Today’s poultry processor must keep up with the demands of high volume processing, food safety and meeting regulation parameters.

X-ray detection has become a clear choice in delivering the best solution to these challenges.
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1.0 INTRODUCTION

Introduction to X-ray detection as a poultry processing inspection solution

Ensuring and maximizing food safety during poultry processing has never been more important. Demanding customers and consumers alike insist production facilities incorporate the best in production science, technology and equipment to ensure the safest-possible products are being consistently produced. As a result, forward-thinking poultry-processing facilities have been incorporating strategically placed X-ray detection systems on-line throughout their production facilities—from raw material check-in through final packaging and distribution.

While volumes continue increasing and line speeds keep accelerating at many production facilities to meet the ever-growing demand for a wide range of poultry products, X-ray detection systems are playing an invaluable food-safety/quality control role. This technology effectively and consistently detects a wide range of physical contaminants while meeting stringent food-quality standards demanded by government inspection agencies, retail and food service customers, as well as poultry processing companies.
Challenges of today’s poultry processors

Incorporating dependable X-ray detection technology is paramount due to the high costs of down time whenever such equipment breaks down or doesn’t run to spec. Lost production time equates to lost sales, and no poultry processing company wants to suffer through a recall that had to be initiated because product was physically contaminated somewhere during the production process. Recalls not only increase the risk of blemishing a processor’s trusted brand, they can result in a company going out of business.

Finding and ridding product with physical contaminants early in the production process minimizes waste and overall production costs. X-ray detection systems inspecting raw materials as they arrive at the production plant quickly detect and remove contaminated product before it moves on down the line. Contaminated product can be traced back and returned to its supplier, potential damage to processing equipment is prevented and the process of adding value can safely continue.

Limitation of current technologies

At present, poultry processors are limited to the types and size of foreign objects that can be detected with currently implemented technologies. Metal detection is the most-commonly used detection technology, but this process is limited to detecting metals only. Although visual inspection is still implemented to find bones, many bones may still be embedded in the meat [figure 1]. This complicates the detection process and results in missing some of these potentially dangerous contaminants. Add to that the possibility of having to increase the line speed, and the chances of visibly detecting bones and other contaminants decrease exponentially.

Labor woes

Many poultry plants are challenged to maintain adequate levels of staffing for their operations due to a shortage of suitable labor. As a result, they are increasingly depending on incorporating automated deboning processes to supplement manual labor. However, one major challenge in using this automated process is it typically results in a significant increase in the amount of bones in products.

The vast amount of product requiring US government inspection during processing is mind-boggling. In fiscal year 2011, the US Department of Agriculture’s Food Safety and Inspection Service listed a grand total of 9,298,324,105 food animals were slaughtered. Included in this total were capon, 81,985 head; duck, 24,373,339; fryer/roaster turkey, 1,153,786; geese, 178,788; heavy fowl, 77,958,405; light fowl, 67,825,751; old breeder turkey, 1,469,408; young breeder turkey, 1,489,586; young chicken, 8,727,534,570; and young turkey, 246,414,535, among others.

![Figure 1: By nature, poultry is very bone intensive](image)
X-ray points to the best solution

X-ray detection technology offers the best solution to finding contaminants with an extremely impressive degree of accuracy. As a result, applications are constantly expanding for this state-of-the-art technology, which is used not only for inspecting for physical contaminants, but also for uncovering defects in poultry product shapes and quality, packaging defects, as well as other product flaws. [figure 2]

Poultry processors should seek out X-ray detection technology providers who have expertise in advanced-sensitivity detection and who can customize X-ray detection systems to meet processing needs. Poultry processors should also seek the help of X-ray technology providers experienced in conducting original technology research and who intimately understand this highly sophisticated process from start to finish. Benefits also derive from working with X-ray detection technology providers who develop their own products through a company team of experts.

