Setting the Standard for Automation™

Fertilizer Symposium, 2017

Radar – 140 GHz and Nucleonic Level Switch/ Transmitters

- Dr. Abhishek Goyal
- Mr. Rajat Goyal

Standards
Certification
Education & Training
Publishing
Conferences & Exhibits

The International Society of Automation Delhi Section

Brief Introduction of EIP

Started in 1983 : First indigenous manufacturer of RF Level Switch

3 Decades of Solid/ Liquid Level and Inventory Measurement Solutions

Key Features of Operations

- Most Advanced Technology
- Highly Customer Oriented
- Prompt Services

Industries : Power, Cement, Steel, Fertilizer, Food, Paint and others

Diversification

Topics

- 94 GHz/ 140 GHz Radar Level Transmitter – World's Highest Frequency Radar
- Nucleonic Level and Density Meter without Atomic Energy Board Restrictions

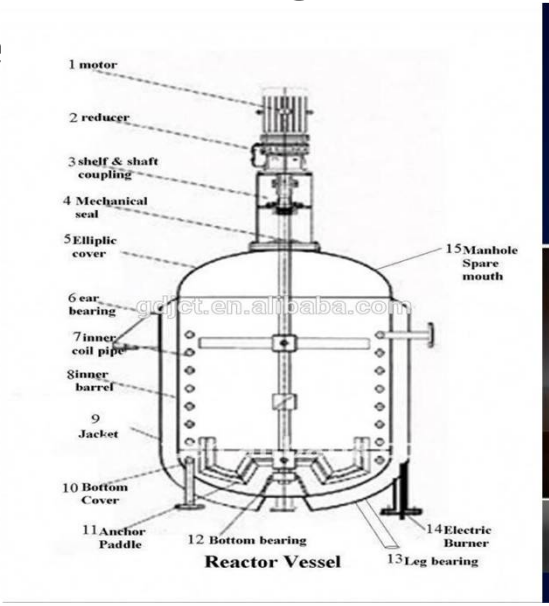
CASE STUDY
INTRODUCTION TO THE 140 GHz AS A SOLUTION

Urea Bagging Hopper Level Measurement

- Process Problems
  - Dusty
  - Very Fast Filling (in 1 or 2 minutes)
  - Small Bin

PBR Reactor Level Measurement

- Process Problems
  - very low die-electric
  - agitator at the bottom (surface is very turbulent)
  - length of the nozzle is 600mm and the diameter is only 75mm.
  - The pressure 15 bar
  - The temperature is around 200 Degree C
  - ball valve in the nozzle



PTA Level Measurement

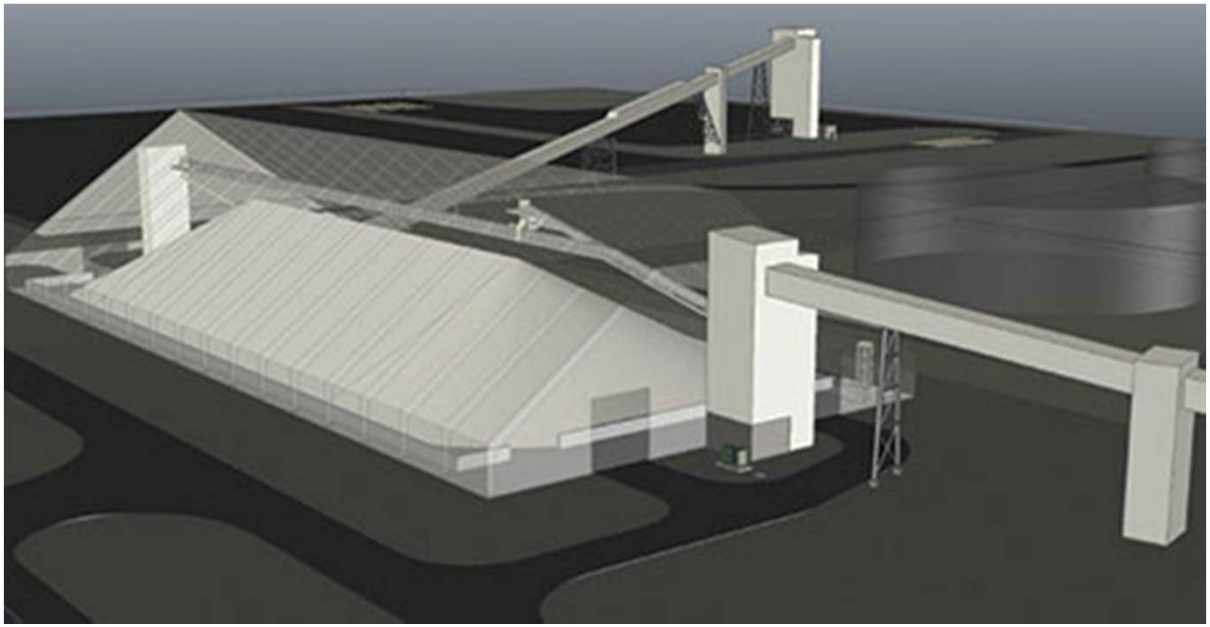
- Process Problems
  - The long nozzle (1170mm) with small opening (150mm)
  - Very Low Di-electric constant of PTA Powder
  - Heavy dust inside the silo
  - Fumes in the silo
  - Correct level identification during the fluidizing process when nitrogen is passed into the silo.

Acid Level Measurement

- Process Problems
  - Acid up to 98%
  - Fumes
  - High Temperature
  - Unfavorable installation Location

Product Silo Inventory Measurement

- Process Problems
  - Large Area
  - Dust

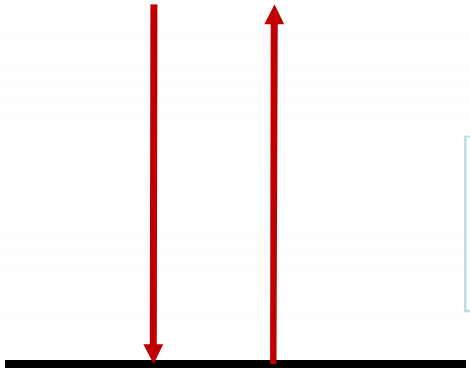


Level / Inventory Transmitters Bulk Solids and Powders

Principle
Continuous Solid Level Measuring
(for Non Contact Instruments)

