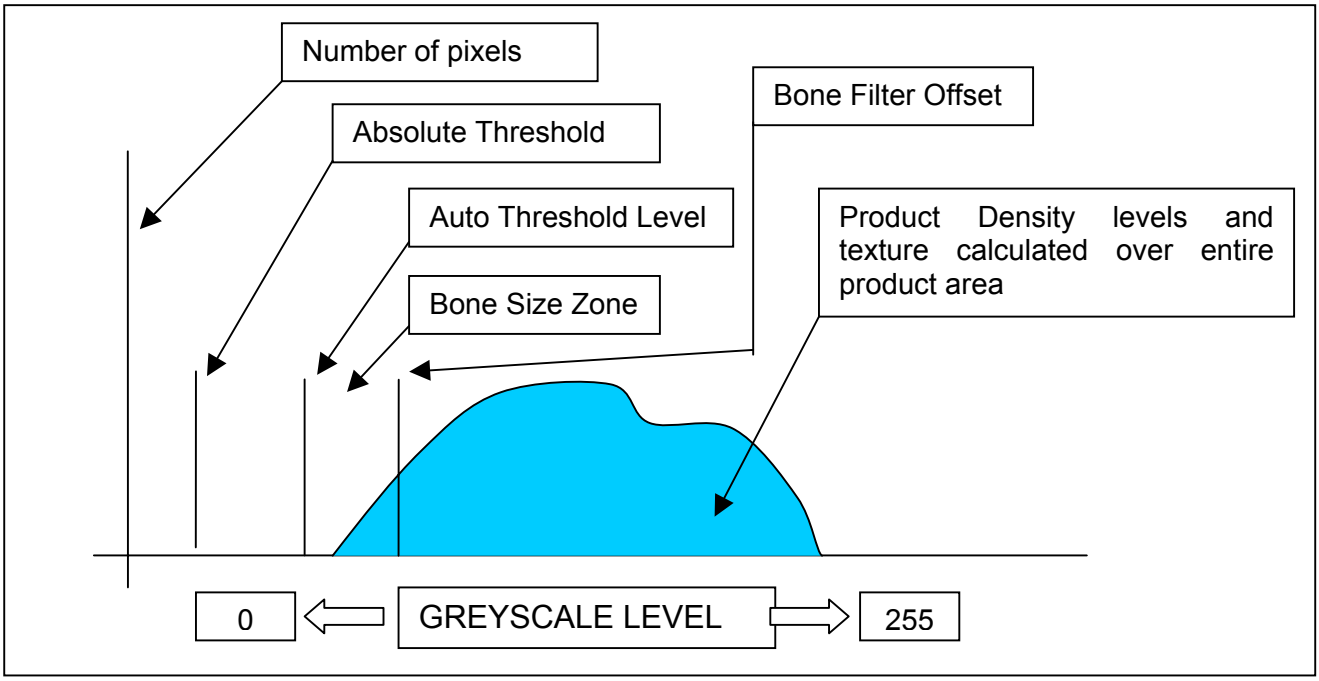
This mode of analysis is only used on pipeline and conveyor bulkflow systems. The algorithm is still of an adaptive nature but it incorporates some additional functions that allow the user to optimise the system for pipeline and bulkflow applications. The main difference that should be understood is that these systems do not require a photocell to trigger the start of inspection. Instead the system is continuously scanning and the image shown on the screen is one of a section (number of scan lines) at a time of either pipe (pipeline model) or conveyor (Conveyor bulkflow model). The inspection is carried out in the following way:

1) The system will capture the product image representative of a number of scan lines in a section at a time and display it on the screen.

2) The whole of the greyscale area is then examined so as to calculate its greyscale distribution and texture level whereupon an Auto threshold (reject point) will be set. In addition to the calculated Auto threshold we can manually to increase or decrease sensitivity by adjusting the **AUTO SENSITIVITY**.

3) The system will then check the contam size count whereby if it is higher than the manually set **ABSOLUTE THRESHOLD** and lower than the **AUTO THRESHOLD** value a reject will be registered.

4) In addition to the above, three further parameters can be set to enhance or tolerate certain product characteristics such as small bones in pet food etc. These are shown below and described on the next page.



5) The **BONE FILTER OFFSET** parameter as indicated sets the area that the **BONE FILTER SENSITIVITY** parameter will operate in and is referenced to the **AUTO SENSITIVITY** value. Any contaminants that fall into this zone will have a size factor applied to them. In addition dense areas in this zone that are less than size are highlighted in brown and contaminants are highlighted in red/yellow on the image.

6) The **BONE FILTER SENSITIVITY** parameter will set the number of adjacent contaminant pixels required before a reject is registered. For example this can allow the user to regulate the size of a contaminant such as small pieces of bone that may not be required to be rejected such as pet foods (in some cases).

7) The **ABSOLUTE THRESHOLD** allows the user to set an absolute reject point regardless to whether it is product or contaminant. This is useful to guard against the possibility of a very large lower density contaminant being factored into the histogram.

8) **WINDOW TOP** and **WINDOW BOTTOM** is set to limit the inspection width. This may be set to exclude fixed objects (such as product guides) from the analysis area.

**EXPLORER (All Models)**

This mode of analysis is used in conjunction with the **AUTO** algorithm and is in effect overlaid as an additional form of analysis. This algorithm is useful when inspecting products, which contain texture and irregularities whereby an additional analysis is applied to the densest areas in order to find a smaller dense contaminant. The inspection is carried out as follows:

1) After the **AUTO SENSITIVITY** level is set the system draws a line back into the product corresponding with the figure set in the **EXPLORER THRESHOLD OFFSET**. This is referenced from the **AUTO THRESHOLD LEVEL** line.

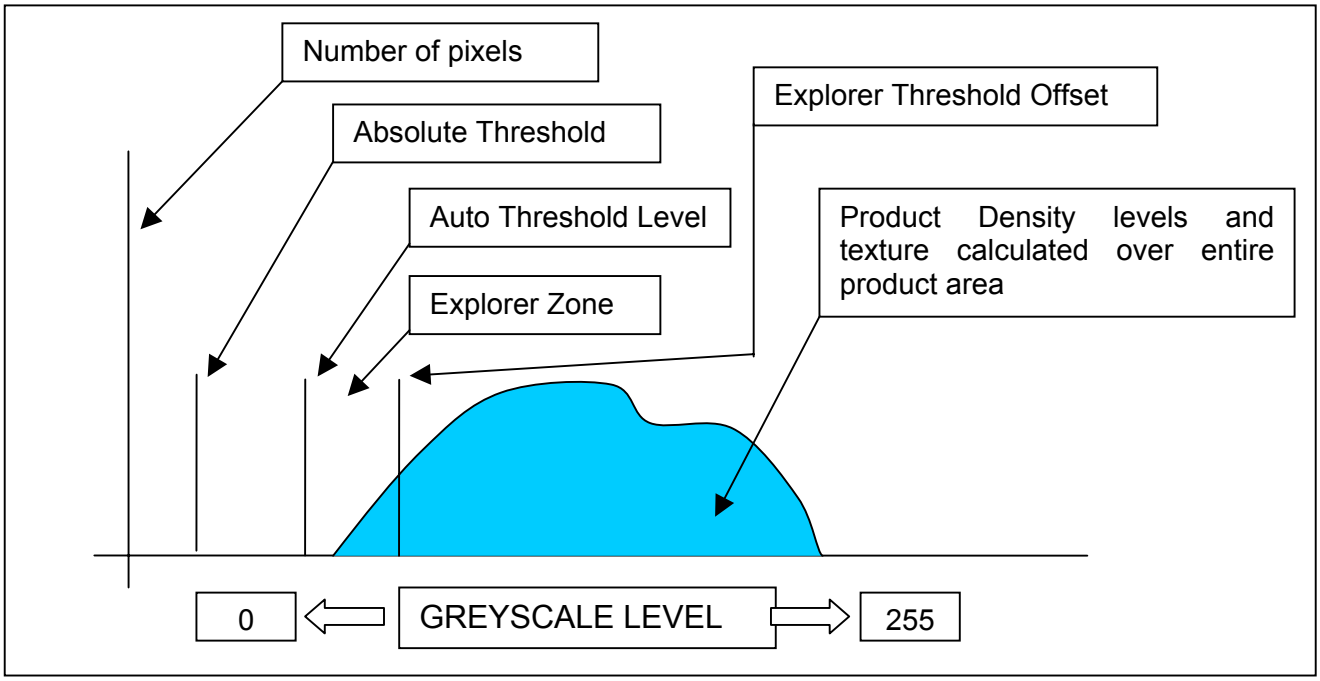
2) The system then looks for a large transition between pixels associated with a contaminant.

