

INFORMATION ON RADIOACTIVE CONTAMINATION (RaC) OF IRON/ STEEL PRODUCTS, ITS DETECTION & EQUIPMENTS FOR MEASUREMENT, IN THE FORM OF FREQUENTLY ASKED QUESTIONS (FAQ)

- 1Q) What is Radioactive Contamination in Steel/ Iron/ alloy/casting products?**
- A) Scrap metal, engine block scrap and other miscellaneous scrap (incoming) when purchased, may get mixed up with any of the Radionuclide substances (Sources), such as Co-60, Am-241, Cs-137 etc.(medical & industrial sources) can enter the factory accidentally leading to Radioactive contamination, when processed further in a steel industry. Also semi-finished inputs such as flats, bars, rounds, castings, other parts, received from vendors as inputs, may have radioactive contamination already.
- 2Q) How it can happen?**
- A) There are lot of industrial & medical radioisotope products used in cancer hospitals & industries. When they are disposed, illegally,(not following AERB guidelines) it is likely that they come into steel plants & large foundries thru input scrap metal or thru semi-processed inputs purchased from other industrial unit, & can lead to radioactive contamination of the end product.
- 3Q) What is the remedy & how to detect & segregate contaminated parts?**
- A) There are sensitive low level radioactive contamination inspection systems, Truck/container monitoring systems (large) and smaller Portable instruments offered by companies world over. In India, **Nucleonix Systems** a reputed company with its vast design, development & manufacturing experience into Nuclear Instrumentation has developed about **FOUR** different products to meet requirements of steel industry in different situations to detect radioactive contamination.
- 4Q) Which are these four products?**
- A) The following are the FOUR products.
- 1. Rad check meter RC705B**
 - a) With Internal detector**
 - b) With external detector probe**
 - 2. Truck/Container Monitoring System For Radioactive Contamination – (Type: TR1020)**
 - 3. Gamma Ray Spectroscopy System for Radioactive Contamination Measurement by Nuclide Identification & its quantification.(To measure contamination in Bq/gram)**
 - 4. Package monitoring system Type:PMS 1009**
- 5Q) What is Rad Check Meter, in what situations we can use this product?**
- A) It is a low cost economical instrument which checks for radioactive contamination (photons / Gamma Radiation) in steel/alloys/ iron samples / scrap metal, when the meter front face is kept close to sample (almost touching). It is a handheld instrument suitable for scanning manually. There are more than Two Hundred meters supplied by us throughout the country, which are in working condition.
- 6Q) What is a G.M detector based Radiation monitor? Whether one can use it for checking of Radioactive Contamination in steel / iron/ alloy / castings products?**
- A) Low cost (Rs:15,000 to Rs:40,000) G.M. detector based meters are offered by some companies & they cannot detect low level radioactive contaminations. Higher contamination levels, only they can detect & hence are not recommended for this application.

Only sensitive meters which can measure from 1 μ R/hr or 10 nSv/hr onwards are to be used. At Nucleonix System we have a product called **Rad Check Meter** in our range. This is a portable meter to be used either with internal or external probe.

7Q) When Truck/Container Monitoring System is to be used for Radioactive Contamination?

A) This system comprises of two large **volume plastic scintillator detector pillars**, electronic measuring & alarms unit and software with PC. Highly recommended at the entry/exit gates to check for Radioactive contamination in. In-coming trucks / containers carrying scrap metal, input raw material, iron, steel, alloy products etc. Also it can be used for checking outgoing finished goods in trucks.

8Q) When Gamma Ray Spectroscopy System for Radioactive Contamination Measurement by Nuclide Identification & its quantification is to be used?

A) This is a powerful tool used for exact **quantification of nuclide, present in a contaminated sample**. This system identifies & quantifies the contamination in Bq/Kg or Bq/gm of the sample. This is an ideal choice in quality assurance departments of all steel. / iron / alloy/Foundry casting industries (medium & large). This facilitates loading of sample up to 2 to 3 kg on to the detector area, for measurement.

9Q) What is the 'unit' of measurement that is normally used in these above systems?

A) Normally the units used in these meters globally are Sv(sivert). In India we have been using R (Roentgen). But Nucleonix Systems has been providing both these units Sv & R. Additionally meters may have CPS(), CPM() modes. All Nucleonix meters have FOUR modes of operation nSv/hr, μ R/hr, CPS, CPM.

In the Rad Check Meters you may find μ R/hr (micro roentgen / hour) & nSv/hr (nono sivert / hour)

μ = micro = 10^{-6}

n = nano = 10^{-9}

m = milli = 10^{-3}

10Q) How do you define Sv & R ?