Various types of X-ray detection systems featuring a range of automatic detection sensitivities can find a wide range of contaminants on high-speed poultry lines. Such contaminants include ferrous, non-ferrous and stainless metals, glass, wire, stones, low-density bones in bulk filets trim meat and thighs, and rubber. X-ray detection technology can also satisfy product weight calculations via weighing technology plus offer expert analyses for unaccounted-for items. X-ray inspection assists poultry processors in successfully satisfying government regulations, both domestically and internationally, while meeting specific retail/food service customer needs.

**FIGURE 2** X-RAY ABSORPTION VARIES WITH X-RAY ENERGY
How X-ray technology works – finding the contaminants

All X-ray systems work by creating a density-based image, which the computer uses to determine if any contaminants are present within the product. The images are normally displayed in gray scale, and contaminants appear darker since they are more dense and, therefore, absorb more X-ray energy. The entire system is fully automated, and no user interaction is required. The X-ray images are very advantageous for pinpointing reject locations and showing the operator the size of the contaminant.

X-ray system’s software analyzes each product image and dynamically looks for all sizes and types of contaminants. The detection capabilities are affected by both the product attributes (product thickness, speed, variation) and the type of contaminant. The process is dynamic, and each inspection tool looks through the entire image simultaneously for any possible defects. Upon completion of the image analysis, the system will determine if the product should be accepted or rejected. If a product is rejected, the software notifies an automatic reject system, and the adulterated product is promptly and safely ejected from the production line. All rejects are logged and recorded with a time and day stamp. On most systems, the images can be saved for later usage or viewing.

Different levels of X-ray inspection

Although standard variations of traditional X-ray detection systems are highly effective, newer X-ray solutions can create and analyze two X-ray images for each product to greatly increase detection capabilities and minimize false rejects. As previously stated, all X-ray systems look for contaminants by looking for density variations within the product. Dense contaminants, such as metal, are easily detected. However, low-density contaminants can be very difficult or impossible to detect. Low-density contaminants include bones, especially poultry bones, among other items.

Dual energy X-ray inspection leads to higher, more accurate detection

Dual X-ray wave systems deliver an extremely accurate, high-speed reading of poultry and meat products in an affordable manner. Such systems analyze two different X-ray energy signals, allowing the system to distinguish between the product being processed and contaminants – thus, enabling a higher detection rate of low-density items. [figure 3]

This technology is not new, however, it is newer to food processing. Dual energy X-ray absorptiometry has been used in medical practice for analyzing bone density, and dual energy based systems have been running for a decade in the security sector to look for plastic explosives in luggage.

Featuring a pre-set memory capability sufficient to handle multiple product recipes, dual X-ray systems are extremely versatile and very flexible for poultry production facilities that process a wide range of products.

Major poultry processing contamination detection challenge: It’s about the bones

Dual X-ray systems are highly suited for the stringent quality-control requirements in poultry processing plants. Such systems provide dramatically enhanced sensitivity to bone fragments in poultry – particularly for difficult-to-discover, low-density bones. Poultry processors can now successfully and consistently identify wishbones, fan bones, scapula bones and more in poultry meat at detection levels previously impossible to achieve utilizing standard detection equipment.
DUAL X IMAGE PROCESSING LEADS TO A HIGHER DEGREE OF DETECTION

- **Figure 3**

- **Diagram:**
  - Bone
  - Meat
  - Poultry meat signal + bone signal (Low energy)
  - Poultry meat signal (High energy)
  - Poultry bone signal

- **Graph:**
  - X-ray energy
  - Attenuation coefficient
  - Poultry meat
  - Poultry bone

- **Text:**
  - Signal processing ⇒ equalize the level of the meat signals and then cancels out the product signals by subtraction.
  - The product (meat) signal disappears, leaving only the contaminants.
2.0 FITTING X-RAY INSPECTION SYSTEMS IN A POULTRY PROCESSING PLANT

In determining where X-ray detection technology fits into the processing line, three major areas should be considered: bulk, raw processing; packaged products; and pumped products.

