MIRION TECHNOLOGIES

# Application Note

## iPIX™ – A Gamma imager to support various applications

### Introduction

iPIX instrument is a unique gamma imager that quickly locates low level radioactive sources from a distance and estimates the dose equivalent rate to a specific radionuclide at the location of iPIX unit. It is the ideal tool to map radioactive areas before entering into an unknown situation, and thus reduce the dose exposure (ALARA – As Low As Reasonably Achievable) during standard operation or decommissioning tasks. iPIX imager can also be an appropriate instrument to detect any suspicious radioactivity in security and safeguard applications, as well as for emergency and post-accident situations.

This Application Note provides some examples of typical situations encountered in the field of radiation work in nuclear installations and elsewhere.

Some of the numerous applications of iPIX imager:

- Printed images that can be used by workers to identify possible locations of radioactive materials or radiation leakage.
- Inspection of radio-chemical process (tanks, drums, pipelines...).
- Initial hot spots mapping in preparation for maintenance or dismantling activities.
- Source localization prior to decontamination.
- Monitoring of decontamination activities.
- Reduced exposure with improved job planning (according to the ALARA principle).
- Planning for maintenance during outages of nuclear power reactors.
- Industry with difficult nuclear conditions (high dose rates, hot cells).
- Remote survey of radiological conditions.
- Evaluation and dimensioning of protective shielding.
- Quality Assurance control in manufacturing.
- Emergency situations such as: spills, transportation accidents, fires, terrorist “dirty bombs”, etc.

### An easy to carry and deploy instrument

There are many gamma imagers available on the market. Most of these solutions have been developed by research laboratories and are still closer to lab products than real industrial products. The industrial design, automation and user friendly interface of the iPIX imager help users to complete source localization within a remarkable time.

Users rarely connect a gamma imager from their office. They have to carry the instrument into the field, passing through turnstiles and walking long distances to reach the working area of interest. Therefore, lightweight and small instrument volume helps to reduce the pain of completing each task. It may also reduce the time to wait for the security officer to open the side access door to the radiation controlled area as the user may be able to pass through turnstiles while holding iPIX imager and tripod in hands.

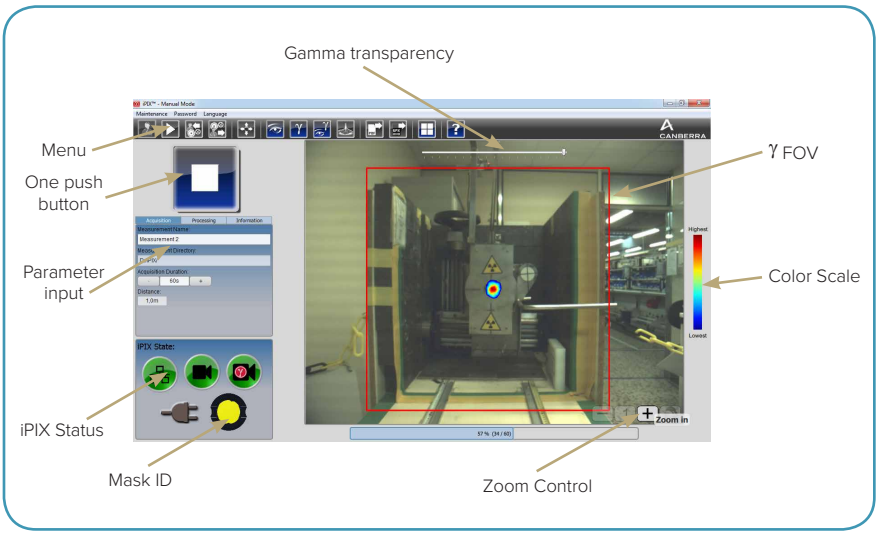

iPIX unit weighs 2.6 kg and represents 1.5 liter (1500 cc) in volume only.

## Industrial design

Operating in an industrial nuclear environment is challenging due to accidental drops and shocks to the instrument as well as the risk due to contamination. iPIX imager has been tested for drops from 60 cm height with no damage. 60 cm represents the typical elevation of someone hand carrying the unit with its handle. As no fan is used to cool down the unit head, airborne contaminants are prevented from entering in the camera enclosure. IP65 rating allows cleaning in case of surface contamination. For this purpose, an IP cap is placed on top of mask to prevent humidity and dust from entering in this area.