A) The SI unit of dose equivalent

1 Sv = 1 J /kg (one 'Joul' of energy deposited 1 kg of air)

Roentgen (R) : Is defined as the exposure that results in the generation of 1 electro static unit of charge ($2.0 \text{ g} \times 10^9$ ion pairs) per 1 cm^3 of air STP (0.001293 gms)

$1 = 2.58 \times 10^{-4} \text{ C/Kg}$.

Gray : Absorbed dose is a measure of energy deposition in any medium by all types of ionizing radiation and $1 \text{ GY} = 1 \text{ J/Kg}$

Since an exposure of 1 R results in an energy deposition of $869 \times 10^{-5} \text{ J/Kg}$ in air it follows that

$1 \text{ R} = 869 \times 10^{-5} \text{ Gy}$

$1 \text{ R} = 8.69 \text{ m Gy}$

$1 \text{ R} = 10 \text{ m Gy}$

$1 \text{ R} = 10 \text{ mSv}$

$1 \text{ Sv} = 1 \text{ R}/10 \text{ m}$

$1 \text{ Sv} = 100 \text{ R}$

11Q) Can we have some conversions between Sv & R ?

- A) 1 Sv/hr = 100R/hr
1mSv = 100mR/hr
1 μ Sv = 100 μ R/hr
10nSv = 1 μ R/hr
10 μ Sv/hr = 1000 μ R/hr
 = 100 mR/hr
0.1 μ Sv/hr = 10 μ R/hr

12Q) What is Becquerel (Bq) ?

- A) SI unit of activity. It is define as no. of radioactive transformations or isomeric transitions per second = 1 Bq. It defines the source 'activity' or 'strength'

13Q) What are the clearance levels radioactive contamination in European countries, UK & USA?

- A) European country currently recommends a clearance level of 0.5 Bq /g for Beta & gamma emitters, while Germany recommends a lower level of 0.1 Bq/g, the United Kingdom 0.4 Bq/gm & Japan 0.5Bq/g.

14Q) What is Natural background radiation?

- A) In the nature exists background radiation, due to geo-structure, terrain, rocks, cosmic radiation flooring, tiles , walls etc. also contribute to background radiation levels. Natural background varies from place to place and could be in the range of (3-4) μ R/h to (30-40) μ R/h. (0.03 μ Sv/h to 0.4 μ Sv/h). At a single location also, natural background varies and this is called statistical variation. For practical purposes, we take the **highest observed reading** in a location as natural background.
Rad check meter is an instrument which measures radiation dose rates from natural background radiation levels onwards. Its sensitivity is typically 1 μ R/hr or 0.01 μ Sv /hr.

15Q) Is natural background level different at different places?

- A) Yes, it is different in different cities & places, for e.g. in Hyderabad it is more, it is approx 30 μ R /hr. In Mumbai it is approx (6 to 8) Micro-R/hr. (About FIVE times less than that in Hyderabad).

16Q) Whether contamination reading as shown in the display will be same in different places?

- A) No, unless the background level is same at two different places where you would have made measurement, meter reading will be different for the same contamination levels. This is because the background at these two places may be different.
Please note that **natural background levels get added up to the meter reading along with reading due to sample contamination, i.e,**
Meter reading = Sample contamination + Natural Background
However if you account for reading due to background, then it will be same.

17Q) What is check source & why is it required ?

- A) Check source is a small (low level) Radioactive Gamma Source (Cs137). This is basically required to check whether your **Rad Check Meter** RC705 is responding to radiation.
To check your Rad Check Meter, place the radioactive source close to the front face of the meter & observe the meter reading to go up. When you take the source away, the reading drops.
This **check source** also could be used for carrying out QA of the product by verifying the stability of the reading with source over the one year period when calibration is valid. Incase

there is a drift of more than 10% with respect to the initial reading when procured from factory, contact factory as there could be some problem with the instrument.

18Q) Does this “Rad Check Meter” indicate nuclide type and absolute level of contamination?

A) No, this meter primarily indicates (gross) or total contamination in relative terms. The reading also varies with distance from the sample.

If your interest is to know absolute nuclide which got contaminated (such as Co-60, Cs-137, Am-241 etc.) and its contamination level in terms of Bq/gm, then you need to go in for our **“Nal Scintillation detector based gamma ray spectroscopy system with multi-channel analyzer”**. This is a foolproof test and recommended for steel industry having smelting/induction furnaces.

19Q) Is there any Equipment offered by Nucleonix Systems to know the exact nuclide which has contaminated? Whether the equipment can quantify the contamination level in Bq/gm or Bq/Kg?