- TOF (Time of Flight) Pulse
- FMCW

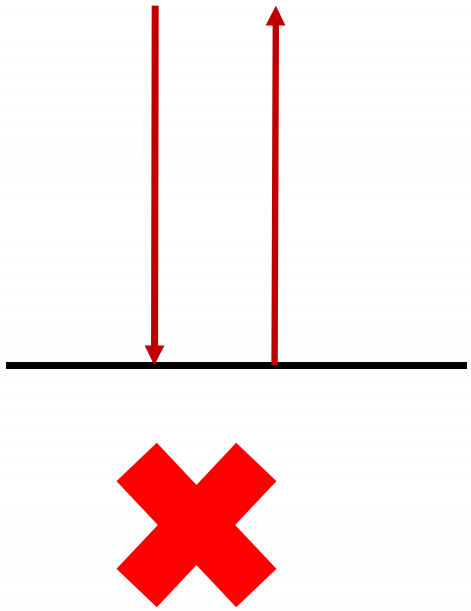
Explaining Time of Flight

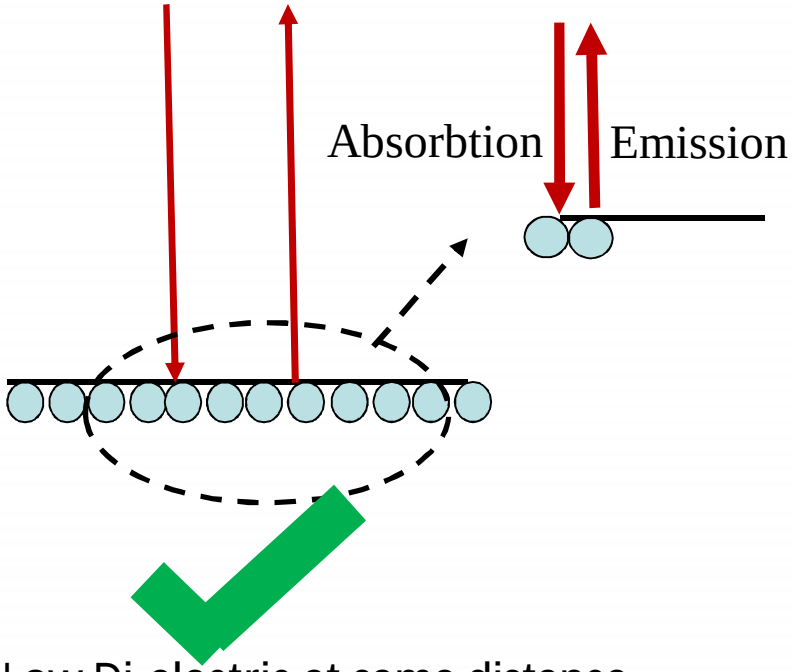


Distance (D1) = (Time/2) * (Speed)

Die-electric and its importance

- Electromagnetic waves are effected
- D2 = D1 (however, appears D2>D1)



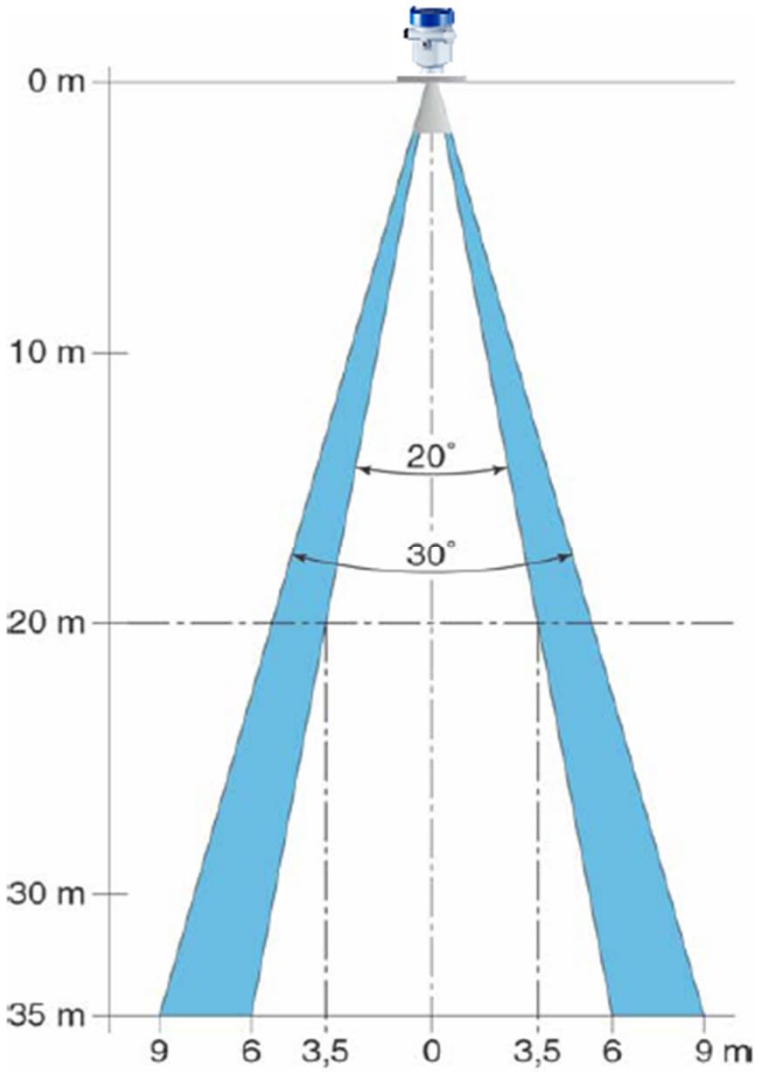


Distance (D1) = (Time/2) * (Speed)

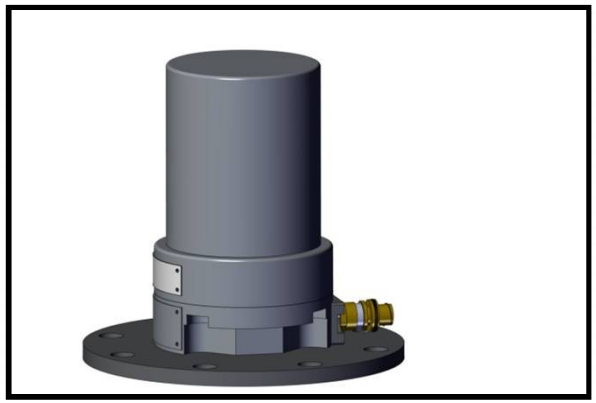
If Low Di-electric at same distance,
Absorption and Emission takes time
Distance (D2) = {(Time + x)/2} * (Speed)

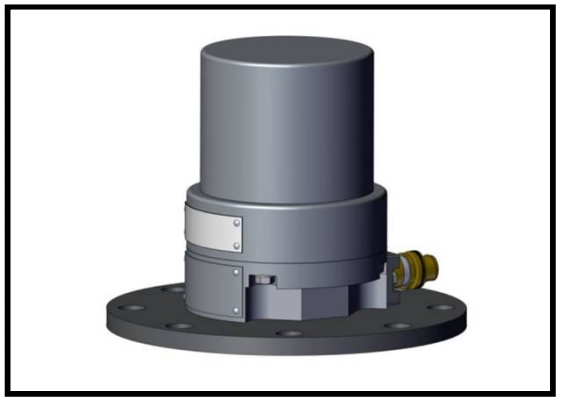
Solve Di-electric problem – Low Beam

1. Di-electric importance
2. Principle of operation of a Radar
3. Beam Angle – 2 Degree



94 GHz/ 140 GHz Radar





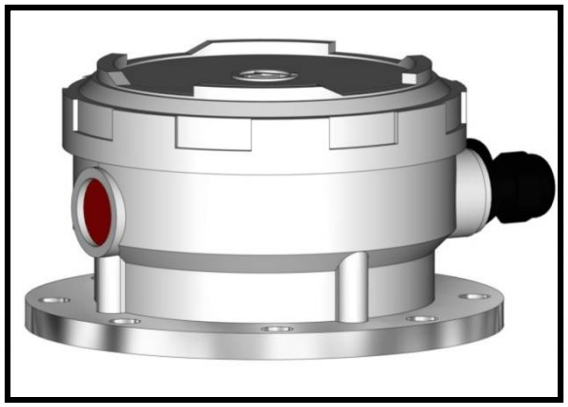
Operating frequency – **94/ 140 GHz**

Beam width – **1°-4°**

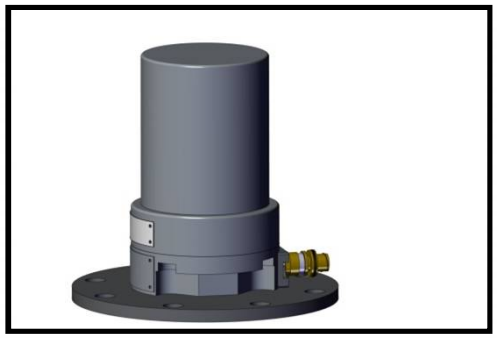
Extremely high sensitivity – **0.05mm**.