## User friendly software

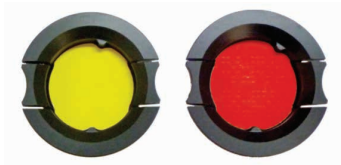
iPIX imager does not require a high level of expertise to be operated. It only needs the distance to object and optional information such as measurement name and comments before user can start acquisition by pressing a single button. If radionuclide equivalence is selected between Am-241, Cs-137 and Co-60, a dose equivalent rate coming from the gamma field of view (FOV) will be displayed and automatically saved with measurement data. This represents net result coming from the measured scene, excluding surrounding background or fields not coincident to the FOV.




## A camera that covers large range of applications and environmental conditions

Energy of contaminants and background level impact measurement quality when using gamma imagers. iPIX imager has been designed to adapt to these various conditions by selecting a collimation mask:

- 2 masks (yellow or red) of different thicknesses are available for energy and background level trade-off.



Also, iPIX imager remains linear for measurements up to 10 Sv/h (1000 rem/h) by automatically selecting an adequate shutter time, thus covering situations that can be very critical for workers using other mean of measurement.

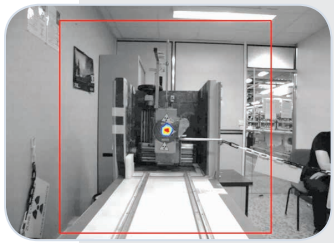
The iPIX unit covers energy ranges from 30 keV up to Co-60 and features excellent efficiency at low energies with radionuclides like Am-241, supporting Fuel cycle, Decommissioning/Dismantling, NPP maintenance activities and Homeland security applications with very quick measurements.

## Three views to support diagnosis and decision

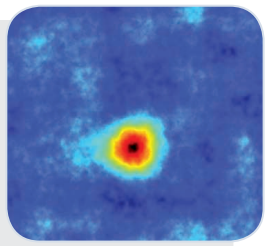
Beside the visible image, iPIX software provides user with three additional images:

- Superimposed image (available during and after measurement): It shows the radiation layer on top of visible view. The Gamma layer represents a cut of the total gamma signal – 85% of the maximum reading by default.
- It is the ideal image to use for final report and communicate results as it is very simple to understand.
- Decoded Gamma Image (available during and after measurement): It shows radiation statistics over the entire Field Of View with a color scaled representation: Blue is the lower signal and red is the higher signal. It is the window of choice to estimate measurement signal to background ratio while iPIX imager is acquiring data. We expect to see a majority of blue all around hot spots to consider the statistics to be good enough. An image with Yellow green all around is a sign of bad statistics that requires a longer acquisition time.
- 3D Gamma image (available only after measurement is complete): it represents the total gamma signal using a 256 x 256 matrix with elevation of gamma strength by pixel. It is a very important display to ensure that a strong hot spot is not hiding another smaller one or to distinguish multiple hot spots close to each other.

