

PHARMACEUTICAL METAL DETECTORS

PATIENT SAFETY, COMPLIANCE & INSPECTION CONFIDENCE

Understanding metal detection in tablets, capsules, powders, blister packs, bottles, sachets, and pharmaceutical packaging lines.

Pharmaceutical metal detectors help protect patients by identifying metal contaminants that could cause harm or compromise product quality. Designed to support GMP programs, reduce contamination risk, and verify finished-product integrity before release to market.



INSPECT



Every product is inspected.



DETECT



Metal contaminants are identified.



REJECT



Contaminated products are removed.



VERIFY



System performance is confirmed.



ENGINEERED TO INSPECT.
DESIGNED TO PROTECT.

WHY INSPECT PHARMACEUTICAL PRODUCTS?

THE FINAL QUALITY ASSURANCE CHECK

Even in tightly controlled pharmaceutical production, metal contamination can still be introduced after blending, granulation, compression, encapsulation, filling, blistering, bottling, or cartoning. Final inspection with pharmaceutical metal detectors is essential to protect patients, ensure product quality, and maintain regulatory compliance and brand integrity.



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DETECT



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VERIFY



System performance is confirmed.

CONTAMINATION CAN STILL BE INTRODUCED BY:

TABLET PRESS TOOLING WEAR



Wear or breakage of punches, dies, or turrets.

CAPSULE FILLER PARTS



Loose or worn components can shed metal.

BOTTLING EQUIPMENT



Wear of guides, chutes, or capping components.

BLISTER MACHINERY



Forming, sealing, or cutting parts can wear.

FASTENERS



Loose or broken screws, bolts, or mounts.

CUTTING BLADES



Blade wear or breakage during cutting operations.

MAINTENANCE ACTIVITY



Dropped tools, parts, or improper reassembly.

BROKEN SCREENS



Damaged screens allow fragments to pass.

UPSTREAM PROCESSING EQUIPMENT



Pumps, mixers, blenders, and other equipment wear.



FINAL INSPECTION SHOULD

PREVENT CONTAMINATED PHARMACEUTICAL PRODUCTS

FROM MOVING DOWNSTREAM.

WHERE PHARMACEUTICAL METAL DETECTORS ARE USED

INSPECTION ACROSS PHARMA & NUTRACEUTICAL PRODUCTION

Packaged and conveyed pharmaceutical products can often be inspected automatically before final release or shipment to help ensure patient safety, regulatory compliance, and brand protection.



1 TABLETS & CAPLETS



Compressed solids, coated tablets, chewables.



2 CAPSULES



Hard-gel, softgel, and filled capsule formats.



3 POWDERS & GRANULES



Sachets, stick packs, and pre-portioned doses.



4 BLISTER PACKS



Thermoformed blister packs and strip packs.



5 BOTTLES & CONTAINERS



HDPE bottles, small jars, desiccant-containing packs.



6 NUTRACEUTICAL & OTC



Supplements, gummies, powders, and consumer health products.



IF THE PRODUCT CAN BE PRESENTED THROUGH A CONTROLLED APERTURE, IT CAN OFTEN BE INSPECTED AUTOMATICALLY.

HOW THE TECHNOLOGY WORKS

ELECTROMAGNETIC DETECTION THROUGH A CONVEYOR APERTURE

InspeX metal detectors create a balanced electromagnetic field across the detector aperture. When metal passes through, it disturbs the field. The system detects the change, analyzes the signal, and activates a reject to remove the contaminated product—helping ensure product safety and quality.



TRANSMITTER COIL

Generates a stable electromagnetic field across the aperture.

PRODUCT PASSES THROUGH

Product flows through the balanced field in the detector aperture.

RECEIVER COILS

Sense the field across the aperture in multiple planes.

METAL DISTURBS THE FIELD

Metal contaminants distort the electromagnetic field and change the balance.

SIGNAL IS ANALYZED

The system analyzes the change in field amplitude and phase.

REJECT IS ACTIVATED

If the signal exceeds the set threshold, the reject is triggered to remove the product.

1 CREATE THE FIELD



The transmitter coil generates a controlled, low-frequency electromagnetic field across the aperture.

2 ESTABLISH BALANCE



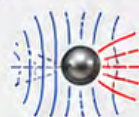
Receiver coils measure the field in multiple planes. The system achieves a balanced condition.