3) In order for a large transition between pixels to be considered a contaminant the calculated figure must be greater than the set figure in the **EXPLORER SENSITIVITY** entry box. This in effect allows the user to set the sensitivity of the rescanned area.

4) Contaminants found by **EXPLORER** are highlighted in yellow on the image.

5) Red spots may occur which can be due to the **AUTO ANALYSIS** but reddish brown can also be caused by **EXPLORER** being too sensitive. In this case the **EXPLORER SENSITIVITY** needs to be increased to de-sensitize the system.

The diagram below is a representation of the histogram that will be seen when in **PRODUCT SETUP** screen.




**NOTE: Remember that the EXPLORER mode of analysis is overlaid on top of the normal AUTO analysis. Therefore all the AUTO parameters should be considered when setting up the AXIS machine for EXPLORER (refer to AUTO ANALYSIS described earlier).**

# Glossary of Parameters

## COMMON PARAMETERS

**AUTO SENSITIVITY** – The system will automatically set a Auto Threshold level (reject point) for each product that passes. In some cases it may be necessary to make a further adjustment to increase or decrease the sensitivity. This can be achieved by adjusting the AUTO SENSITIVITY LEVEL. Adjustment up will decrease sensitivity and adjustment down will increase sensitivity.

**CONTAM SIZE** – Once the system has calculated the number of contaminated pixels present it will compare the figure to the entered value in the CONTAM SIZE entry box. If the calculated figure is greater than the entered value a reject will be registered.

**PEC DELAY (Photo electric cell)** – Just prior to the x-ray beam a photo electric cell is situated in such a way that when obstructed (i.e. product passing) it will signal to the computer that the start of the pack has been registered. Inspection is started when the PEC is triggered by the product. The system captures an image the length of which is determined by the PRODUCT LENGTH. The PRODUCT LENGTH must be correctly entered otherwise not all the product may be analysed.

**WINDOW TOP** – This parameter is used to mask off part of the inspection area and can be observed as a blue band at the top of the screen. It is useful when a section of the conveyor belt is contaminated or when a guide rail runs through the x-ray beam. The entered value in the WINDOW TOP entry box is referenced from the top of the screen.

**WINDOW BOTTOM** – This parameter is used in the same way as WINDOW TOP with the exception that the entered value will signify the start of the masked area at the bottom of the screen. This can also be observed as a blue area only at the bottom of the screen. However, the figure is still referenced from the top.

**WINDOW WIDTH** – This is available in bulkflow/pipeline applications and is used to set the lines per inspection frame.

**PRODUCT LOCATOR** – This parameter is used to isolate the product from the background. Progressively reduce this figure to obtain a clear image of the product on a white background.

## X-RAY SCAN

**RUN POWER** – The RUN POWER parameter gives the user the opportunity to set the correct level of x-ray energy required to penetrate through a product. The greater the density of the product the higher the RUN POWER required and vice versa. The correct level of power can be examined by observing the histogram in the PRODUCT SETUP screen. As a rule of thumb the darker the image the better the sensitivity to all contaminants. If the power is too low then the darkest part of the histogram will be close to the zero greyscale level. A desirable greyscale level is around 40 to 50 but it may not always be possible. The maximum kV available will depend on whether the AXIS unit is a low power (up to 50kV) or a high power (up to 75kV).

**NORMALISATION POWER** – During normalisation the signals from each of the detector array diodes is set to provide a uniform output. Normally the NORMALISATION POWER would be set the same as the RUN POWER but the system has the capability of calibrating the detector at a different x-ray setting from that for inspection. If for example a product is very dense and the max kV has been reached but the product still requires more penetration. In this case if we enter a value in the NORMALISATION POWER entry box lower than the entered figure in the RUN POWER box we can increase the level of penetration. However care should be taken when using this method because it is possible to over penetrate and lose the ability to detect small contaminants.

**X-RAY mA** – The x-ray mA will in effect set the intensity of the x-rays and is generally always set at its maximum allowable for the type of unit (i.e. Low or High power). The Low Power = max 2mA and the High Power = max 5mA.

**ASPECT RATIO** – This is the aspect ratio of the image on the screen i.e. the scaling of height and width. The value is normally to be set to 1, but for applications where the product flow length is greater than the scan length this may be adjusted to include a complete image of the product. When changed from a value of 1 the image seen on the screen will be slightly distorted.

**BELT SPEED** – The BELT SPEED value must be set to the actual speed of the system conveyor in metres per minute.

## AUTO MODE

**SENSITIVITY –** This sets the level of sensitivity which is applied to the Auto algorithm.

**ERODE TOP/BOTTOM** – In some cases the product may be packaged inside a cardboard box or container that has a thick leading and trailing edge. In such a case it is possible that these edges can be seen by the system as a dense area. For these specific cases the ERODE TOP/BOTTOM parameter can be used to ignore a set number of pixels in from the offending edges. However, care must be taken not to erode the actual product.

**ERODE LEFT / RIGHT** – This parameter works in a similar way to ERODE TOP/BOTTOM Where it is necessary for the system to ignore the left and right edges for a set number of pixels. However, care must be taken not to erode the actual product.

**ABSOLUTE THRESHOLD –** This defines the size of the contaminate to be detected and is measured in pixels.

## EXPLORER

**SENSITIVITY –** This sets the difference between a suspect pixel and the surrounding pixel intensity. For example with a setting of 20, the suspect pixel must have a greyscale value at least 20 less than the surround pixels in order to qualify as a contaminate.

**THRESHOLD OFFSET –** This parameter is applied to the AUTO THRESHOLD creating an intensity range for inspection using the EXPLORER algorithm. For example if the AUTO THRESHOLD value = 80 and the EXPLORER THRESHOLD OFFSET value = 20, areas of the product with pixel greyscale values between 80 and 100 will be inspected using the EXPLORER algorithm.

**FILTER –** This parameter applies an algorithm comparing the target pixel with its neighbours.

OFF - No filters applied

LOW - Filters 1, 2, & 3 applied

MEDIUM - Filters 2, 3 & 4 applied

HIGH - Filters 3, 4 & 5 applied

FULL - All filters applied

## AUTO with BONE FILTER

**BONE FILTER OFFSET –** This defines the area that the BONE FILTER SENSITIVITY operates in.

**SENSITIVITY –** This sets the number of adjacent contaminate pixels that are required before a reject is registered.

## REJECT

**REJECT DWELL** – This parameter is used to set the length of time that the reject will operate for once activated.

**REJECT DELAY** – This parameter is used to set the delay time required before the reject is activated. This will be dependent on the belt speed or flow rate.

**PRODUCT LENGTH** – This parameter defines the flow length of the product. Depending upon the product presentation it may be necessary to add an allowance for product skew.

**CONF WINDOW** – This is the reject confirmation window, which is the time period allowed during which a reject confirmation signal is expected.