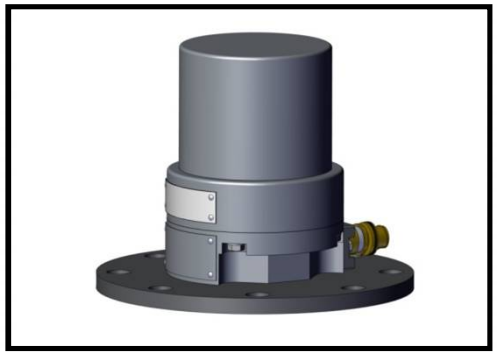
Accuracy – **±1mm**

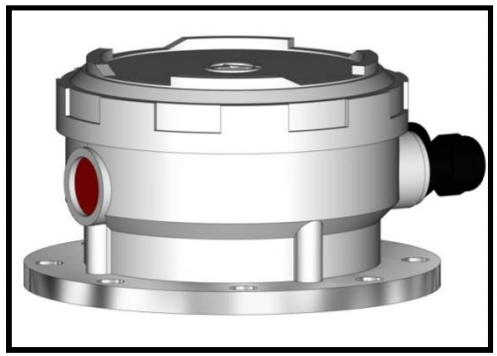
140 GHz with Beam Angle of less than 1° to 2°



94/ 140 GHz Non Contact Radar







Main specifications:

1.Operating frequency – **94/ 140 GHz**.

2.Beam width – **1°-4°**.

3.Extremely high sensitivity – **0.05mm**.

4.Accuracy – **±1mm**.

5.Working for Temperature

6.Explosion-proof embodiment – 1ExdIIBT6.

7.Protected horn-lens antenna.

8.Highly reliable measurements.

9.Integrated antenna heating.

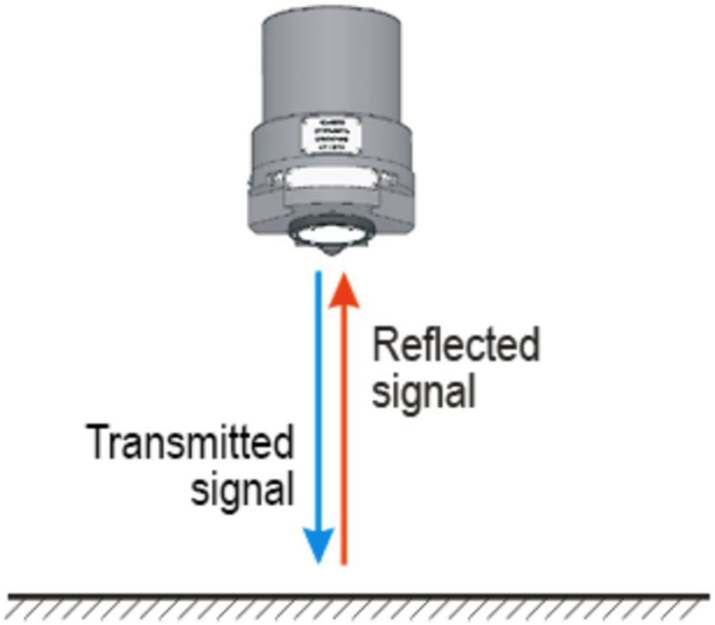
10.Standard interfaces (4-20mA, RS485-ModbusRTU).

Launched

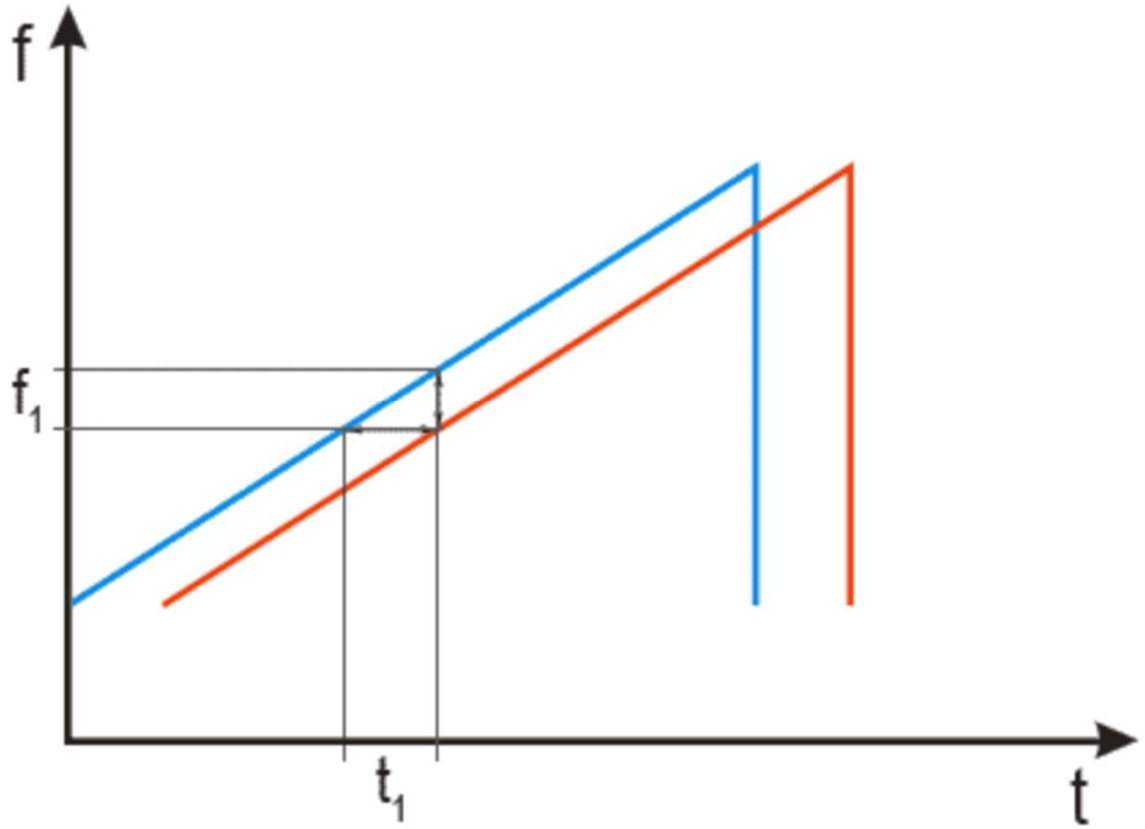
Level transmitter with the world's highest frequency!