A) Yes, we have a system already in our manufacturing range, which is being used now by many customers in DAE & universities for Research purpose.
This system is called **“Nal Scintillation Detector based gamma ray spectroscopy system with multi channel analyzer”**

This system records gamma ray spectra of different isotopes present in the sample under test & spectra can be analysed to know the type of nuclide & also its contamination level in terms of Bq/gm or Bq/kg. This system will cost about Rs. 5.0/6.0 lakhs, depending on the system configuration.

20Q) Which unit of measurement is recommended for measurement in Rad Check Meter?

A) Since ‘Seivert’ is used in EU & UK it is better to measure in nSv/hr using Rad Check meter. Of course one can also measure in μ R/hr, but has to use conversion factor for interpretation in μ Sv/hr or nSv/hr if required.

21Q) Can we have conversion from μ R/hr’ or μ Sv/hr’ or nSv/hr to Bq, as Radchk Meter does not measure in Bq?

A) It i Conversion from μ R/hr’ or μ Sv/hr’ or nSv/hr to Bq for a contaminated steel sample it is difficult to give a conversion factor right away for the following reasons.
One is size, shape, mass of sample & sample orientation distance from the detector probe face etc influence while making measurement & hence one cannot give exactly any conversion.

It is possible to give conversion for a **point source** (standard source) if we know the type of nuclide.

Also in respect of contaminated steel samples, we are not sure that contamination spread, is uniform (homogeneous) throughout the mass. Precisely what we measure is what is emanating from the contaminated sample which is measured & quantified. What is embedded deep inside, which may not be emanating because of energy loss when the gamma photons reaches the surface of the sample will not be detected. Since it is not emanating it is of no consequence.

However, it is possible to make a fair judgment & arrive at a conclusion to declare a component as

- (i) CLEAN
- (ii) CONTAMINATED Or
- (iii) SUSPECTED ONTAMINATION/LEVEL CONTAMINATION CASE

Please go through our website www.nucleonix.com & read the content under **“case studies report – 1 ”**. This will clearly give an idea on declaring a product into three categories as said above.

By going through our case studies report-1 & by making proper measurements & analysis one can **perhaps say that contamination is less than 0.1Bq/g**. But for exact quantification one has to go through analysis by Gamma Ray Spectroscopy System with MCA (GRS with MCA)

method only. Using Rad Check Meter you can definitely classify the the product and say whether it is

- (i) CLEAN
- (ii) CONTAMINATED Or
- (iii) SUSPECTED CONTAMINATION CASE

Also if your industry is a steel mill/Foundry having induction / smelting furnaces, it is absolutely necessary to go in for **Gamma Ray Spectroscopy System with MCA for sample analysis** to obtain contamination in Bq/g & also to identify type of nuclide that has contaminated.

22Q) Is Radchk meter a Radiation calibrated meter? What calibration standard Nucleonix Systems has at their works/factory? Up to what accuracy it reads.

A) Nucleonix Systems has two calibration labs.

- (i) Low Level Calibration Lab :
- (ii) High Dose Rate Calibration Lab

Rad Check meters are calibrated at low level calibration lab using a **Gamma survey instrument calibrator** make Amersham , UK/USA. It has NIST (National Institute of standards & technology, USA) traceability.

Rad check meter is calibrated upto 15% accuracy for readings above 100 µR/hr.

23Q) Whether this Rad Check meter measure natural background radiation accurately at any Place?

No, this gives a background reading slightly lower than the actual natural BG. This reading we can call it as the base value. Rad check meter is designed to be more sensitive on the front face of the detector so that it can detect Radioactive Contamination (RaC) from a longer distance compared to an ordinary Micro-R-Survey meter. It is for this reason the meter will show less reading of natural BG.

24Q) When do we say that the product under inspection is contaminated?

A) If you are making measurement with Rad Check Meter & if the reading (when you touch the component closely with meter) goes even slightly higher than the background then one can declare that component as contaminated.

Even, if the reading remains equal to BG or goes marginally lower than BG, then also it is a case of **suspected contamination**. Under this condition checkup more thoroughly & it could be a case of low level contamination.

Best way is to take more mass or material & touch the meter close to the mass & if the reading increases than the previous one then it is a contamination case.

25Q) If it is suspected contamination case (sc) what to do? How to analyze further to ascertain on the status of contamination?

A) In a suspected contamination case it is essential to make a through check. Take large amount / mass of sample and if the meter reading goes up with increased mass. Then, it is definitely a contamination case. Also you can send the samples (2 to 3 kg) to Nucleonix systems for further analysis using Gamma Ray Spectroscopy System with MCA, which is a 100% foolproof method of identifying RaC.

26Q) When do we say & can declare a product to be clean from RaC? (using Rad Check Meter)

A) First record the background (BG) & then go to acquire mode & record BG. Now touch the meter to the surface of the component under inspection if the reading shown goes 10 to 20% lower than the BG reading, then the sample can be declared as clean.