3 PRODUCT PASSES



Product passes through the aperture. The field remains balanced if no metal is present.

4 METAL DISTURBS



Metal contaminant distorts the field, causing a measurable change in the balance.

5 SIGNAL IS ANALYZED



The detector analyzes the change in amplitude and phase and compares it to the set threshold.

6 REJECT IS ACTIVATED



If the threshold is exceeded, an alarm is triggered and the reject removes the contaminated product.



NO CONTACT

No physical contact with the product ensures consistent performance and minimal wear.



FAST RESPONSE

Detects and responds in milliseconds to help remove contaminated product quickly.



HIGH RELIABILITY

Balanced field design minimizes false rejects and delivers stable, repeatable performance.



EASY INTEGRATION

Compact footprint and modular design integrate seamlessly into new or existing lines.

THE THREE PRIMARY METAL CATEGORIES

FERROUS, NON-FERROUS & STAINLESS STEEL

FERROUS — Fe

Contains iron and is magnetic.



IRON



CARBON STEEL FRAGMENTS



TOOLING WEAR



FASTENERS



WIRE



Ferrous metals contain iron and are usually magnetic.

NON-FERROUS — NFe

Does not contain iron. but is electrically conductive.



ALUMINUM



COPPER



BRASS



BRONZE



OTHER NON-FERROUS ALLOYS



Non-ferrous metals do not contain iron but are electrically conductive.

STAINLESS STEEL — SS

Iron-based alloy with chromium. Weakly magnetic (depending on grade).



304



316



OTHER STAINLESS GRADES



Stainless contamination can be more difficult to detect, especially small austenitic fragments.

SENSITIVITY COMPARISON

SENSITIVITY SHOULD BE SPECIFIED INDEPENDENTLY:



Fe



Non-Fe



Stainless Steel

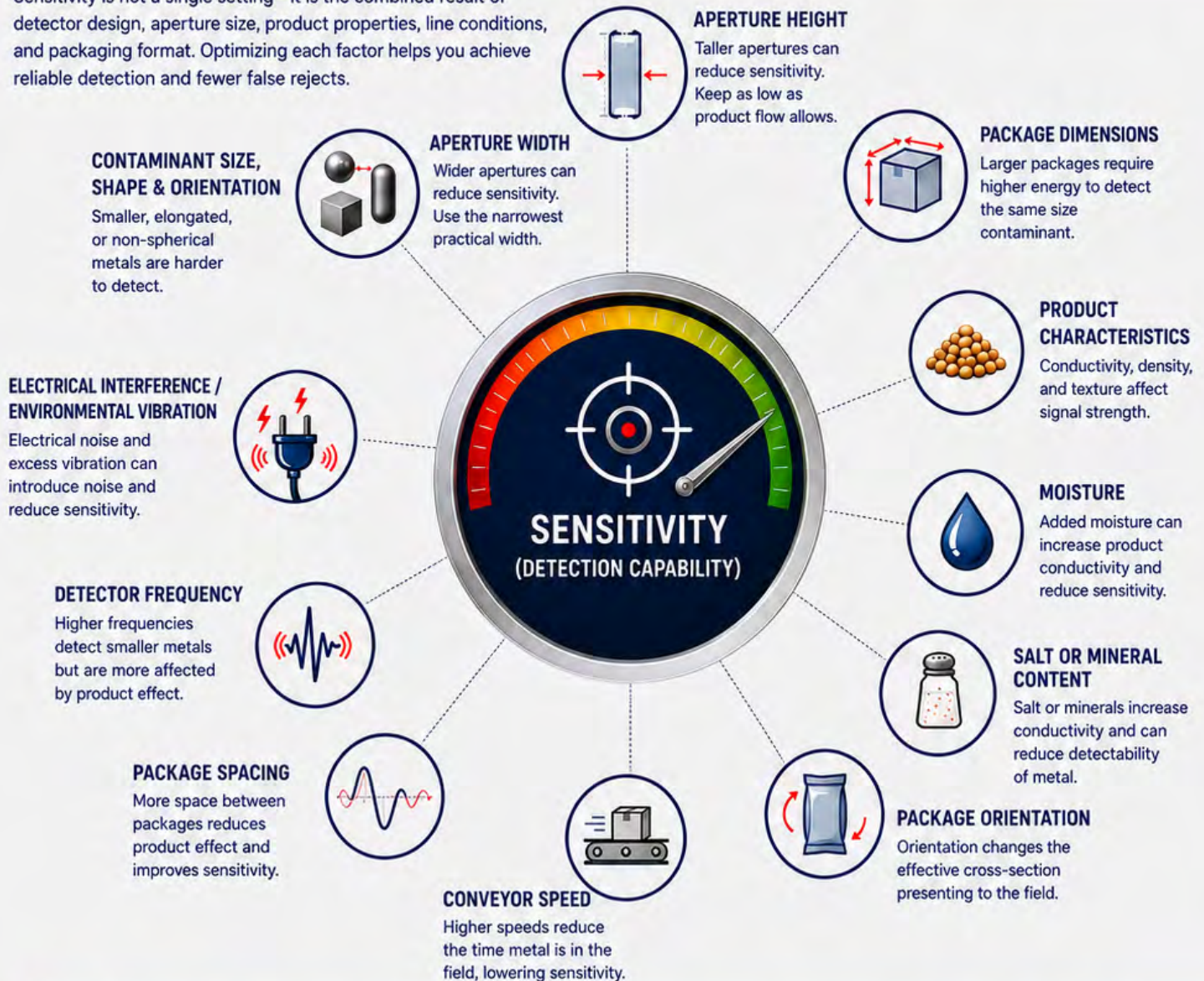


A SYSTEM CAPABLE OF DETECTING ONE METAL SIZE DOES NOT NECESSARILY DETECT ALL METAL TYPES AT THE SAME SIZE.

UNDERSTANDING SENSITIVITY

WHAT DETERMINES DETECTION PERFORMANCE?

Sensitivity is not a single setting—it is the combined result of detector design, aperture size, product properties, line conditions, and packaging format. Optimizing each factor helps you achieve reliable detection and fewer false rejects.



EXAMPLE TEST SPHERE



Stainless Steel
1.5 mm
(Actual size)



SENSITIVITY BELONGS TO THE ENTIRE INSPECTION APPLICATION—NOT SIMPLY THE DETECTOR HEAD.

Optimize every factor. Validate performance. Document results.
DELIVER CONFIDENCE.

VALIDATION, GMP & CHALLENGE TESTING

PROVING THE SYSTEM IS WORKING

Pharmaceutical metal detectors should be challenged and documented routinely to confirm detection, rejection, verification, and traceability. A complete challenge ensures your system continues to meet GMP requirements and protects patient safety.



1 CERTIFIED TEST PIECES



Fe
Ferrous



NFe
Non-Ferrous



SS
Stainless Steel

2 TEST THE PRODUCT AT MULTIPLE POSITIONS



LEADING EDGE



CENTER



TRAILING EDGE

3 A COMPLETE TEST SHOULD CONFIRM



Detection



Alarm



Reject activation



Correct product rejection



Reject confirmation



Event logging

4 TYPICAL TESTING FREQUENCY



Start of shift



Product changeover



Scheduled production intervals



After maintenance



After cleaning



End of run



IQ / OQ / PQ
Qualified to
GMP standards



AUDIT TRAILS
Complete test
documentation



**ELECTRONIC
RECORDS**
Secure &
tamper-evident



**21 CFR PART 11
READY CONTROLS**
Compliant electronic
systems



VALIDATE THE COMPLETE SYSTEM:
DETECTION + REJECTION + VERIFICATION + RECORDS

HYGIENIC SYSTEM DESIGN & LINE INTEGRATION

ENGINEERING THE COMPLETE PHARMA INSPECTION POINT

A pharmaceutical inspection system must be engineered around hygienic design, stable product presentation, reliable rejection, data capture, and seamless line integration to deliver consistent protection and regulatory confidence.