140 GHz with Beam Angle of less than 2°

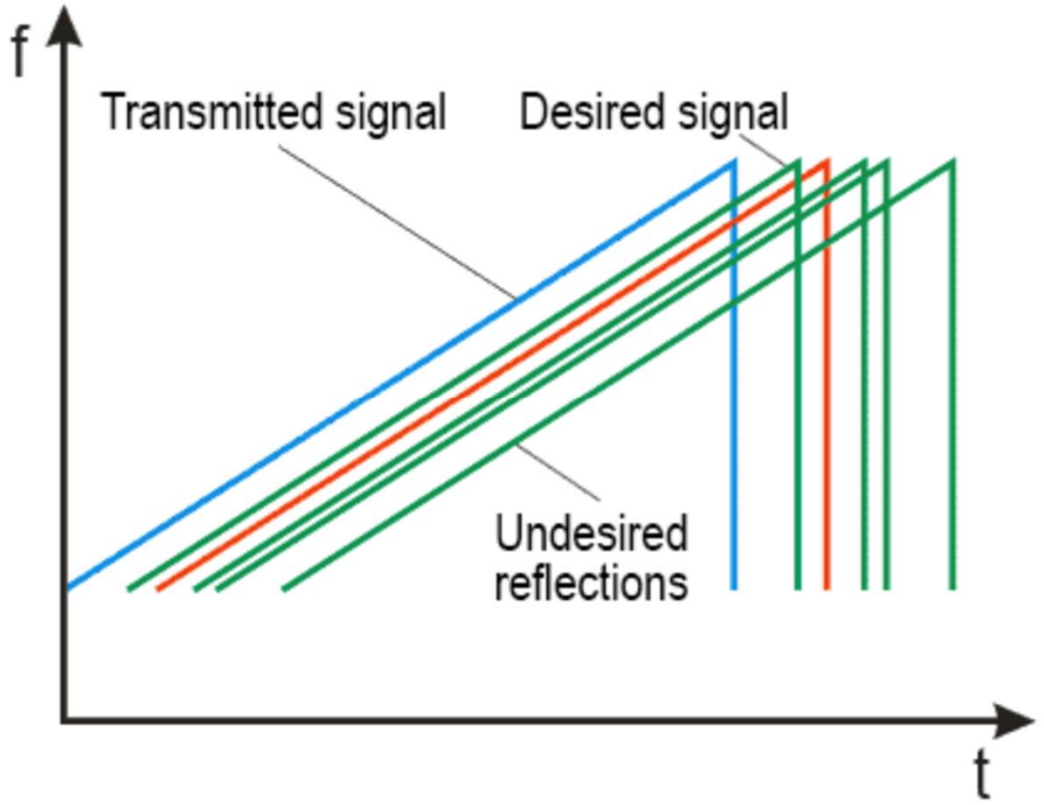
Principle of Operation - FMCW



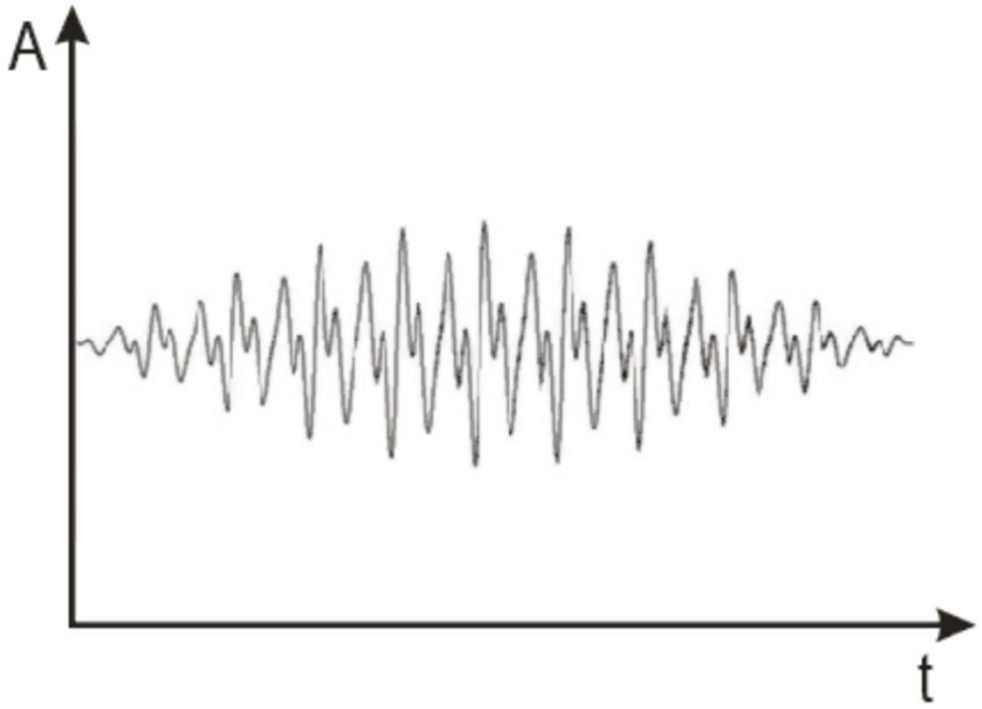
Principle of Operation - FMCW



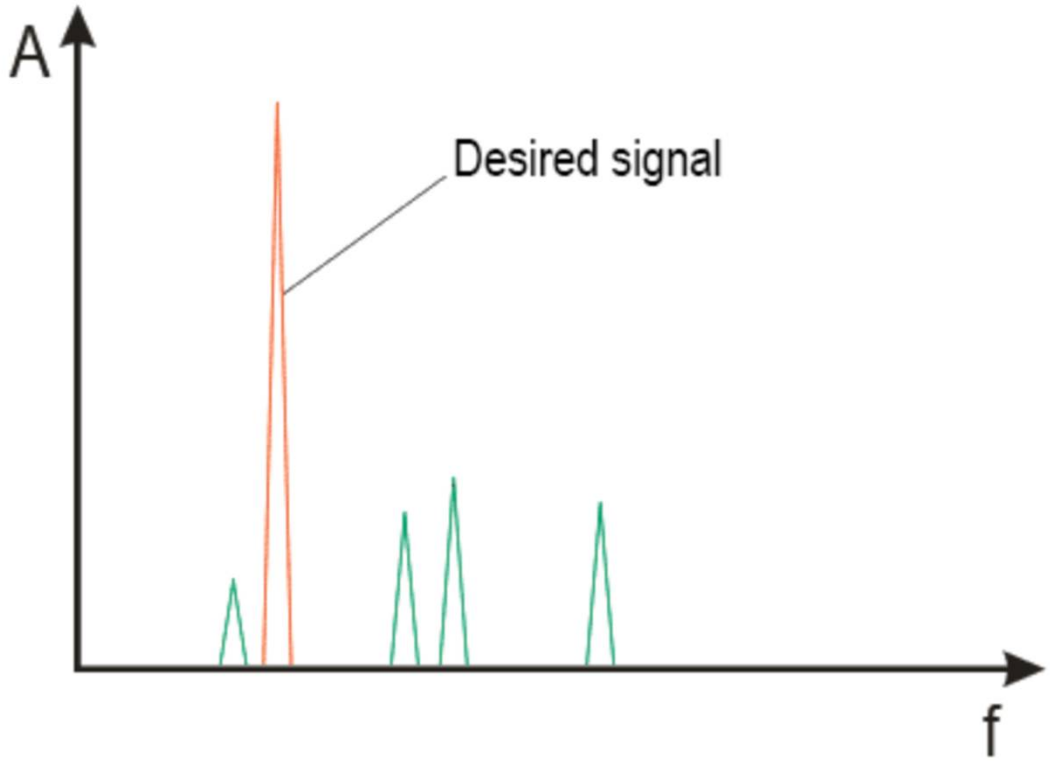
Principle of Operation - FMCW



Principle of Operation - FMCW



Principle of Operation - FMCW

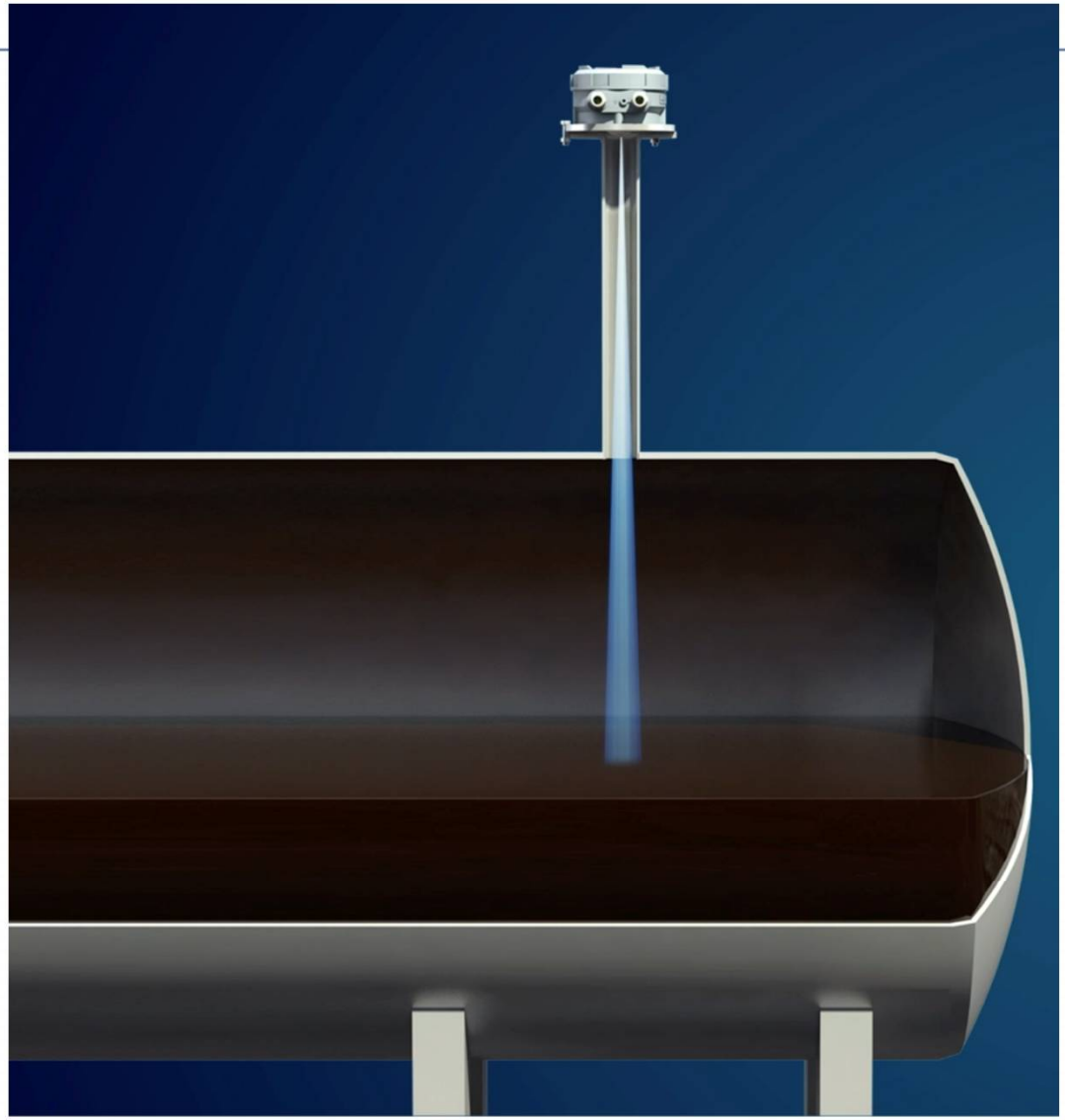


Some Advantages

- **FMCW Principle using the Adaptive Fast Fourier Theorem**
- **Beam angle of 2 Degree**
- **Accurate measurement (+/-1mm)**
- **Enhancement in precision, repeatability and sensitivity (0.05mm).**
- **Works is Very Low Die-electric Constant** of material
- **Does not require any air connection/ purge for cleaning.**
- **Instrument has a 2 Axis Inclination sensor to know the Angle of Mounting and detect any angular constraint**
- **Can pass through a 50mm Thick Ceramic / 80 mm Thick Teflon to provide accurate level measurement.**
- **Works for temperature up to 1600 Degree C and any Pressure**

Why select a 94/ 140 GHz

- Fast filling and empty process
    - 94 GHz FMCW Principle helps in instantaneous result without error
- High Temperature/ Pressure
    - Increased temperature leads to low reflectivity of the medium
- Compact Installation