(If the reading is very close to BG & marginally less or equal to BG it is a suspected contamination case).

27Q) Is fixing preset alarm level advised or not for RaC inspection? Or one should look at the readings carefully & interpret?

A) Please do not fix any preset alarm level for RaC inspection. Best way is to touch the meter to the component & observe the reading (dose rate) to check how closely it is to BG or away from BG or lower than BG. Based on this reading only one should interpret.

Fixing preset alarm level above BG & checking or interpreting for RaC can be misleading & one can miss definitely low level contamination cases. Hence never do this for RaC inspection.

28Q) What is the difference between suspected contamination case (scc) & sure contamination case?

A) Suspected contamination case is a situation, when the Rad Check Meter reading is very marginally lower or same as the BG. This happens if the contamination levels are very low of the order of 0.1 to 0.4 Bq/g.

Under this condition take larger mass of 3/4 kg or much more & touch the meter if the reading goes higher then it a **sure contaminated case**. Also initially itself when you touch the component / part if the reading goes higher than BG, even slightly more, then it is a sure contamination case. Reading need not be 2 times or 1.5 time BG. It can be slightly higher than BG. If you are not sure & think that the sample needs thorough investigation, then send it to Nucleonix for detailed analysis.

29Q) What should be the minimum mass & size of the sample to check for RaC using Rad Check Meter?

A) It is advised for one to take a sample of mass of sample, atleast of three Kg (approx) or more but not less. Also the size & shape of the component should be large enough to cover the complete front face of the detector probe / meter, so that detector face is covered by the sample when touched. Higher the mass, results of inspection will be more authentic.

If your product is small in size & less in wt, then put a few of these components together such that mass & front face of the meter covering criteria, is met. This is important.

30Q) What should be technical qualifications of the person operating the instrument?

A) The person should have a basic science graduate or a diploma engineer with an understanding of radiation. He/she should be very responsible and meticulous in taking the measurements.

31Q) What is Calibration Factor:

A) This is set at factory by Nucleonix when the equipment is calibrated in **Radiation calibration lab**. It may be from (0.75 to 1.5) depending upon the sensitivity of the detector. It is not same for all meters. It can be different for different meters of same type. Customer should not change this calibration factor, which is password protected. If changed will give wrong results and data.

- 32Q) How many background readings are to be noted and averaged to take as an authentic background reading.**
- A) Typically 3 to 5 Background readings, averaging should be alright.
- 33Q) Whether Non-Ferrous Metals, such as copper, aluminum, zinc, brass & non-metals such as plastics, wood etc also can get Radioactive Contamination?**
- A) Normally not. Not heard of.
- 34Q) can only packaging materials such as packing nail, strap (MS) etc. get contaminated and not the actual product under export?**
- A) Yes, there are such cases which have happened and hence, even these packing nails / straps are also to be checked for radioactive contamination.
- 35Q) We manufacture SS, billets rounds, square bars which are longer. Our question is at how many locations we should make measurements with Rad check meter ? If it is contaminated, will it be uniform throughout the length?**
- A) Measurement at 2/3 locations in full length may be enough. If it is contaminated, largely it will be distributed homogenously. Of course a non-uniform distribution of RaC is not ruled out. Your measurement readings at two/three locations will give you an idea on this.
- 36Q) Our Industry manufacturers small sized components such as fasteners, SS rings, door hinges, latches etc., Question is if the components are small in size do we have to check each component ?If we check each component separately whether results are meaningful?**
- A) If the components are small in size, then you can group them to make about 3 kg, put them in a plastic pouch & cover complete front face of the detector. This will satisfy the **mass & size criteria**. Measurements are to be carried out in this fashion only. If you check each component separately results will not be meaningful as **mass & size criteria** is not met.
- 37Q) Can Garments such as Jackets having iron rings, and fancy buttons of iron / SS get contaminated**
- A) Yes, It is possible and hence exporter of these goods with iron rings and fancy buttons of ferrous and SS materials have to check for radioactive contamination.
- 38Q) Can one avoid making measurements at product processing level or check only final packed wooden crate containing finished products in packed condition?**
- A) It is quite risky & since you will not be touching the components very closely, as wooden crate will prevent you meter touching the components, there is a possibility of low level contamination being not detected. This can be damaging to you. Hence we recommend inspection at different stages of production cycle as detailed in our introductory letter.
- 39Q) If you suspect radioactive contamination in your products, (final or raw materials) what is to be done by you?**
- A) After, ascertaining that there is a strong case of Radioactive Contamination by measuring with any of the FOUR suggested products, you can approach AERB for further help & guidance, who will advise, actually after they inspect, your premises, on what to do & how to dispose contaminated material. Please contact Head, Radiological Safety Division, AERB, (Address given below)

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