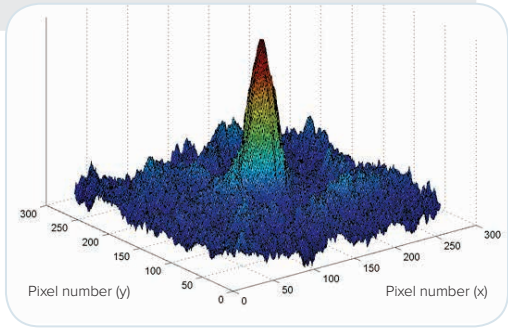
Visible



Superimposed

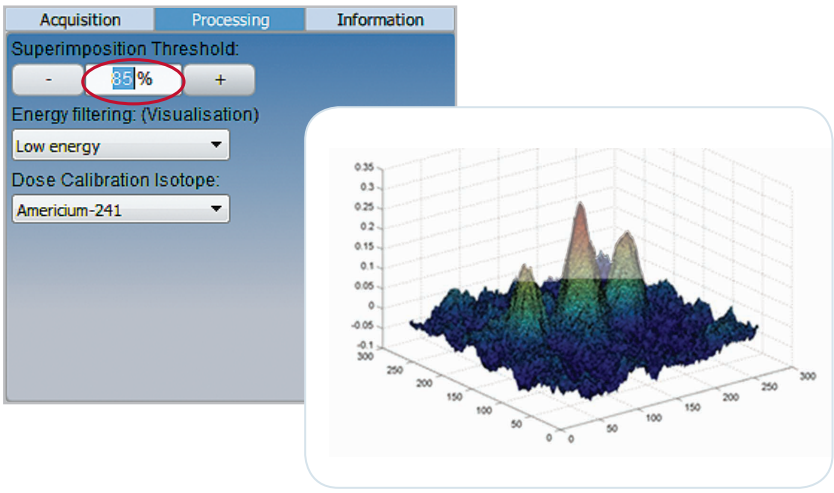


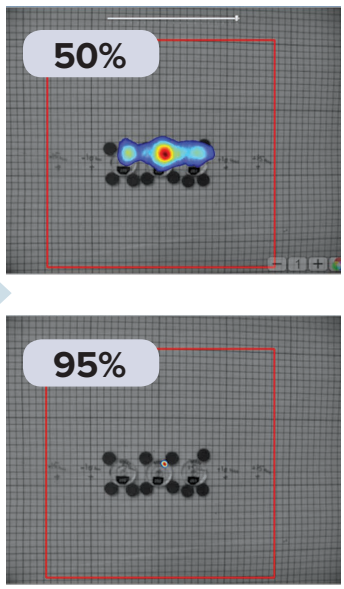
Decoded Gamma




**3D Gamma**

Superimposed image is generated by cutting a slide of variable elevation (0 to 100% of maximum) from 3D image and adding this gamma layer to the visible image:

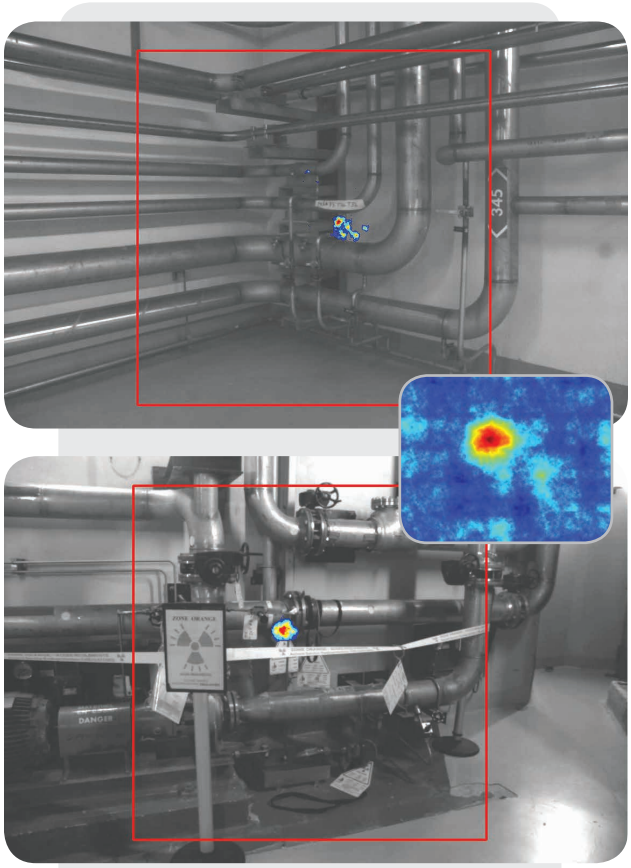


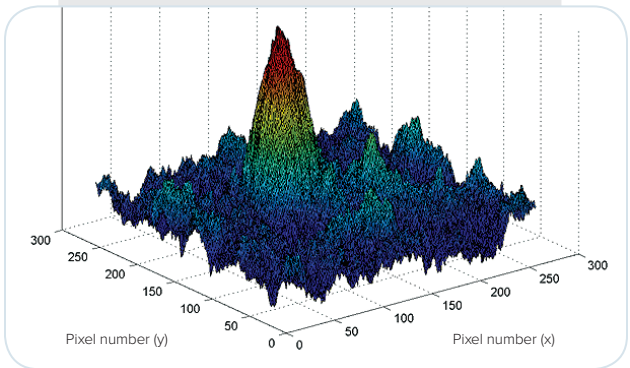

This selection can be made after acquisition via reprocessing to show lower level of radiation beside the higher hot spot.