    - The standard ULM 31A1 Radar sizes around 150 x 100mm
- Maintenance
    - The ULM Radar Level Transmitters require no Air for cleaning and work in the worst possible environment
- Turbulent Liquids
- Processes with Agitator
- Low Di-Electric



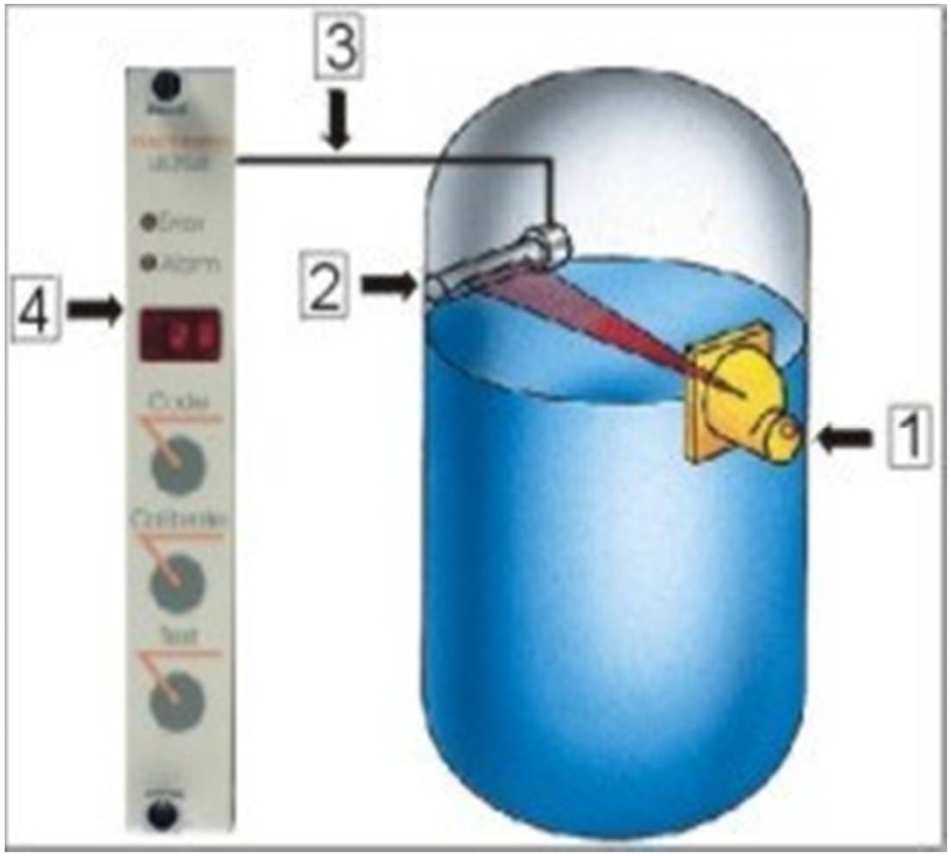
NUCLEONIC DENSITY MEASUREMENT

EXEMPTED FROM AERB REGULATIONS

Principle : Nucleonic Density and Level Measurement

- Degree of Attenuation of Gamma Rays when flowing through a media
- Advantage : absolute independence from the tank and media parameters.
- Measure density or level in extremely tough operating conditions.
- **Radioisotope Nucleonic method : Only true non-destructive method of level or density measurement in the industry.**

Principle : Nucleonic Density and Level Measurement



1. The source holder with radioactive source
2. Radiation detector - is located outside the tank on the opposite side to the source
3. Electrical signal is transmitted to the processing unit by the cables
4. The processing unit module of prosessing data with communication module with ACS and light indication

VIDEO

BIG QUESTION

Video just demonstrated how advanced the Nuclear Technology is for Density and Level Measurement

Why is it not used UNIVERSALLY everywhere ?