KEY ENGINEERING CONSIDERATIONS

- ✓ Conveyor width
- ✓ Line speed
- ✓ Reject-bin security
- ✓ Hygienic construction
- ✓ Conveyor height
- ✓ Package spacing
- ✓ Upstream/downstream accumulation
- ✓ Encoder integration
- ✓ Aperture dimensions
- ✓ Package orientation
- ✓ Reject mechanism
- ✓ PLC communication
- ✓ Belt material
- ✓ Data logging

TYPICAL LINE FLOW



INTEGRATION CHECKLIST

- ✓ Aperture matched to product envelope
- ✓ Stable, centered product presentation
- ✓ Reject timing tied to line speed
- ✓ Washdown or hygienic design matched to environment
- ✓ Secure reject collection
- ✓ PLC/HMI and records integrated with the line

THE COMPLETE INSPEX PHARMA APPROACH



DETECTION IS ONLY THE BEGINNING —
WE ENGINEER THE RESPONSE.

PRODUCT EFFECT IN PHARMACEUTICAL APPLICATIONS

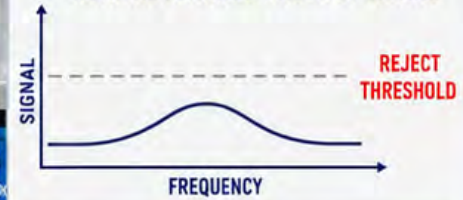
THE PRODUCT INSIDE STILL INFLUENCES DETECTION

Even in sealed pharmaceutical products, factors such as moisture, density, mineral content, conductivity, coating systems, and dosage form can influence the way a product interacts with the detector's electromagnetic field—affecting signal strength and stability.

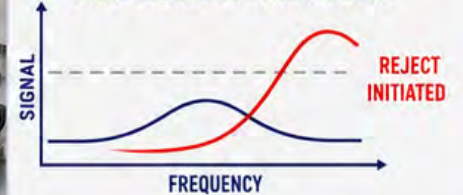


UNDERSTANDING SIGNAL RESPONSE

NORMAL LEARNED PRODUCT SIGNAL



TRUE METAL CONTAMINATION



PHARMACEUTICAL PRODUCTS THAT CAN INFLUENCE DETECTION

TABLET CORES



Density and compression force vary.

FILM-COATED TABLETS



Coating thickness and composition affect signal.

GELATIN CAPSULES



Moisture and fill weight can cause signal variation.

POWDERS



Particle size, moisture, and mineral content influence signal.

GRANULES



Granule size distribution and density matter.

EFFERVESCENT TABLETS



Porosity and ingredients can change signal.

SYRUPS / SUSPENSIONS



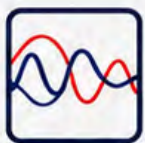
Conductivity and viscosity influence response.

HIGH-MINERAL FORMULATIONS



Mineral content can increase product effect.

MODERN TECHNOLOGY HELPS MANAGE PRODUCT EFFECT



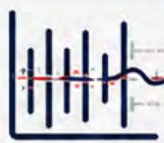
MULTIPLE FREQUENCIES

Analyzes across a spectrum to reduce product interference.



PHASE DISCRIMINATION

Separates true metal signals from product phase response.



DIGITAL FILTERING

Eliminates noise and stabilizes signals for better detection.



PRODUCT LEARNING

Teaches the detector what acceptable product looks like.



RECIPE MEMORY

Stores optimized settings for consistent performance.



COMPENSATION ALGORITHMS

Automatically adapts to product variation over time.



THE GOAL: TEACH THE DETECTOR WHAT AN ACCEPTABLE PHARMACEUTICAL SIGNAL LOOKS LIKE SO **TRUE CONTAMINATION IS IDENTIFIED RELIABLY.**

PACKAGE EFFECT & INSPECTION STRATEGY

THE PACKAGE CAN CHANGE THE RIGHT SOLUTION

Pharmaceutical packaging materials interact with electromagnetic fields differently. The package can affect achievable sensitivity and may influence which detection technology delivers reliable metal contaminant detection for your product and process.

RELATIVELY STRAIGHTFORWARD



HDPE BOTTLES

Non-conductive plastic; minimal signal attenuation.



GLASS BOTTLES / VIALS

Glass has little to no effect on electromagnetic fields.



CARTONS

Typical paperboard cartons do not interfere with detection.



PLAIN PLASTIC SACHETS

Non-metallized plastics provide minimal package effect.



NON-METALLIC TRAYS

Rigid plastic trays have little impact on detection.



PAPER LABELS

Paper labels are non-conductive and typically pose no challenge.

MORE CHALLENGING



ALU-ALU BLISTER PACKS

Aluminum layers attenuate signals and can mask metal contaminants.