## Generation of image showing locations of increased radiation to workers

Good communication and adequate information showing where radioactive hot spots are located is important to lowering dose received during work in a specific area. It also helps to correctly position tags identifying these hot spots.

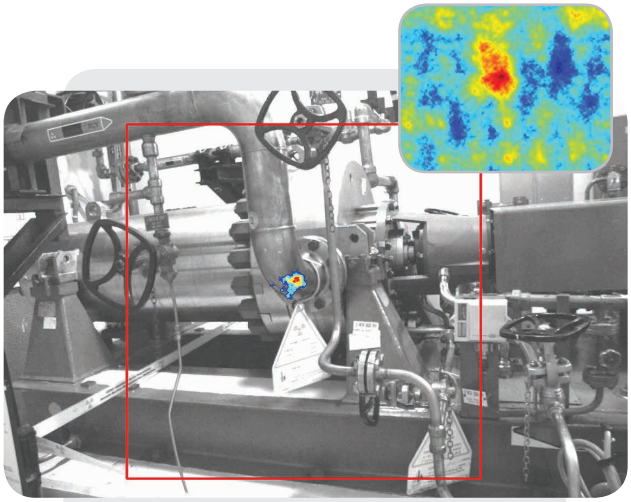


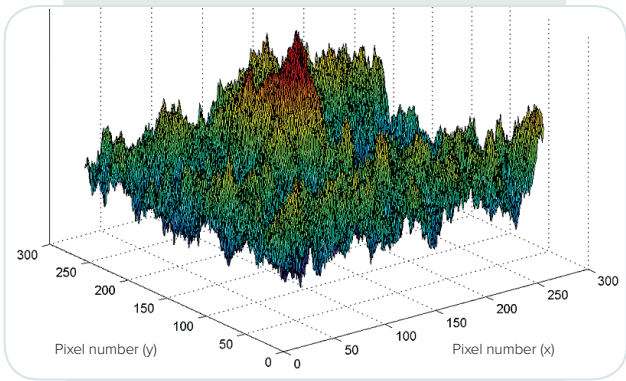



## Inspection of radio-chemical decontamination on pipes

In preparation for outages, and during an outage, source term reduction to reduce worker exposure is accomplished by the use of plant chemistry, flushing, and filtration. The iPIX imager can also be used as a tool to evaluate the efficacy of the source term reduction process.

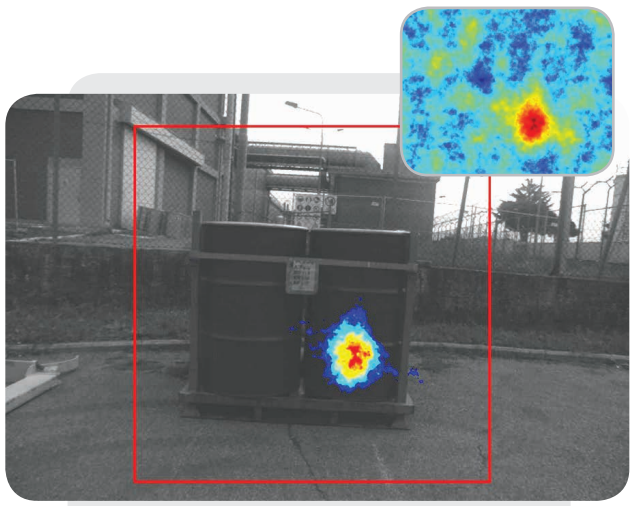





Net FOV dose-rate is 149 µSv/h (14.9 mrem/h) equivalent to Co-60. Image was taken in 2 minutes.