Apprehensions for using Nucleonic Tech.

- **COMMERCIAL STANDPOINT**
  - Strict Atomic Energy Board Regulations
  - Approvals/ Certification required for each and every device imported to India
  - Every Quarterly report to Atomic Energy Board (Renewal at times)
  - Minimum 2 Trained Radiation Scientific Officers in the plant
  - **REASON FOR ABOVE :**
    - Most Conventional devices use Cs-137 and Co-60 as the Gamma source
    - Radioactivity used (around 1.5 GBq) in the devices of the above isotopes is more than the recommended/ exempted limited (100 KBq for Cs-137 and Co-60 source)

Apprehensions for using Nucleonic Tech.

- **HEALTH/ SAFETY STANDPOINT**
  - Radio-isotopes are harmful for the human body
  - Exposure may lead to many health defects starting from head to toe and may also cause infertility
  - Disposal is a problem and source needs to returned to manufacturer
  - **REASON FOR ABOVE :**
    - Most Conventional devices use Cs-137 and Co-60 as the Gamma source
    - Cs-137 and Co-60 are harmful isotopes (By product of Uranium and Thorium)

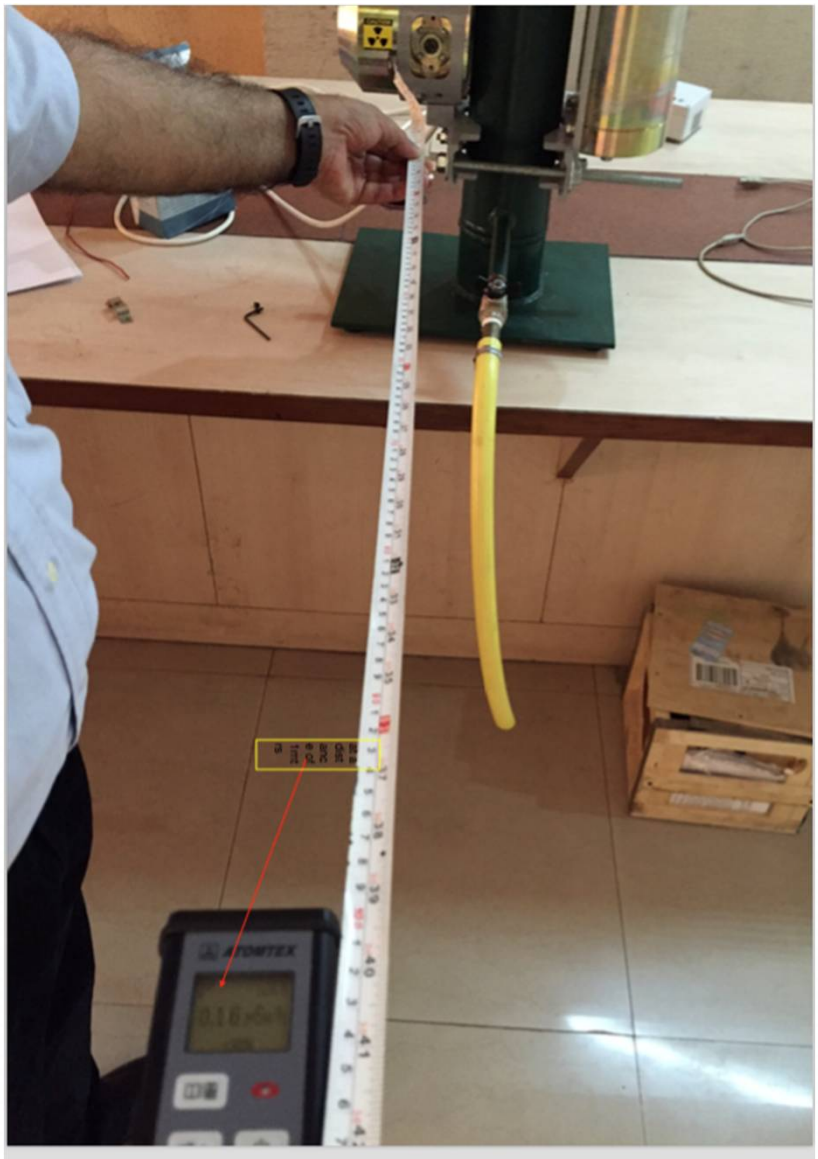
EPT Nucleonic Density and Level Measurement

- **Solves the Problems/ Apprehensions of Conventional Devices**
  - Uses Na-22 as the Gamma Source
  - Radioactivity is 350-950KBq which is around 0.027mCi (Less than the maximum Exempted by AERB that is 1000 KBq for Na-22 Source)
  - No AERB restrictions
  - **Free Import** and **Usage** of the device without any approvals/ certifications
  - Radiation Exposure at 1 meter distance from the device is less than 0.5 microSv/ hr (Yearly exposure is less than 4.5 milliSv)
    - Current exposure in presentation is around 0.2 microSv/hr (Background)
    - Maximum permissible for safety is 200 microSv/ hr
    - 1 CT Scan exposes to 10 milliSv of dose
    - To-Fro flight from Delhi-Kolkata exposes to 240 microSv dose
    - Coal Stockyard exposes to more radiation than this due to Thorium

EPT Nucleonic Density and Level Measurement

- **CONCLUSION**
  - **Advantages from the Commercial Standpoint**
    - No Atomic Energy Board Regulations
    - No End User needs Approvals/ Certification for using the Device
    - No Approvals/ Certification required for each and every device imported to India
    - No Reporting or Renwals
    - No requirement of Radiation Scientific Officers in the plant
  - **Safe from the Health and Hazard Standpoint**
    - Completely safe
    - No disposal concerns