FOIL LIDDING

Conductive foils can reduce sensitivity and complicate detection.



INDUCTION FOIL SEALS

Aluminum seals may interfere with signal penetration.



METALLIZED SACHETS

Metallized films reflect and absorb signals, reducing detection capability.



ALUMINUM TUBES

Metal tubes can shield contaminants from detection.



FOIL-LINED CARTONS

Aluminum liners can attenuate signals and affect sensitivity.



CONDUCTIVE LABELS / RFID COMPONENTS

Conductive inks and embedded components can impact detection.



CAUTION

TRADITIONAL ELECTROMAGNETIC METAL DETECTION IS NOT ALWAYS SUITABLE FOR FULLY ALUMINUM OR HEAVILY METALLIZED PHARMACEUTICAL PACKAGING. THESE APPLICATIONS MAY REQUIRE AN **ALTERNATIVE INSPECTION STRATEGY**.

ENGINEERING PRINCIPLE



UNDERSTAND THE PACKAGE EFFECT

Evaluate how materials interact with the inspection technology.



SELECT THE RIGHT TECHNOLOGY

Match the technology to the product, package, and contamination risks.



OPTIMIZE PERFORMANCE

Fine-tune settings and validate to achieve reliable sensitivity.



PROTECT PRODUCT INTEGRITY

Ensure patient safety, regulatory compliance, and brand trust.



THE INSPECTION TECHNOLOGY MUST BE SELECTED AROUND BOTH THE PRODUCT AND THE PACKAGE.

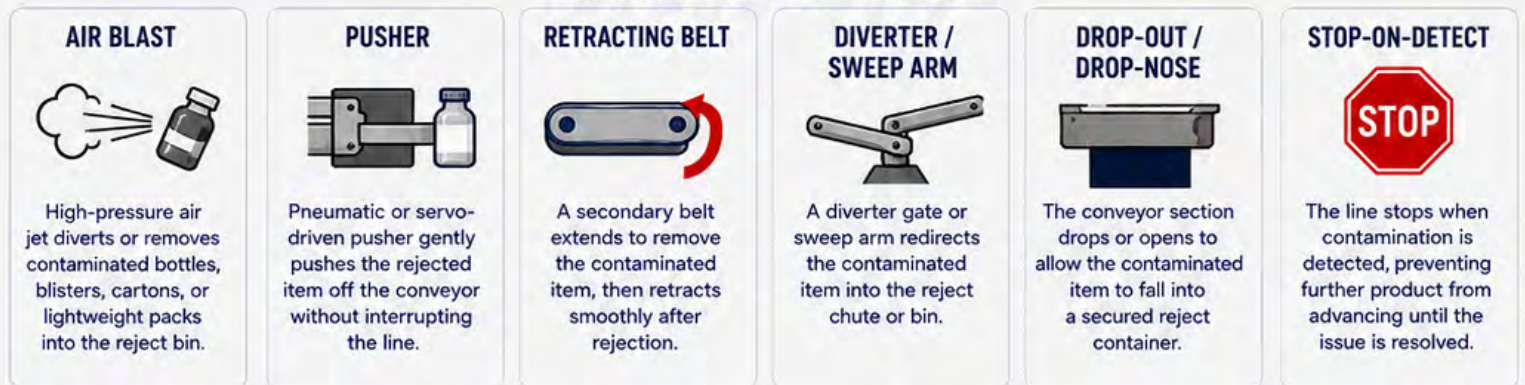
REJECTION SYSTEMS FOR PHARMACEUTICAL LINES

DETECTION WITHOUT SECURE REJECTION IS INCOMPLETE

Once contamination is detected, the affected pharmaceutical unit or package must be positively removed from the line before it can reach downstream processes or patients. A properly designed rejection system ensures contaminated bottles, blisters, cartons, or sachets are reliably separated from the good product stream. The rejection device is a critical part of the protection system.



COMMON REJECT METHODS



REJECT SELECTION DEPENDS ON

- ✓ Product format (bottles, blisters, cartons, sachets)
- ✓ Package dimensions and weight
- ✓ Validation requirements (IQ/OQ/PQ, 21 CFR Part 11)
- ✓ Package stability (handling sensitivity)
- ✓ Containment needs (dust, particles, potent APIs)
- ✓ Reject verification (sensor or vision confirmation)
- ✓ Line speed and throughput
- ✓ Reject-bin security and access control



KEY PRINCIPLE:
THE REJECT DEVICE IS PART OF THE PROTECTION SYSTEM.