Bulk, raw processing

The most common implementation of X-ray detection technology in poultry processing is immediately following the deboning processes. The cone line deboning process typically results in wishbone, fan bones and rib bones being introduced into the butterflies and fillets when a product is pulled or cut from the skeletal frame. Dark-meat deboning of thighs and whole legs via automation is a common cause of bone fragments from broken bones. The deboning process also yields metal contaminants caused by parts and pieces of the actual processing lines becoming detached and falling into the product. [figure 4]

Packaged product

In the absence of X-ray detection upstream in the processing area, many bones introduced in the deboning process will find their way into the product as it is packaged. The equipment and tools used downstream in further-processing and packaging processes present additional opportunities for metal and other foreign objects to adulterate the finished product. Processors will locate X-ray equipment after their packaging operations as a final assurance that foreign objects and contaminants have not made their way into the final packaging.

Pumped product

Poultry trim and ground poultry are typically pumped through pipes as a means of transporting them through the plant. The trim product can be further processed into products, such as nuggets. Processors will install pipeline X-ray into these processes to detect bone and other hard objects so they do not contaminate the final product. They also will locate pipeline X-ray prior to grinding operations to ensure their grinding equipment is not damaged.

FIGURE 4 ► POULTRY BREAST DETECTION SENSITIVITY AT 40MM THICKNESS

Dual X-Ray (DualX featured)  Standard X-Ray
3.0 PUMPED PRODUCT CAN COME WITH X-RAY PEACE OF MIND

Overview of the pumping process and detection requirements it demands

Pumped products include meat and poultry, as well as fluids, semi-solids and slurries. Product supply and pumping systems for a pipeline X-ray typically consist of a product-supply hopper and a pump. In addition, a ball valve is located a little downstream from the X-ray system, which is used to reject product-containing defects. The X-ray sends a signal to actuate the ball valve when a defect is detected. The ball valve opens to divert a slug of rejected product and closes again for normal flow of good product.

Several critical factors must be considered when using a pumping system to supply a pipeline X-ray. Most important, the pumping system must be able to supply the X-ray with a continuous and steady flow rate free of voids and air pockets. The steady flow rate is most critical to the proper operation of the reject ball valve since it is actuated on a time based variable.

If the flow rate changes, it is possible the reject timing will be off and detected defects will not be rejected. The product-supply hopper feeding the pump must be designed to ensure there is a constant backlog of product in the hopper so the pump and X-ray are not starved. A level sensor is typically used in the hopper to maintain the proper level of product. The sensor is set to ensure the hopper is not overfilled and also calls for additional product when the product level gets too low.

There are also important considerations when selecting the type of pump to use. Since the product must be pumped at a steady flow rate, the pump cannot cause cavitation (forming and implosion of cavities in a liquid), which is inherent in pumps utilizing reciprocating technologies. Another critical factor to consider when choosing a pump technology is the required product integrity relative to tearing of the muscle, which can be caused by shear points within the pump.

Detecting contaminants is typically more effective earlier in the production process when pumped product, yet to be processed, can be scanned through an X-ray detection system in a lesser depth and with a more consistent product texture. Depending on a production plant’s critical control points, X-ray inspection systems for pumped products can be used in a variety of areas on a production line.

Attaching X-ray inspection equipment to piped production lines is not difficult to accomplish. Available fittings attach the pipe carrying pumped products to an X-ray machine manifold. Whenever the software detects a contaminant, product is immediately ejected from the pipe. Effective X-ray system designs also eliminate air bubbles, which are found in pumped poultry operations.

All effective X-ray systems will automatically respond to product flow-rate changes of the customer product. Speed signals from the production-line pump adjust the scan speed plus the timing of the associated reject function.
Choose your degree of detection wisely

There are many types of X-ray detection technology solutions offered in the market place, but none are created equal. Single X-ray detection runs the inherent risk of generating higher false rejects and features the inability to perform bone detection to a higher level. Moving to a high definition (HD) machine allows a higher-resolution performance detecting at a level of 0.4mm and 0.2mm in diameter. Finally, a move to dual-wave, or two X-ray waves, will provide the ability to detect the low-density contaminants that are so hard to find, such as poultry bones, glass and stones.