Nuclear Exposure Safety Limity



Nuclear Exposure Safety Limit

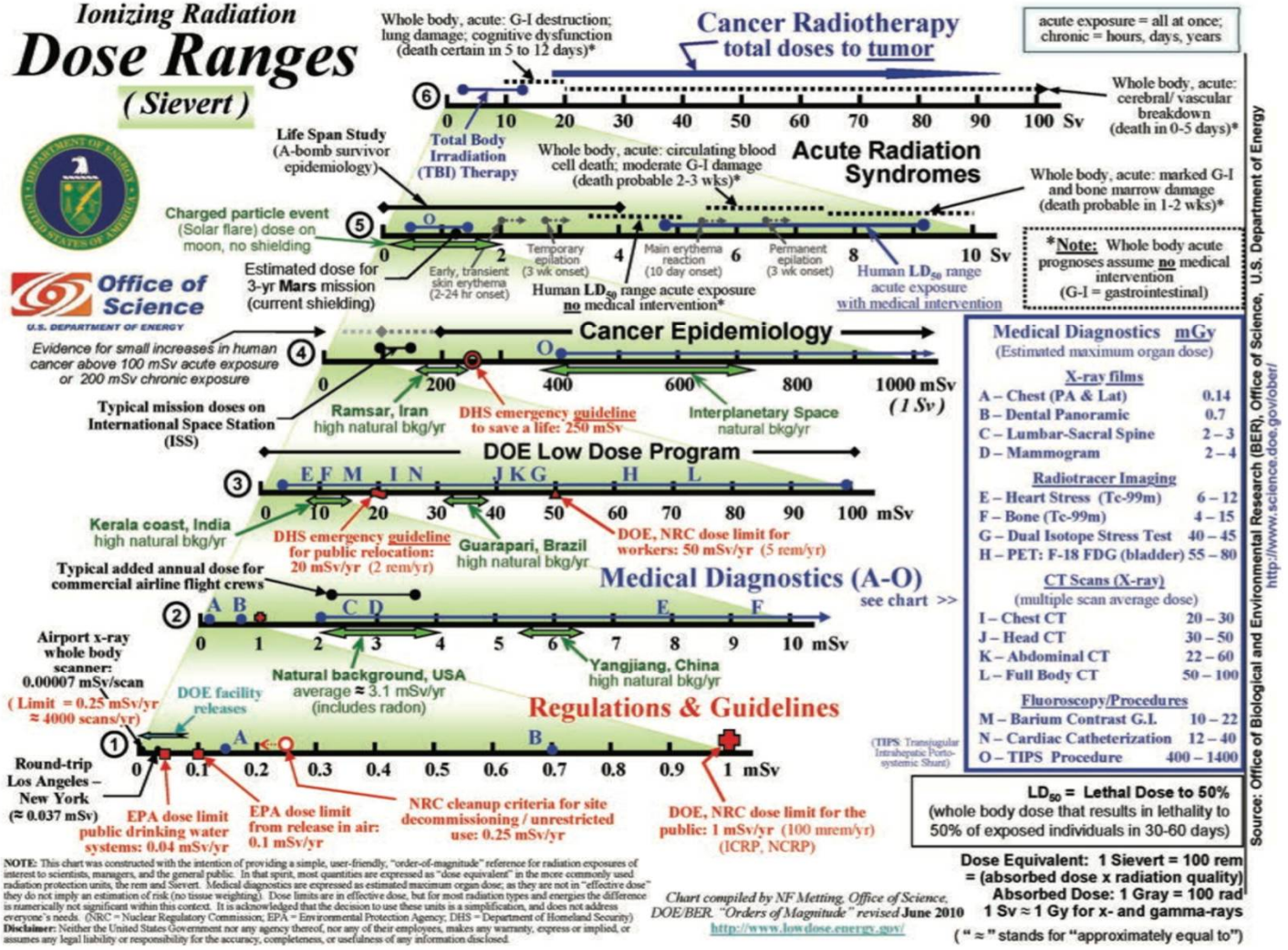


FIGURE 17.4 This chart compiled by Dr. Noelle Metting, Office of Science of the U.S. Department of Energy, puts into perspective the different dose ranges relevant to radiation therapy, diagnostic radiology, and background radiation.

Nuclear Exposure Safety Limity

TABLE 17.5 Summary of Recommended Dose Limits

	NCRP	ICRP (If Different)
Occupational Exposure:		
Stochastic effects: effective dose limits		
Cumulative	10 mSv × age	20 mSv/y averaged over 5 years
Annual	50 mSv/y	50 mSv/y
Deterministic effects: dose equivalent limits for tissues and organs (annual):		
Lens of eye	150 mSv/y	150 mSv/y
Skin, hands, and feet	500 mSv/y	500 mSv/y
Embryo/Fetus Exposure:		
Effective dose limit after pregnancy declared	0.5 mSv/month	Total of 1 mSv to abdomen surface
Public Exposure (annual):		
Effective dose limit, continuous or frequent exposure	1 mSv/y	No distinction between frequent and infrequent—1 mSv/y
Effective dose limit, infrequent exposure	5 mSv/y	
Dose equivalent limits; lens of the eye	15 mSv/y	15 mSv/y
Skin and extremities	50 mSv/y	50 mSv/y
Education and Training Exposure (annual):		
Effective dose limit	1 mSv/y	No statement
Dose equivalent limit for lens of eye	15 mSv/y	No statement
Skin and extremities	50 mSv/y	No statement
Negligible Individual Dose (annual):	0.01 mSv/y	No statement

Based on National Council on Radiation Protection and Measurements: *Recommendations on Limits for Exposure to Ionizing Radiation.* NCRP Report No. 116. Bethesda, MD; 1993; and International Commission on Radiation Protection: *Recommendations of the ICRP.* ICRP Publication 103. New York, NY: Pergamon Press; 2007.

Queries Still Pending

- Why is the device being discussed by only one company. What is the patent/ algorithm :
  - **HIGH RESOLUTION DETECTOR : Works with even smallest of radioactivity**

- Then **Why only Na-22** as a source and no other isotope
  - **Na is a natural element in the body and excreted** through urine, perspiration and sweating
  - Hence, Na-22 is excreted fully from the body and never stays inside to cause any damage

AERB Safety Directive
Exclusion, Exemption and Clearance of Radionuclides in Solid Materials

AERB Directive No. 01/2010
[Under Rule 3, 5 and 6 of the Atomic Energy (Radiation Protection) Rules 2004]
Ref.No. No.CH/AERB/OPSD/25125/2010 dated November 26, 2010
Subject: Exclusion, Exemption and Clearance of Radionuclides in Solid Materials

Radioactive practices in India are governed by the Atomic Energy (Radiation Protection) Rules 2004. As per sections 5 and 6 of the rules and the current IAEA strategy, some of the radioactive practices and sources within practices need not be subjected to regulatory control based on the principle of exclusion, exemption and clearance.

The terms exclusion, exemption and clearance are defined as;

a. Exclusion means the deliberate exclusion of a particular category of exposure from the scope of an instrument of regulatory control on the grounds that it is not considered amenable to control through the regulatory instrument in question.
b. Exemption is the determination by the regulatory body that a source or practice need not be subject to some or all aspects of regulatory control on the basis that the exposure (including potential exposure) due to the source or practice is too small to warrant the application of those aspects.
c. Clearance is the removal of radioactive materials or radioactive objects within authorized practices from any further regulatory control by the regulatory body.

The criteria for exclusion, exemption and clearance of radionuclides in solid materials within radioactive practices have been examined by AERB from the consideration of regulatory control. Accordingly, the following directives are hereby issued:

1. Solid materials containing unmodified concentrations of naturally occurring radionuclides in raw materials, except the radioactive materials / waste generated from operation of Uranium and Thorium mining and milling facilities, are excluded from the regulatory requirements. 40K in the human body and cosmic radiation on the surface of the earth also come under exclusion.
2. Exemption of artificial radionuclides in moderate amount of solid materials (upto one tonne) shall be based on the radionuclide levels prescribed in Table-1. For radionuclides of natural origin Table-1 applies if these radionuclides are incorporated into consumer products, or used either as a radioactive source (e.g. ^{226}Ra, ^{210}Po) or for their elemental properties (e.g. thorium, uranium).
3. Exemption / clearance of artificial radionuclides in bulk amount of solid materials shall be based on the radionuclide levels prescribed in Table-2.
4. Clearance of naturally occurring radionuclides in bulk amount of solid materials from any authorized practice shall be based on the radionuclide levels prescribed in Table-3.
5. For exemption / clearance of a mixture of radionuclides in solid materials, the sum of the ratios of the concentration of individual radionuclides present in the solid material to the levels prescribed for the corresponding radionuclide in the respective table shall be less than unity.
6. Exemption / clearance of radionuclides in solid materials in excess of the levels prescribed in the respective tables or those not prescribed shall be subject to the specific approval of AERB.