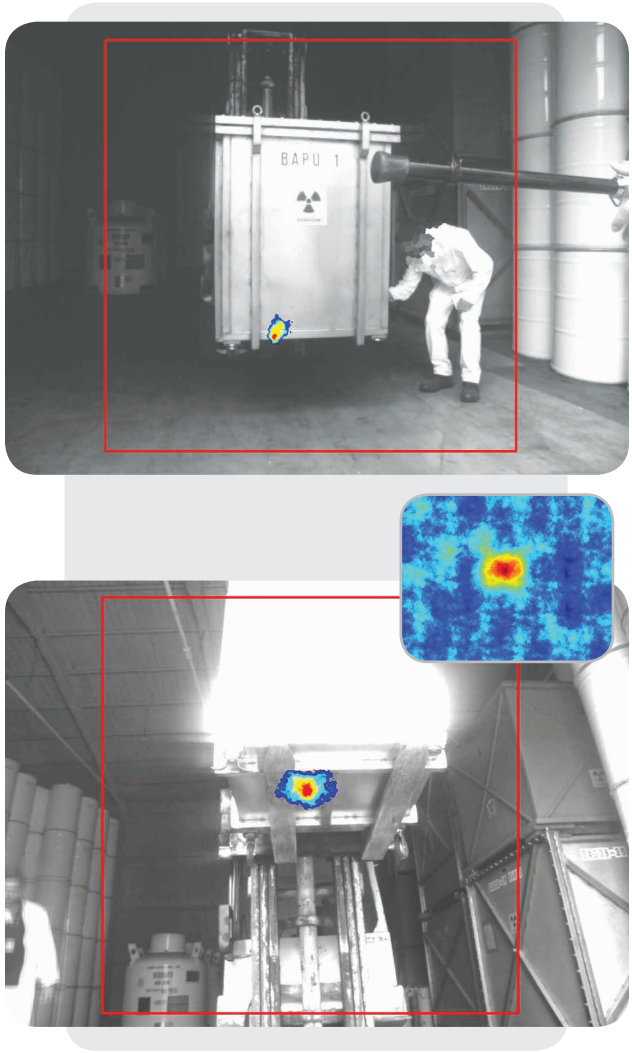
## Reduced exposure with improved job planning (according to ALARA principle)

Having a clear picture of the radiation environment in which workers are present enables the ALARA planning staff to estimate personnel dose, task planning and prioritize required shielding. In the example below, a drum hot spot is identified that should first be evaluated and remediated to remove the source of potential dose exposure prior to planned work or movement.




Net FOV dose-rate is 1 µSv/h (100 µrem/h) equivalent to Cs-137. Image was taken in 5 minutes.

The example below shows a container loaded with a glove box contaminated with Am-241 on one limited area. iPIX imager was able to locate the hot spot in 2 minutes while a worker was still screening another side with a handheld survey meter. A second measurement with a different view angle nailed down the precise location of the hot spot. This information allowed the worker to safely remove the glove box from the container while keeping hot spot at reasonable distance.

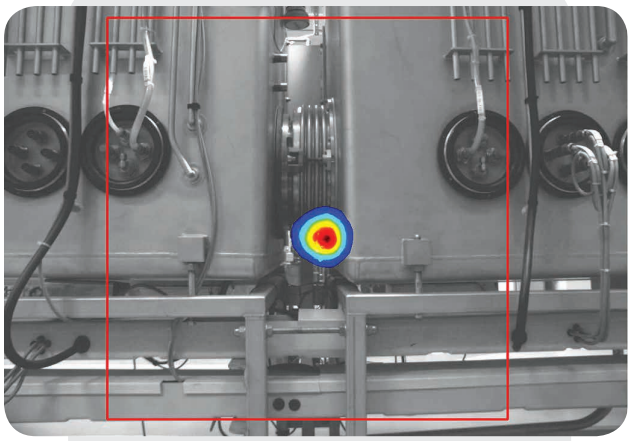


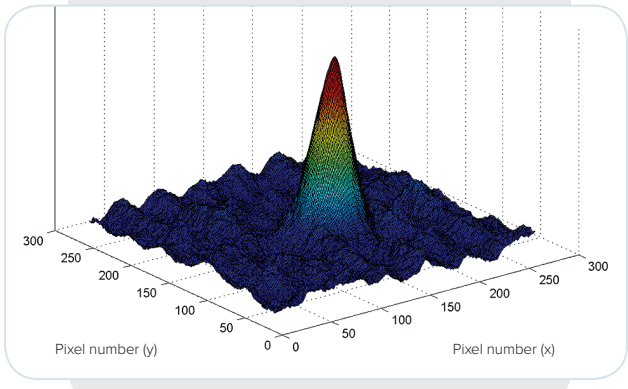

Net FOV dose-rate is 1 µSv/h (100 µrem/h) equivalent to Am-241. Images were taken in 2 minutes each.