## REPORTS

**START TIME** – This parameter is used to setup the START TIME of a new report.

**INTERVAL** – This parameter is used to set the time period between shift reports.

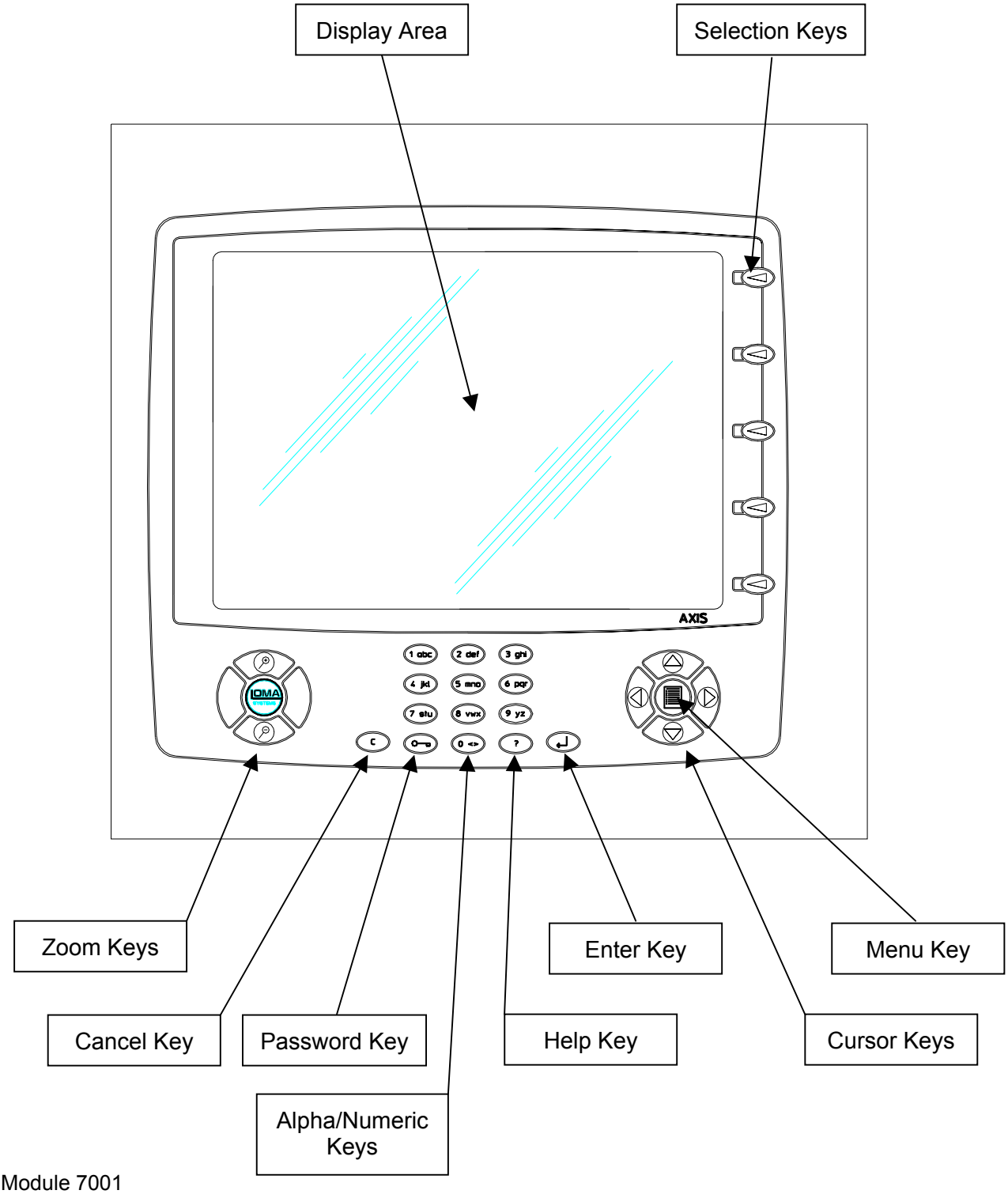
**BATCH SIZE** – This parameter is used to set the number of packs or items required in a batch.

**OUTPUT** – This parameter is used to enable/disable shift and batch report printing at the end of the elapsed time.

# USER INTERFACE (Conveyor & Pipeline)

The user controls the system from an on-screen menu system via a monitor screen and membrane switches. To change the current system setup, the user is presented with on-screen decision boxes that correspond to the function selection keys (F1 to F5) on the right hand side of the screen. These are used to choose the action to be taken.

## FRONT PANEL LAYOUT



## MEMBRANE KEYPAD

***Refer to Front Panel Layout Diagram shown on previous page.***

***Password Key (key graphic)***

The password system is active at all times. If the user presses the password button, a password entry dialogue will be shown on the screen. Normal passwords are entered as four digit numbers. For further information see Password Section.

***Enter Key ('CR' graphic)***

The enter button is used to confirm data entry whenever the user needs to make a choice. It does not exit from the screen in use.

***Cancel Key ('C' graphic)***

The cancel button is used to discard all data entry from the screen in use.

***Help Key***

The help button activates a simple help file which can be navigated using the up/down keys, and provides information about the current screen that the user is in.

***Menu Key***

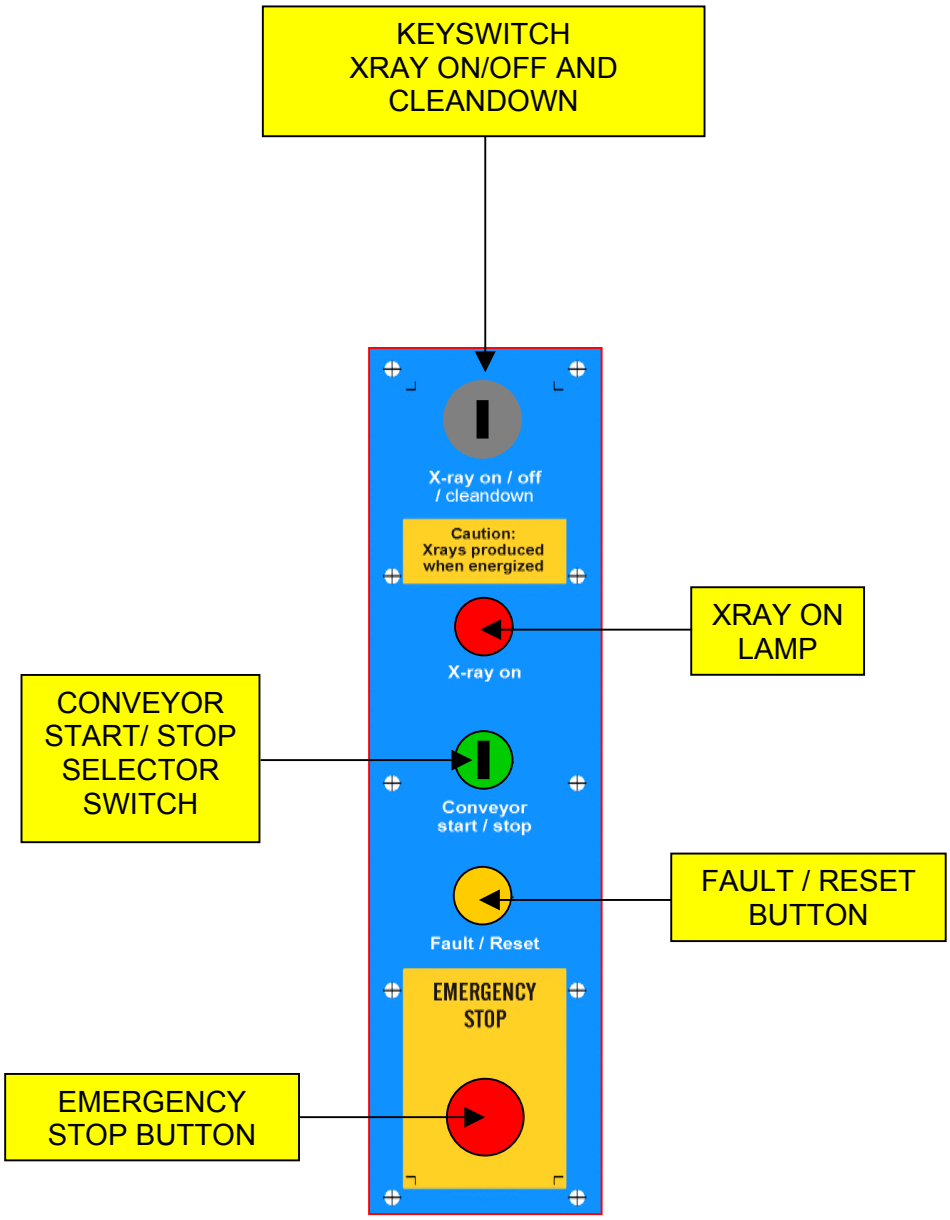
The Menu button returns the user to parent menu / screen.