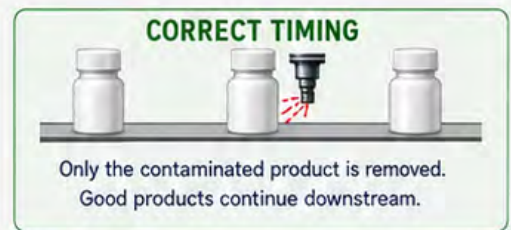
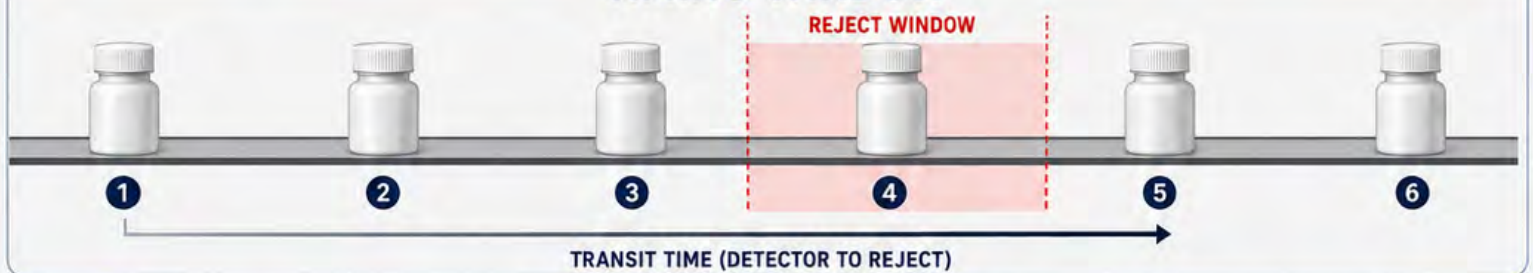
REJECT TIMING & PRODUCT TRACKING

REMOVE ONLY THE AFFECTED PHARMACEUTICAL UNIT

Effective rejection depends on precise timing and tracking. The control system must track the exact product from the detector aperture to the reject point, calculate the transit time, and trigger the reject mechanism only for that item. This ensures the contaminated unit is removed while good products continue downstream without interruption.



TIMING WINDOW



FACTORS THAT AFFECT REJECT TIMING



CONVEYOR SPEED
Changes in speed directly impact transit time.



DETECTOR-TO-REJECT DISTANCE
Greater distance requires more transit time.



PACKAGE LENGTH
Longer packages take more time to fully clear.



PACKAGE SPACING
Insufficient spacing can limit timing accuracy.



PLC PROCESSING TIME
System scan time affects overall response speed.



REJECT RESPONSE TIME
The air system and actuator response add delay.



ENCODER ACCURACY
Accurate position feedback is critical for precision.



LINE ACCELERATION / DECELERATION
Speed changes affect product position and timing.



DETECT → TRACK → ACTIVATE → REMOVE → VERIFY

FAIL-SAFE SYSTEM DESIGN

WHAT HAPPENS WHEN SOMETHING GOES WRONG?

A properly engineered pharmaceutical inspection system monitors its own critical functions. If a reject, sensor, conveyor, or control function fails, the line must move to a safe state to prevent uninspected product from being released downstream and to protect patient safety and regulatory compliance.



TYPICAL MONITORED CONDITIONS



EXAMPLE FAIL-SAFE LOGIC



FAIL-SAFE RESPONSE

- | | |
|--|---|
|  Stop upstream feed or conveyor |  Prevent additional product from entering the inspection point |
|  Alarm the operator |  Secure rejected product |
|  Require fault acknowledgement before restart |  Record the fault event for traceability |



**A FAIL-SAFE INSPECTION SYSTEM
DETECTS FAILURES IN THE INSPECTION SYSTEM ITSELF.**

DATA INTEGRITY, AUDIT TRAILS & 21 CFR PART 11

DOCUMENT PERFORMANCE. PROTECT COMPLIANCE.