## Initial hot spot mapping in preparation for maintenance or dismantling scenarios

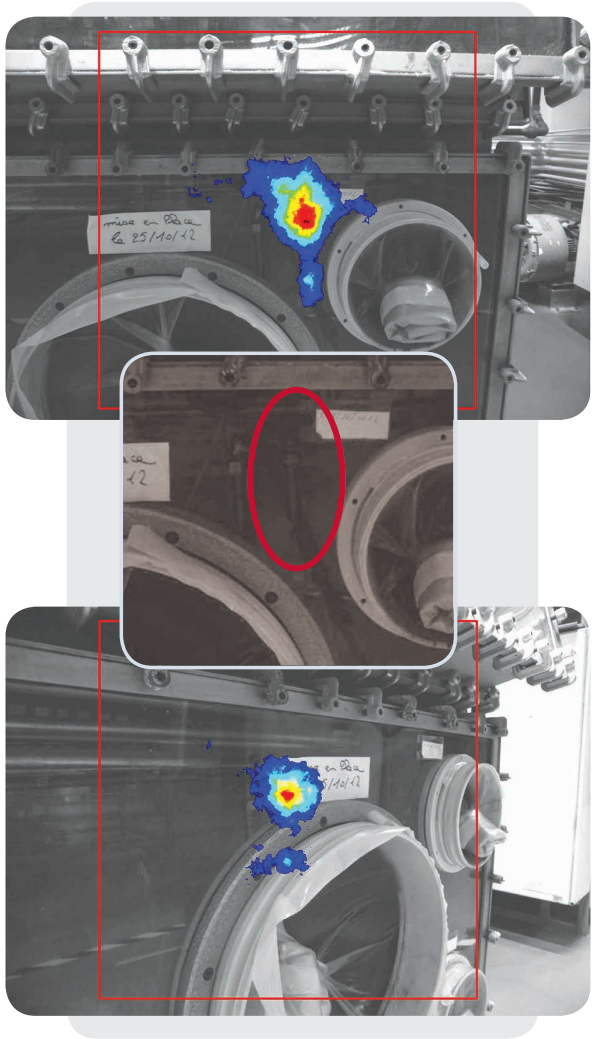
Prior to conducting operations in areas of potential high dose equivalent or contamination, a thorough radiological survey to identify hot spots should be conducted to assist with task planning and achieving ALARA objectives. However, in this situation, the survey process itself may have the potential for significant personnel exposure. The iPIX unit offers a significant advantage in that it can quickly identify areas of concern while reducing overall exposure, and keeping the project within the overall dose budget.

The example below shows two glove boxes linked with each other by a tunnel where a high risk of contamination exists. iPIX imager created the following Am-241 hot spot images within a few seconds, reducing both time to complete the job and dose received by worker:






The weight and dimension of the iPIX unit allow for easy placement in difficult areas and the instrument can be moved quickly to generate a second view angle, thus locate hot spot in volume. The first measurement below was taken facing the glove box and left the worker with the idea that the hot spot was located on the front wall. The second measurement with a different view angle revealed the origin of the hot spot to be inside the glove box on a bent pipe.