***Zoom In / Zoom Out Keys***

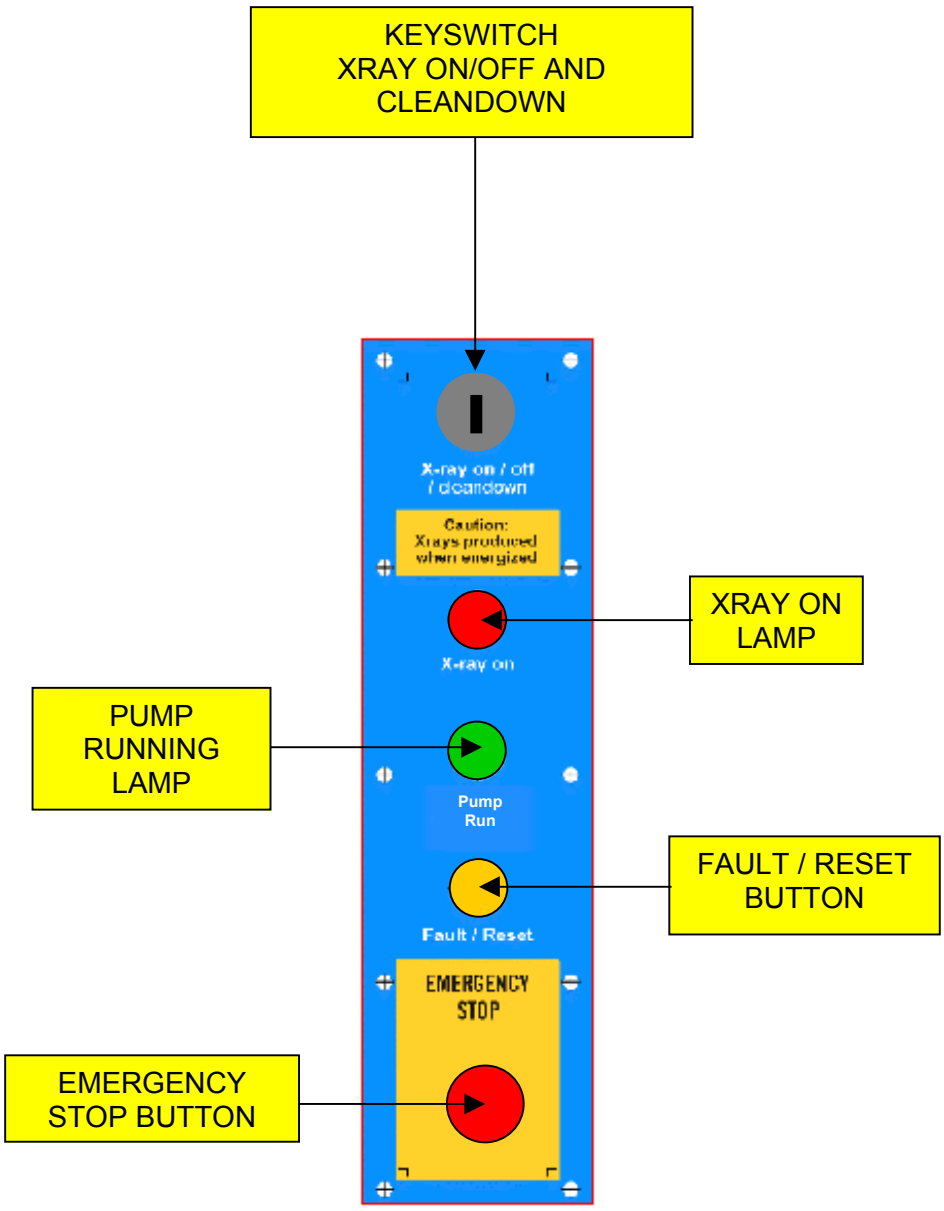
The Zoom feature is used to highlight and Zoom in on Contaminated Pixels on existing images. It will be initiated by pressing the "Zoom In" button. This will select the First Contaminant pixel which will then be highlighted. Pressing the button again will select the Next Contaminant pixel, and so on and so forth until all Contaminated Pixels have been seen. Once all contaminated pixels have been seen the image will return to the first one again.

Coming out of zoom will be initiated by pressing the "Zoom Out" button.

# CONVEYOR OPERATOR CONTROL PANEL



# PIPELINE OPERATOR CONTROL PANEL



# START UP PROCEDURE

The Loma AXIS x-ray inspection system has been designed in such a way that it is very easy to power up ready to inspect product. However a few points should be considered before switching on.

1. Check that the air supply to the machine is on.
2. Check that all the guards are in their closed position.
3. Check that all four emergency stops are in their out position.
4. Check that all the access panels are in their closed position.
5. For conveyor systems check that there is no remaining product inside the machine.

When these checks have been carried out and the necessary actions taken it is now ok to switch the Loma AXIS machine on by following the steps below.

**Step one:** Switch the machine on by the isolator positioned at the bottom left side of the machine. The alarm will sound and the amber fault light will be on.

On power up the PC will automatically boot and the system will eventually show the main menu screen. Refer to section on System Display Screens.

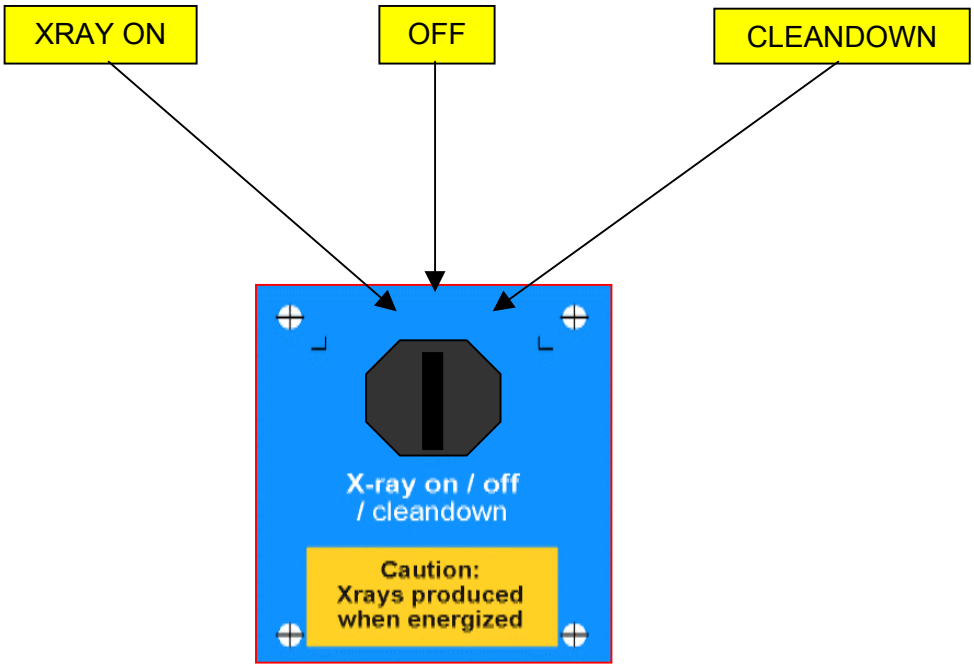
**Step two:** Press the amber fault reset button located on the front user control panel and the alarm will be muted. Press the reset button again and the fault lamp will switch off.