Pharmaceutical inspection systems increasingly require secure electronic records, user access control, audit trails, and traceable event history to support GMP and 21 CFR Part 11 expectations. Designed-in data integrity helps ensure that inspection results are trustworthy, traceable, and always inspection-ready.



USER ACCESS LEVELS

Role-based access with unique user IDs and secure authentication.



AUDIT TRAILS

Complete, tamper-evident records of all system activities and changes.



ELECTRONIC RECORDS

Secure electronic records that meet 21 CFR Part 11 requirements.



EVENT & BATCH HISTORY

Detailed history of detections, rejects, and batch-related events.



RECIPE MANAGEMENT

Controlled recipe creation, versioning, and change management.



TIME-STAMPED ACTIONS

All actions are time-stamped and linked to the user performing the action.



DATA EXPORT / BACKUP

Secure export and backup options for long-term retention and retrieval.



ALARM / REJECT LOGGING

Automatic logging of alarms, rejects, and operator responses.

INSPECTION DATA WORKFLOW



LOGIN



SELECT RECIPE



RUN PRODUCT



DETECT EVENT



REJECT VERIFIED



RECORD STORED



REVIEW / REPORT

DATA INTEGRITY & COMPLIANCE CHECKLIST



Capture who changed what.



Record when it changed.



Log which recipe was active.



Record what events occurred.



Confirm whether reject verification was successful.



**IF IT IS NOT DOCUMENTED,
IT IS NOT VALIDATED.**

IQ / OQ / PQ & VALIDATION DOCUMENTATION

TURNING PERFORMANCE INTO COMPLIANCE CONFIDENCE

Successful pharmaceutical inspection projects require documented qualification and validation from installation through routine production to ensure the system performs consistently, meets regulatory requirements, and protects patients and your brand.



QUALIFICATION & VALIDATION WORKFLOW



TYPICAL VALIDATION DELIVERABLES



VALIDATION SHOULD CONFIRM

- ✓ **Detection Performance** – Detects validated contaminants across all product types and conditions.
- ✓ **Reject Activation** – Rejects are triggered accurately when contaminants are detected.
- ✓ **Reject Confirmation** – Confirm reject device removes contaminated product.
- ✓ **Recipe Security** – Recipes and settings are protected and access-controlled.
- ✓ **Audit Trail Function** – All events, changes, and alarms are logged with user accountability.
- ✓ **Record Retention** – Data is securely stored and retained for the required period.



VALIDATION TURNS
DETECTION + REJECTION + RECORDS
INTO PHARMACEUTICAL CONFIDENCE.

INSPEX ENGINEERS THE PHARMACEUTICAL CRITICAL CONTROL POINT

PATIENT SAFETY. COMPLIANCE. CONFIDENCE.

An effective pharmaceutical inspection system combines advanced metal detection technology with hygienic design, stable product presentation, automatic rejection, reject verification, validation, and secure data traceability to protect patients, ensure compliance, and build confidence in every product you deliver.



THE COMPLETE INSPEX PHARMA APPROACH



ELECTROMAGNETIC DETECTION

High-sensitivity metal detection for ferrous, non-ferrous, and stainless steel contaminants.



APPLICATION ENGINEERING

Custom system design to meet your product, line, and facility requirements.



PACKAGE PRESENTATION

Stable, centered product presentation for consistent detection performance.



AUTOMATIC REJECTION

Reliable, hygienic reject systems remove contaminated products automatically.



PACKAGE TRACKING

Track each package and reject event for full line visibility and accountability.



REJECT VERIFICATION

Confirm contaminated products are removed — verify every rejection.



FAIL-SAFE LOGIC

Intelligent controls and alarms ensure safe operation and protect product integrity.



VALIDATION

Documented IQ/OQ/PQ support to meet GMP and regulatory standards.



DATA & TRACEABILITY

Secure data capture, audit trails, and reporting for full compliance and traceability.



**DETECTION IS ONLY THE BEGINNING —
WE ENGINEER THE RESPONSE.**

PHARMACEUTICAL INSPECTION SOLUTIONS



TABLETS & CAPSULES



POWDERS & GRANULES



BLISTER PACKS



BOTTLES & SACHETS



COMBINATION SYSTEMS



PARTNERS IN PROTECTION. ENGINEERED FOR CONFIDENCE.