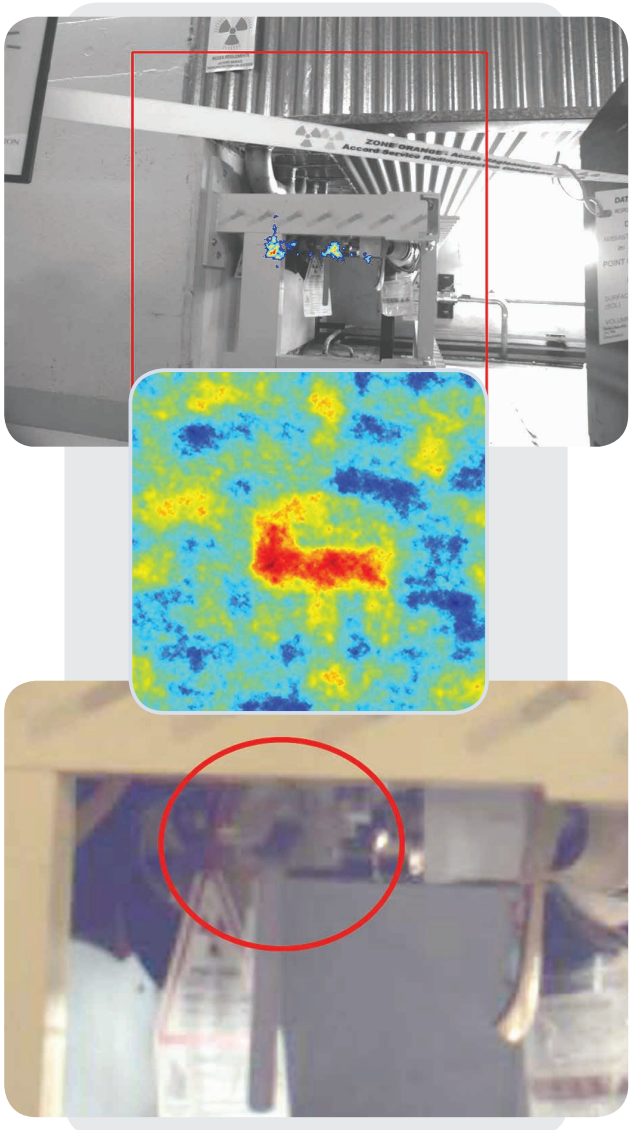
Such a hot spot cannot be safely and precisely located with a survey meter as it requires the worker to put the meter inside the glove box for a detailed survey, generating significant body extremity dose. This hot spot was discovered with iPIX imager although a survey had been completed on the glove box. A detailed report of the precise location of hot spots guided the worker during the dismantling activity such that he could start by removing the element of interest and mitigate the dose impact for the rest of the job on this specific glove box. The dose scenario was lowered and the worker operated in better conditions.

Only a few minutes were necessary to map the entire glove box, generating a dose-rate at the surface of the hot cell of few mSv/h.

## Evaluation and dimensioning of protective shielding

Some contamination cannot easily be removed and the only solution is to shield the origin of the dose-rate prior to starting work in the area. iPIX images taken before and after shielding has been installed help to focus shielding where it is needed most and to verify that it is as effective as possible.

The example below shows that a better job could have been done right around the valve that is still generating dose-rate of 42 µSv/h (4.2 mrem/h) of Co-60 at the location of the iPIX unit.



A significant source of dose-rate coming from a wall trough pipe was shielded with a scaffolding structure at approximately 5 meters high. The image taken shows radiation leaks at the top and the bottom generating a net incremental dose-rate of 27 µSv/h (2.7 mrem/h) of Co-60 at the iPIX location.

## Quality Assurance control in manufacturing

iPIX imager can be integrated into manufacturing processes and/or Quality Assurance Programs that use or generate radiation: Luggage X-Ray check conveyor, Lead Paint Handheld XRF Analyzer, Radiation thickness gauge, etc.

iPIX imager has been used to look for X-Ray leaks on a luggage conveyor curtain, ensuring that travelers do not get exposed to radiation when picking-up their belongings. In case of a leak on the X-Ray generator that is usually placed below the conveyor, a simple image can reveal area of insufficient wall material and drive corrective action.

Curtain X-Ray leak check.

## Conclusion

iPIX unit is portable, simple to operate and quick to set-up such that measurements can be made within minutes of it being deployed. Information can be gathered quickly and from a safe distance while the unit is counting. And it is easy to take shots from multiple angles to eliminate any question as to where hot spots are located.

iPIX imager supports the ALARA principle by helping workers to mitigate excess received dose during time spent in a specific area of risk.

**www.mirion.com**

ISO 9001 SYSTEM CERTIFIED
MERIDEN CT
SMYRNA GA
OAK RIDGE TN
CONCORD ON



C49237 - 07/2016