**Step Three:** The operator will be able to switch the conveyor on and off using the front panel switch but switching the conveyor off will disable x-rays. The system will load the parameters of the last used product or the default product.

**Step Four:** Insert the key into the keyswitch located on the control panel and turn to the left x-ray on position. This does not mean that x-rays are on, just that they are merely in stand by position awaiting the command to switch on from the system computer.

**Note:** It is good practice to leave the system at this point to warm up the electronics for approximately half to one hour so as not to incur any drift as the system warms up. The machine will also not normalise until there is sufficient current flowing in the filament circuit.

**KEYSWITCH POSITIONS**




## Cleandown Mode

Conveyor - Cleandown mode allows the conveyor to be run with the covers open for cleaning. It also ignores non conveyor related faults.

Pipeline - Cleandown mode allows the reject valve to be forced to the normal position to allow cleaning.

## System / Product Parameters

All product relative parameters are stored in a database. The system parameters e.g. grabber and lane information are also stored in the database. These product and machine settings can be saved to a floppy disc. This can be done using the following method:

## Help Screen

A help screen is available by pressing the '?' key. It will contain useful information relevant to the present screen.

# Normalisation

As described in the Principles of Inspection section a fan shaped beam of x-rays is produced. It can be seen that the detector diodes in the middle of the beam receive more energy than those on the outside due to the increased distance travelled. Therefore each diode signal is adjusted to ensure that for a given x-ray power each diode output is the same. This process is called Normalisation. It is carried out on start up, when there is a product change or if the kV power or belt speed parameters are changed.

This process is the same for both conveyors and pipelines but the methods are different. For both there must be no product in the x-ray path during normalisation. See section on Normalise Screen Messages

# Conveyor Normalisation

The procedure for normalisation is as follows:

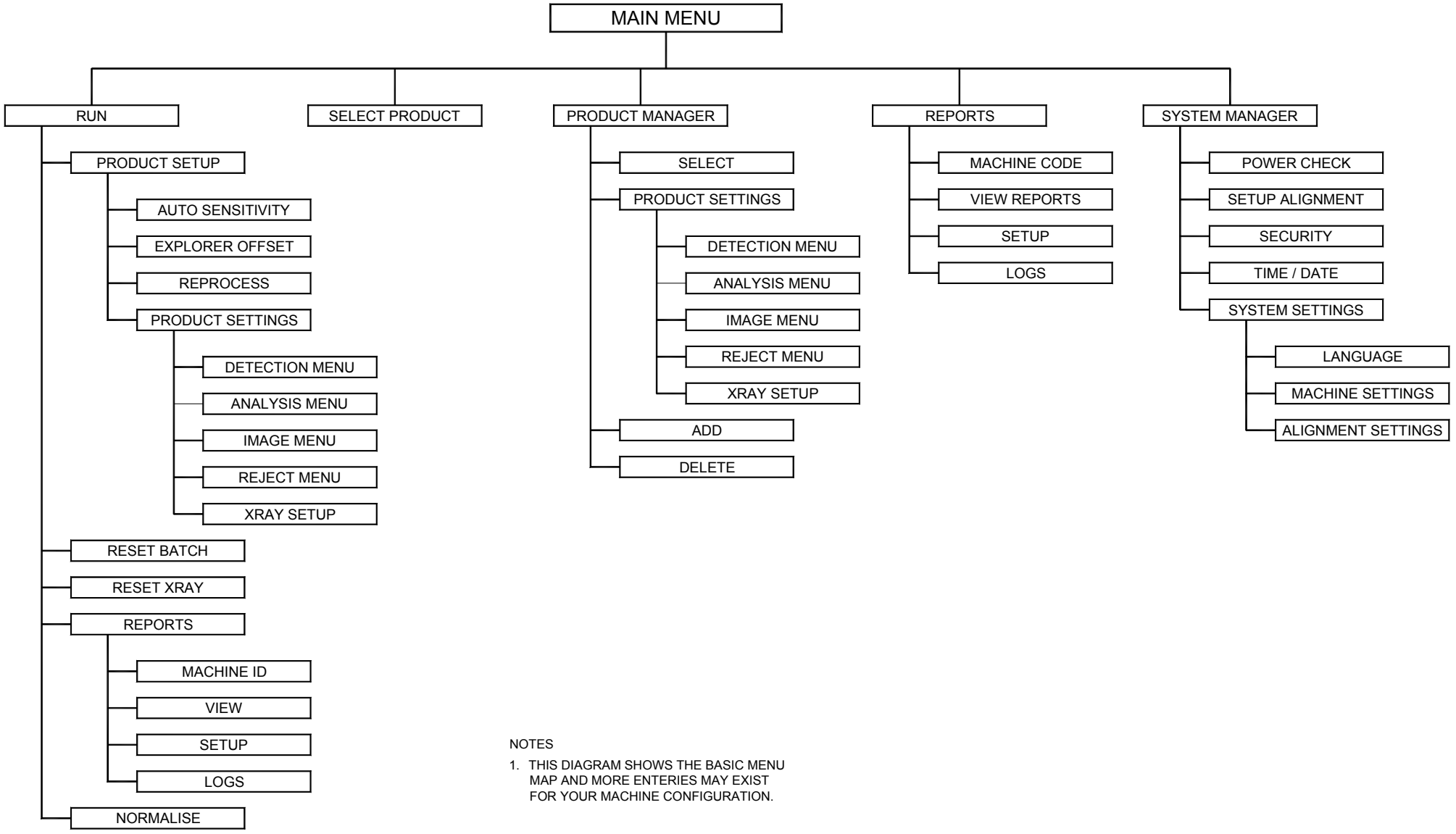
1. Make sure the system is at the Main Menu.
2. Ensure that machine is clear of all products and further products are inhibited.
3. Start the conveyor.
4. Check that the selector switch is in the on position.
5. Select the system Run Screen.
6. If Normalisation does not automatically start then press the Normalisation key and Normalisation will start. Once completed the machine will enter scanning mode ready to inspect.

# Pipeline Normalisation

During the Normalisation process nothing must block the path from the x-ray source to the x-ray detector. The AXIS pipeline cabinet is on wheels, which allows the system to be pulled forward so that the Product Pipe is no longer in the x-ray beam. When first switched on the shutter mechanism opens. Normalisation must then be completed and pulses received within 10 minutes otherwise the shutter will close again. The procedure for normalisation is as follows:

**Warning : Caution potential crushing hazard**

1. Make sure the system is at the Main Menu.
2. Release the bottom locking bracket and pull the system fully forward into the Normalisation position
3. Select the system Run Screen.
4. If Normalisation does not automatically start then press the Normalisation key and Normalisation will start. Once completed the machine will enter scanning mode ready to inspect.
5. Push the system back into the Run position locking the bracket in place.