Operational flexibility

Many poultry processing lines change the flow of product from shift-to-shift or day-to-day. When running this type of operation, make sure your X-ray detection system adjusts just as easily, or better than, the rest of your line, thus, assuring smooth transitions in your daily operations.

Minimizing false rejects

If you know your raw or finished product presents X-ray detection challenges, such as finding poultry bones, invest in the X-ray detection technology that will serve your greatest needs.

Ease of maintenance

Maintaining uptime is crucial on any poultry processing line. If the equipment does need to be repaired, and during the daily cleaning schedules, you’ll want a piece of equipment that is user-friendly. Some options exist where belt removal or preparation for cleaning can be accomplished by hand without utilizing any tools. This hands-on solution saves everyone time and money.

Cost of ownership

Downtime, repairs, ease of operation, accuracy and avoiding product issues all speak to the cost of ownership of your X-ray detection equipment. If the technologies are robust, the reporting flows seamlessly into your measures, repairs are a non-issue and daily cleanings become effortless, then your equipment investment will quickly pay for itself.

Machine longevity

Take time to research the X-ray detection manufacturer’s standing record on how long machines are staying in the field and how often the equipment needs to be repaired.
5.0 SUMMARY AND CLOSING THOUGHTS

The best detection solution is the solution that comes with careful planning with your chosen supplier. Decide on placement and detection goals when deciding if several detection points should be part of the solution. Be careful to isolate the needs of your operation as it relates to the type of poultry cuts you’re processing and the detection limits that you deem necessary for operational efficiencies and product performance in the market place. To that, take the time to test the X-ray equipment that you’ll be running every day. Look for easy set-up, flexibility in setting operation perimeters and confirm easy repair and cleaning accessibility.

Also, take the time to look into the future. Regulations will continue to refine acceptable limits, so focus on a technology that can continue to not only meet today’s standards, but also those of tomorrow.

Finally, give careful consideration to putting a dual X-ray wave system into your solution. As explained, poultry bone detection comes with the need for a higher degree of technologies to find the low-density types of poultry bones. Making dual X-ray a part of the solution will deliver a higher degree of meeting the goals of your successful detection plan.
6.0 ABOUT ANRITSU

Anritsu Industrial Solutions USA exists to significantly advance food product quality and to assure consumer safety from foreign material inclusions. There is no greater priority than the safety and security of your customers. When it comes to detection, you can’t settle for anything less than the best. For nearly half a century, Anritsu has been designing superior detection and inspection equipment for the protein based processing industries. Across the globe, we provide a superior return on investment while ensuring your company is in compliance with the most stringent quality control programs. No other company can provide better support, experience and technology to detect contaminants or quality issues within your products, especially in the way of X-Ray solutions including dual X-ray wave technologies.

The DualX X-Ray Technology, first revealed to the world last year after 10 years of research and development by Anritsu Industrial Solutions, further advances the detection of metals and significantly advances the detection of lower density contaminants. The system uses two different X-ray energy signals providing the automatic ability to differentiate the product profile from the contaminants, which allows automatic and accurate detection of hidden, low-density contaminants including glass, stones, wire, rock, rubber and bone.

Anritsu continues to be the leading edge innovator within the detection arena pushing past the traditional detection technologies through the use of a HD and UltraHD imaging systems as standard. DualX Technology further extends the lead in detection capabilities providing improved contaminant detection within organic products and ‘busy’ images by effectively separating inorganic material data from organic data. The result is improved contaminant detection performance in certain applications.

For manufacturers looking to utilize this advanced technology, Anritsu products offer simple “Auto Learn” capabilities that allow easy setup and quick ROI. Anritsu DualX is packaged within a highly engineered and durable system solution, including a small footprint, no-tool maintenance and overall production line longevity.

If you would like to receive more information, go to www.us.anritsu-industry.com/moreinfo or call toll free at 866-200-5276.