NOTES

1. THIS DIAGRAM SHOWS THE BASIC MENU MAP AND MORE ENTERIES MAY EXIST FOR YOUR MACHINE CONFIGURATION.

# AXIS MENU MAP (CONVEYOR)

# Menu Screen Navigation

The table shown below illustrates the access requirements for each screen.

| Screen | Password Level | | | | |
|---|---|---|---|---|---|
| | None | Operator | Supervisor | Quality | Engineer |
| Main menu | Yes | Yes | Yes | Yes | Yes |
| Run menu | | Yes | Yes | Yes | Yes |
| Change Product | | | Yes | Yes | Yes |
| Product Settings | | | Yes | Yes | Yes |
| Product manager | | | Yes | Yes | Yes |
| Product Setup | | | Yes | Yes | Yes |
| Reports (machine id) | | | Yes | Yes | Yes |
| Logs | | | Yes | Yes | Yes |
| View Report / Log | | | Yes | Yes | Yes |
| New Product | | | | Yes | Yes |
| Product code | | | | Yes | Yes |
| Delete Product | | | | Yes | Yes |
| Reject Setup | | | Yes | Yes | Yes |
| Reject Setup No | | | Yes | Yes | Yes |
| Reject Confirm/Binfull | | | Yes | Yes | Yes |
| Report Setup | | | | Yes | Yes |
| Detection Menu | | | | Yes | Yes |
| Image Setup | | | | Yes | Yes |
| Analysis Menu | | | | Yes | Yes |
| Missing Items | | | | Yes | Yes |
| X-Ray Scan | | | | Yes | Yes |
| Auto Mode | | | | Yes | Yes |
| Explorer | | | | Yes | Yes |
| Bonefilter | | | | Yes | Yes |
| Security | | | | | Yes |
| System manager | | | | | Yes |
| Setup Alignment | | | | | Yes |
| Power Check | | | | | Yes |
| Language | | | | | Yes |
| Time / Date | | | | | Yes |

# LANGUAGES

The language to be used will be set via the User Interface (Password Protected). The following languages will be available:

English

English (US format)

Danish

Dutch

Spanish

Portuguese

German

French

# Password Protection

The LOMA AXIS inspection system has been designed with the intention of producing an inspection system, which is protected against misuse from untrained personnel. **Refer to the AXIS MENU MAP for guidance.**

With this in mind four levels of password protection are present on the AXIS machine.

The password system is active at all times. If the user presses the password button, a password entry dialogue will be shown on the screen. Normal passwords are entered as four digit numbers.

If a function button is pressed which requires a higher level password than the one currently active, the password dialogue will be called automatically.

Engineer level access allows entry to the password system.

The password level will be automatically reset to the lowest level when the user returns to the “Run” screen.

There are five levels as follows:

Level Zero - Default level (Main Menu only)

Level One - Line Operator

Level Two - Supervisor

Level Three - Quality Assurance

Level Four - Engineer

Operation at any level will automatically allow access to any of the functions at lower levels.

The Line Operator interface (the run screen) will allow:

- Simple controls to start and stop the system
- Controls to acknowledge and clear certain faults
- Viewing basic statistical information
- Normalisation of the x-ray system

It is protected by a 4 digit password access (level 1)

The Supervisor interface will allow:

- Setting of the product type to be run
- Training of the system for a new product e.g. threshold
- Adjusting the sensitivity parameter
- Viewing the contaminate, run error and system fault logs

It is protected by a 4 digit password access (level 2)

The Quality Assurance interface will allow:

- Copying of product parameters in the product list
- Creating a new product
- Batch report setup
- Clearing the contaminate, run error and system fault logs
- Saving or downloading batch reports, logs or reject images
- Setting the kV level
- Setting belt speed

It is protected by a 4 digit password access (level 3)

The Engineer interface will allow:

- Setting detection parameters associated with the image processing
- Access to service diagnostics
- Normalisation of the detector for kV and mA levels
- Saving of all product and machine setup parameters to disc

It is protected by a 4 digit password access (level 4)

The factory settings for the four respective levels are 1111, 2222, 3333 and 4444. It is the users responsibility to decide what levels of access personnel shall have and also change the passwords from the ones provided if they require.

# Fault and Error Messages

The Loma AXIS x-ray inspection system has been designed to incorporate a failsafe system. There are two kinds of error conditions that can be generated by the Axis machine; run errors and system faults. Error data is logged continuously and when any of the following errors are detected, the error type will be displayed as a text message on the screen and the machine response actioned whilst the condition is still active and for system faults until the reset is done from the operator panel. Error conditions will be time and date stamped in the log.

## Run Errors

The following run error conditions will be logged:

Touching packs

PV test required

Conveyor only mode (reject disabled)

Rejects too close (applies to pulse reject only)

The run error relay will be closed until the condition is removed or clears itself. The conveyor will continue to run.

## System Faults

When a system fault occurs the following actions take place:

The system fault relay will be closed

The fault lamp is lit and the alarm sounds

The generation of x-rays will be terminated

The conveyor will stop

A system fault message is displayed on the screen

The error condition will be logged

The system fault will remain active until the condition is cleared and the system is reset. To clear the fault condition the operator must first reset the offending condition (such as an open guard) and then Press > the amber fault lamp on the front left hand side of the control panel to reset the fault. In addition also Press > fault reset on the touch panel. The system faults shown on the next page will be logged:

# System Fault Indications and Possible Actions

| Indicated Fault Condition | Action to be taken |
|---|---|
| Guard Switch | 1. Check all guards are closed.<br>2. Check all emergency stops are out.<br>3. Check all access panels are on. |
| Low Air Pressure | 1. Check air supply to machine and that it is switched on. |
| Red Lamp Failure | 1. Check the filament bulb is not broken.<br>2. Check that the lamp is secure. |
| Tank Over Temperature | 1. Check tank and cabinet cooling systems are functioning.<br>2. Check radiators for blocked fins . |
| Conveyor Fault | 1. Check motor overload (if fitted). |
| X-Ray System is Out of Specification | 1. Check x-ray switch is on.<br>2. Check power level parameters.<br>3. Check beam path is clear.<br>4. Check system is warmed up and that mA value is at maximum. |
| Software Crash (watchdog failure) | 1. Reboot machine |
| PEC Blocked | 1. Check product path at PEC and clear blockage as required. |
| Reject Confirmation Sensor | 1. Check that bin is not full. |
| Reject Confirm Fail<br>(customer option) | 1. Remove offending product and retest<br>2. Check reject timings are correctly set<br>3. Check air supply to machine is okay<br>4. Check reflector is clean<br>5. Check PEC operation |
| Bin Full<br>(customer option) | 1. Remove product blocking the sensor or photocell.<br>2. Check reflector is clean<br>3. Check PEC operation |

# System Fault Indications and Possible Actions (continued)

| Indicated Fault Condition | Action to be taken |
|---|---|
| Reject Verdict Too Late | 1. |
| PLC Has No Data | 1. Reboot machine. |
| PSU Fault | 1. Reboot machine. |
| Grabber Fault | 1. Reboot machine. |
| Sensor Error | 1. Reboot machine. |

**If no specific fault is indicated then an authorised person trained by LOMA may need to carry out basic fault finding to isolate the problem and find the cause. If in any doubt then the LOMA Service Centre must be consulted.**

# REPORTS

## Shift and Batch Reports

The Axis machine can be setup to produce reports which can reflect activities of a single batch or a complete shift.

They can be printed either directly to a serial printer set at 9600 baud or if a node is supplied and fitted they can be sent as part of a Lomanet system. Both are carried out via the 9 way din plugs at the rear of the machine.

Example of report style:-

```
----------------------------------------
|   LOMA AXIS X-RAY INSPECTION SYSTEM  |
----------------------------------------

              BATCH REPORT

 Time : 10:25:00 Date : THU 29 MAR 2001

 Machine Identification :       Line 6


 Product Number :                     2
 Product Identification :     CHEESE
 Batch Start Time :           10:20:00
 Batch Finish Time :          10:25:00
 Total Packs :                     785
 Accepted Packs :                  778
 Rejected Packs :                    7

========================================
```

### Batch & Shift Report Generation

**Manual;** Batch Reports may be generated manually (by the user) via the user interface.

**Automatic;** Reports may be generated automatically:-

- If the current product is changed before the completion of a batch or shift interval
- If the system is powered down then powered up while in “run mode” before the completion of a batch, the current Batch will be terminated and a new Batch started.
- A Shift Report may be generated by completion of a predetermined time interval, set by the user between 5 minutes & 24 hours. A “start” time is also provided.
- Batch Reports may be automatically generated by batch size, set by the user from 10 to 10,000 where batch size equates to the number of accepted packs.

Batch Reports and Shift Reports may be disabled by the user. All production data will be reset if the total pack count exceeds 999,999.

**Setpoint Status Report**

A setpoint Status Report will be generated each time the machine is taken into “run mode” and will include the following parameters:-

- Machine Type
- Report Title
- Time & date
- Machine ID
- Product number
- Product ID
- Source kV
- Source mA
- Algorithm (e.g. convolution, search, dual AUTO, & so on)
- Reject Status & timing values
- Last normalise time/date

**Other Reports**

It is possible to print the fault/error log contents including the following parameters:-

- Machine Type
- Report Title
- Report Time & date
- Machine Identification
- Error/fault description
- Time/date problem occurred

From the REPORTS screen the MACHINE ID must first be entered. This is done using the alpha numeric buttons at the bottom of the front panel and then selecting the character required by pressing the appropriate button down the side. The relevant report type must first be selected by choosing SELECT by pressing the REPORTS toggle switch until this is seen and then ACCEPT. The chosen report is then selected using the ARROW buttons and then pressing ACCEPT. This report can then be VIEWED or SETUP by once again using the REPORTS toggle switch and then ACCEPT.

## Reject Images

The standard conveyor can store up to 300 reject images.  These are continually overwritten as rejects occur.

## Fault Log

The standard conveyor will record a list of faults in sequential order which can be either viewed or sent to a printer.

# Supplements

If your machine is fitted with non standard software which has enhancements or added functions supplements are provided with this manual in this section for reference.

# MAINTENANCE

## CONTENTS

# Inspection and Cleaning

Loma x-ray inspection systems should provide trouble-free operation, particularly if a sensible routine maintenance procedure is carried out, as described in this section. The following topics are covered:

- Inspection and Cleaning
- Routine maintenance.

If you have any queries relating to the maintenance of your x-ray system your Loma Service Centre will be pleased to advise you.

## WARNINGS

1. **LETHAL HAZARD – ELECTRICAL AND COMPRESSED AIR SUPPLIES. This equipment uses electrical and compressed air supplies that can be lethal. Unless absolutely necessary, inspection and cleaning must not be carried out without first isolating the machine from all electrical and compressed air supplies.**

2. **WORKING ON EQUIPMENT. If it is essential to work on the equipment with electrical and/or compressed air power connected, the work must be undertaken only by qualified and authorised personnel who are fully aware of the danger involved and who have taken adequate safety precautions to avoid contact with dangerous voltages or compressed air supplies.**

3. **REJECT DEVICES. At no time, with air and/or electrical power applied to an automatic reject device, should any part of the body be placed within the operating area of the reject device. Under no circumstances must the system be operated with any reject valve removed. When working on pipelines the additional precaution of isolating the pump must also be taken before any work is carried out.**

## Cleaning Materials Required

The following materials are required to clean the machine:

- Mild detergent.
- Clean water

## Daily

1. Isolate the electrical and compressed air power supplies to the system.
2. Check that there is no build up of debris on the conveyor and in the case of a pipeline clear any remaining product left inside the product pipe.
3. Check that the belt and belt rollers are clean and are free from a build up of either product or foreign material, e.g. wrapping film. Material on the rollers may cause incorrect tracking of the belt and also transfer dirt to the conveyor belt.
4. Check that the reject container is not full. This is particularly important if a 'Bin Full' detection device is not fitted. If necessary, empty the container in accordance with company practice on removal of rejected product.
5. Either wipe or wash the system using a mild detergent solution. Pay particular attention to the centre section of the main cabinet behind the curtains as this area is not seen when in production.
6. Clean / wipe the photoelectric cell (PEC) and the reflector. These are located behind the inside curtains in the centre main cabinet and are mounted either side of the conveyor. Should the machine be fitted with an overhead PEC wipe clean the face only as this is distance setting where no reflector is necessary.
7. Clean / wipe the curtains on the infeed, inner left, inner right and outfeed.
8. If a hose wash is to be used the following information may be of use:

   If necessary the Loma AXIS conveyor model has the facility to override the interlock switches for the purpose of running the conveyor to wash down. To do this the power must be switched on and the key switch must be in the cleandown position (refer to operators section).

   **Note: When the keyswitch is in the cleandown position x-rays cannot be generated therefore the user must insure that the AXIS is not in RUN in order that a fault condition is not generated.**

   - Water jet nozzle is <12.5mm (1/2") diameter, rounded.
   - Water delivery rate is <105 litres/minute (23.1 gallons/minute) rounded.
   - Distance of nozzle from equipment 2.5 - 3 metres (8.2-9.8 ft) rounded.

   **Note: Do not inject water directly into bearings.**

9. If not already actioned in the previous step switch on the electrical and compressed air power supplies to the system.
10. Switch the keyswitch to the x-ray on position, enter RUN mode and check that the reject mechanism successfully rejects a contaminated product into the reject bin.

## Weekly Inspection

1. Isolate the electrical and compressed air power supplies to the system.
2. Check the security of fixtures and fittings and that all guards are securely fastened in place.
3. Check that all interlocks and emergency stops function correctly.
4. Check that the system and associated equipment has been cleaned correctly and there is no build-up of product or debris, particularly in the centre section of the conveyor model.
5. Check that all of the curtains (conveyor model) are in good condition and that there are no splits in the material.
6. Inspect the conveyor belt for damage and contamination.
7. Check that the conveyor belt is correctly tensioned and is neither too tight nor too slack. If a belt is too loose, adjust it as described in the section titled **Routine Maintenance Daily / weekly.**

   **Note: Over tensioning the belt may cause damage to bearings and motors.**
8. Check the internal radiator fins are clear of dust and debris.

# Routine Maintenance (Daily/Weekly)

1. The AXIS system is fitted with an air regulator and an integrated automatic water trap. Check that the bottle/filter is clean and the outlet not blocked.

2. Switch on the electrical and compressed air supplies to the system.

3. Switch the keyswitch to the x-ray on position, enter RUN mode and check that the reject mechanism successfully rejects a contaminated product into the reject bin.

4. Check that the conveyor belt is tracking correctly. If tracking is not correct, adjust it as described in the section titled **Routine Maintenance (Weekly/Monthly).**

The **'Daily/Weekly'** routine must be carried out on a daily basis when the system is in constant use, but can be stretched to a week when the demands on it are low. If you have any queries relating to the maintenance of your system, your Loma Service Centre will be pleased to advise you.

## WARNINGS

1. **LETHAL HAZARD – ELECTRICAL AND COMPRESSED AIR SUPPLIES. This equipment uses electrical and compressed air supplies that can be lethal. Unless absolutely necessary, maintenance must not be carried out without first isolating the system from all electrical and compressed air supplies.**

2. **WORKING ON EQUIPMENT. If it is essential to work on the equipment with electrical and/or compressed air power connected, the work must be undertaken only by qualified and authorised personnel who are fully aware of the danger involved and who have taken adequate safety precautions to avoid contact with dangerous voltages or compressed air supplies.**

3. **REJECT DEVICES. At no time, with air and/or electrical power applied to an automatic reject device, should any part of the body be placed within the operating area of the reject device. Under no circumstances must the system be operated with any reject valve removed. When working on pipelines the additional precaution of isolating the pump must also be taken before any work is carried out.**

# Routine Maintenance (Weekly/Monthly)

## Recommended Greases and Oils

**CONTAMINANTS. Oils and greases must always be handled with care. Prolonged bare skin exposure to certain oils and greases can cause skin problems. Always handle oils and greases in accordance with the manufacturer's instructions.**

### Oil

| Manufacturer | Oil Type |
|---|---|
| SHELL | Transformer 148 (x-ray tank) |

### Grease

| Manufacturer | Type |
|---|---|
| B.P. | Energrease LS2 |
| Mobil | Mobilux EP2 |
| Texaco | Multifak All Purpose EP2 |

## Greasing

All AXIS conveyor units fitted with outboard bearings require greasing at regular intervals.

Bearings should be greased four (4) times per year, unless the environment or cleaning regime dictates that they are greased more frequently.

1. Isolate the electrical and compressed air power supplies to the machine.

2. Remove the covers from the motor drive housing to gain access to the grease nipples on the drive unit bearings.

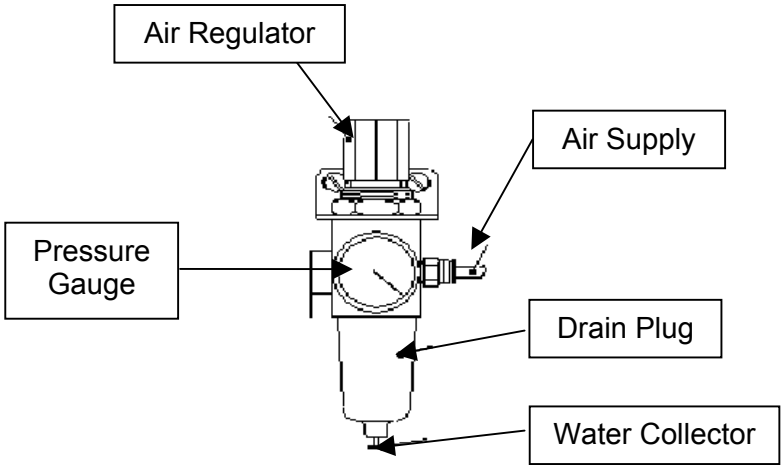
3. Using a grease gun, apply grease to each nipple in turn. Take care not to apply too much grease. Grease should not issue from the bearing. Refit the covers to the motor drive housing.

4. Using a grease gun, apply grease to each nipple on the remaining roller bearings throughout the system. Take care not to apply too much grease. Grease should not issue from the bearing.

5. Switch on the electrical and compressed air power supplies to the AXIS machine.

## Air Regulator/Water Trap Maintenance

All AXIS Systems are fitted with an air regulator/filter unit. Adjust the pressure setting as described below:




1. Check that the regulator pressure setting is correct. This should be between 60psi (4.2 bar) and 80psi (5.5 bar). To adjust the regulator pressure, pull up the cap and turn it either clockwise to increase the pressure or counter-clockwise to decrease the pressure. Push down the cap to lock it when finished.

2. Check that the water trap is empty. Empty it by pressing the drain pin.

   The 'Weekly / Monthly' routine must be carried out on a weekly basis when the system is in constant use, but can be stretched to a month when the demands on it are low. If in doubt, your Loma Service Centre will be pleased to advise you.

# Electrical Services/ X-Ray Cabinet

1. Check that the internal cabinet fan is working, this is located in the upper section of the cabinet. This should be running all the time that mains power is on. **Note: Do not attempt to check this with x-rays on and interlocks overridden.**

2. Check that the fan is working on the x-ray tank cooling system located at the lower rear of the cabinet on the conveyor model and at the lower inside right on the pipeline model. In addition the PC fan also needs be checked that it is operational (to do this the radiator needs to be removed first). **Note: Do not attempt to check this with x-rays on and interlocks overridden.**

   **Caution: DO NOT operate the system if either of these two fans are not running. In this unlikely event, check the fuses or contact your local Loma Service Department.**

3. Check the oil level in the x-ray tank is approximately 15 mm below the filler plug. The filler plug is located on the top of the x-ray tank situated in the upper area of the cabinet on both the conveyor and pipeline models. If the level is lower than stated telephone your local Loma service office for advice. **Note: This oil level should not change unless a leak in the system is present. In addition it should be noted that the oil is of a special insulating type and should not contain any moisture or air bubbles (Refer to RECOMMENDED OIL AND GREASE).**

4. On pipeline models check that the shutter mechanism inside the collimator assembly is operating correctly and that the DELAY BEFORE ON timer setting is correct. This timer is located at the front of the cabinet behind the access panel.

# Setting & Adjusting the Conveyor Belt Tension & Tracking

**NOTE: Do not over-tension the belt, as this will cause premature wear of the bearings and damage the belt.**

If the belt slips or moves during normal operation, check the condition of the rollers and make sure that debris has not built up between the rollers and the conveyor belt. This alone can cause tracking problems.

Follow the steps described below:

**Note: If any difficulty is found with tensioning or tracking, consult your local Loma Customer Service Department.**

## Adjusting the Belt Tension (conveyor model only).

The belt tensioning screws are located adjacent to the second roller in from the end of the AXIS conveyor.

1. Check that the belt and all rollers are clean and free from debris and greasy elements.

2. Check that all rollers are square across the conveyor and are free to rotate.

3. With the belt in a slack condition, i.e. belt slipping when the motor is running, and centralised along the length of the conveyor, adjust the tensioning screws evenly until belt drive is achieved.

4. Increase the tension until there is no slip condition with the belt under load (full product load).

## Setting the Belt Tracking

The belt tracking screws are located adjacent to the rollers at the end of the AXIS machine

With the belt tension set, the belt should now be running down the centre of the conveyor. If the belt moves to one side, this indicates that the tracking needs to be adjusted.

1. Turn the tracking screw on the same side of the conveyor to which the belt is moving by a quarter turn clockwise.

2. If the belt still moves in the same direction, repeat Step 1 until the belt moves back to the centre of the roller.

**NOTE: Do not over-tension the belt whilst adjusting the tracking.**

3. If necessary, slacken the opposite tracking screw by turning a quarter turn counter-clockwise.

**NOTE: When making adjustments to the tracking each adjustment should be in small increments at a time. In addition time should be allowed for the belt to move before further adjustments are made.**

# Adjusting the Drive Chain Tension (conveyor model only)

## WARNING

**When the cover is removed from the drive module the sprockets and chain are exposed. Care must be taken when making adjustments.**

1. Remove the drive cover from the drive unit (In some cases it may be necessary to remove the reject bin).
2. Check the tension of the drive chain. The chain should not be so tight that there is no movement whatsoever, inversely it should not be so loose that the chain jumps the sprocket when running.
3. If the chain needs adjustment loosen the four bolts securing the motor and adjust accordingly.
4. After adjustment tighten the four motor bolts and re-check the tension.
5. Check to ensure the sprocket alignment is correct and the grubscrews that lock the sprockets to the shafts are tight.
6. If necessary lubricate the drive chain with a suitable lubricant.
7. Replace the drive cover and any other covers removed.

**Note: If an encoder is fitted care must be taken to ensure that its position in relation to the sprocket is maintained.**

Adjusting the Reject Mechanisms

## WARNING

**REJECT DEVICES. At no time, with air and/or electrical power applied to an automatic reject device, should any part of the body be placed within the operating area of the reject device.**

If the reject Delay and reject on times need to be adjusted, these are set up via the user interface from the control panel. Refer to the menu titled setup reject.

### Pusher and Plough Rejects

At the solenoid valve, adjust the two throttle screws, in conjunction with the reject delay and dwell times, until the required reject timing and speed of operation are obtained. The air pressure supplied to the conveyor affects both the reject timing and the speed of operation.

### Air Blast Reject

Since this type of reject has no throttles, the only variables that can be adjusted are the reject delay and reject on times.

### Signal Only

Where signal only is required adjustment to the dwell and delay reject times is all that's necessary unless an auxiliary reject is fitted outside of the AXIS machine.

# WIRING SCHEMATICS
# CERTIFICATE of CONFORMITY

# PARTS LISTING & SOFTWARE LICENCE