TABLE-1: EXEMPT CONCENTRATION AND ACTIVITIES FOR NATURAL AND ARTIFICAL RADIONUCLIDES IN MODERATE AMOUNTS (1 TONNE) OF MATERIAL

Radionuclide	Activity concentration (Bq/g)	Activity (Bq)
H-3	$1x10^{6}$	$1x10^{9}$
Be-7	$1x10^{3}$	$1x10^{7}$
C-14	$1x10^{4}$	$1x10^{7}$
Na-22	$1x10^{1}$	$1x10^{6}$
Na-24	$1x10^{1}$	$1x10^{5}$
P-32	$1x10^{3}$	$1x10^{5}$
S-35	$1x10^{5}$	$1x10^{8}$

Radionuclide	Activity concentration (Bq/g)	Activity (Bq)
Ru-106	$1x10^{2}$	$1x10^{5}$
Rh-105	$1x10^{2}$	$1x10^{7}$
Ag-110m	$1x10^{1}$	$1x10^{6}$
In-115m	$1x10^{2}$	$1x10^{6}$
Sb-122	$1x10^{2}$	$1x10^{4}$
Sb-124	$1x10^{1}$	$1x10^{6}$
Te-129	$1x10^{2}$	$1x10^{6}$

AERB Letter

दूरभाष / TELEPHONE : 91-22-2599 0100 / 0101
फैक्स / FAX : 91-22-2599 0650, 2558 3230
वेबसाइट / WEBSITE : www.aerb.gov.in

नियामक भवन / NIYAMAK BHAVAN,
अणुशक्तिनगर / ANUSHAKTINAGAR,
मुंबई / MUMBAI-400 094.

ISO 9001:2008

सत्यमेव जयते

भारत सरकार
GOVERNMENT OF INDIA
परमाणु ऊर्जा नियामक परिषद
ATOMIC ENERGY REGULATORY BOARD

RADIOLOGICAL SAFETY DIVISION

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Waste Management Section

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Fax. No. 25990650
dashsharma@aerb.gov.in

Ref: AERB/RSD/TRCPG/CP/Adv/2016/2833

August 22, 2016
23

Sub: No Objection Certificate for import of radioactive material

This has reference to your letter No. EIP/RG/AERB/16/505/ dated 20/08/2016, regarding the issuance of no objection certificate for the import of radioactive material as mentioned below:

Radioisotope	:	Na-22
Activity in each device	:	0.7 MBq
Make	:	EPT Ltd., Russia
Model	:	IPB-1K
Quantity	:	04 Nos.
Validity	:	One year from the date of issue of this letter

In exercise of powers conferred under section 16 of the Atomic Energy Act, 1962 read in conjunction with Rule 3 of the Atomic Energy (Radiation Protection) Rules, 2004, promulgated under the said Act, the Atomic Energy Regulatory Board (AERB) has no objection from radiological safety stand point to the import of the above-specified radioactive material by you. This NOC is subject to the following conditions:

Even though the end users of the aforementioned equipment are not required to obtain consent from AERB; however, M/s EIP Enviro Level Controls Pvt. Ltd., Noida-201 301, shall submit periodic reports, in the months of January and July every year, to AERB with the following:

(a) The number of units supplied and installed with contact details of the buyers.
(b) Servicing and maintenance details highlighting the major problems, if any.

22/8/16

(P.K. Dash Sharma)

Some Technical Parameters of the device

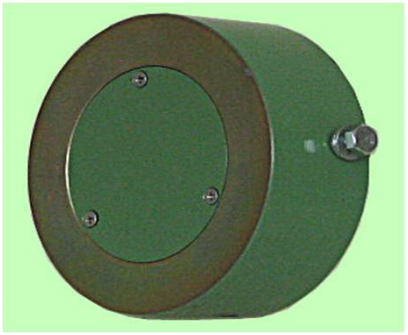
Range of measured density, kg/m3	From 300 to 2500
Outer pipe diameter, m	From 0,05 to 0,7
The limit of the absolute error, kg/m3	From 6 to 20
Standart current output	0-5 mA or 4-20 mA
Digital indication on a front panel of data processing block	
Power consumption, W	Not more than 10
Range of working temperatures, ºC	
- for a detection block	from – 40 up to + 70
-for a block of data handling	from 0 up to +50
Versions of detection blocks: •hermetically sealed •explosion proof (PB Exdl/IExdllCT6) •Mechanical protection - IP65	

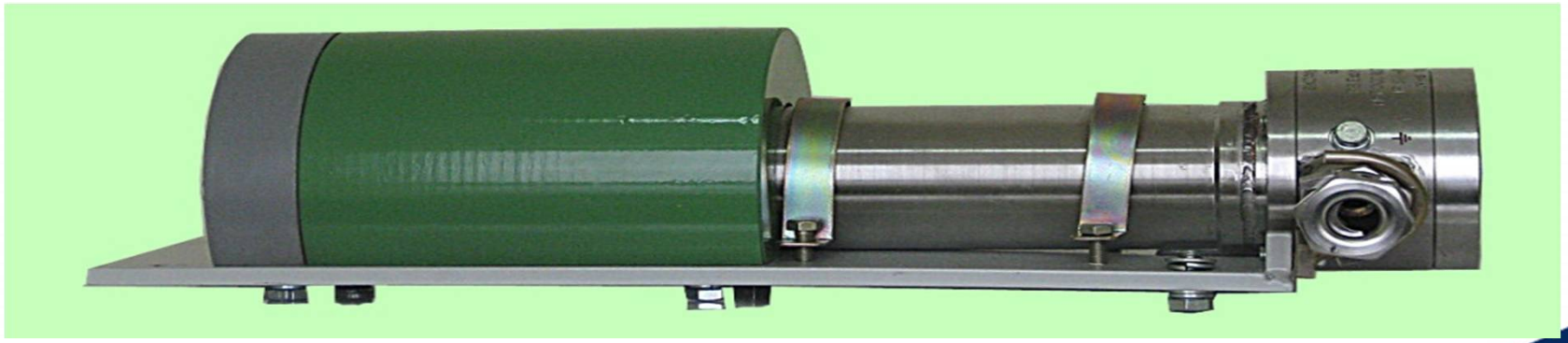
Applications

Radioisotope methods of control are generally essential in extremely tough operating environnent

1. toxic, aggressive and biologically hazard materials;
2. corrosive and abrasive substances;
3. molten and cryogenic materials;
4. radioactive substances with high or/and alternative activity;
5. foams, slurries and sludge;
6. powder and other high suspended solids;
7. pulp, ore and other dry bulk materials;
8. vessels without pressure restrictions;
9. vessels without temperature restrictions
10. In the conditions of buildup of the controlled media to the sides and constructions of the process tank
11. opacity, the presence of vapor or mist above the controlled level.

Instrument Images



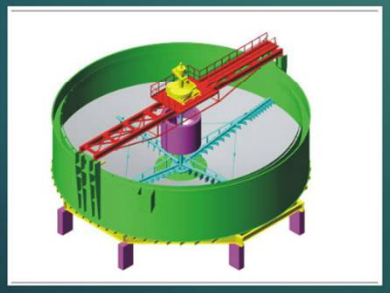


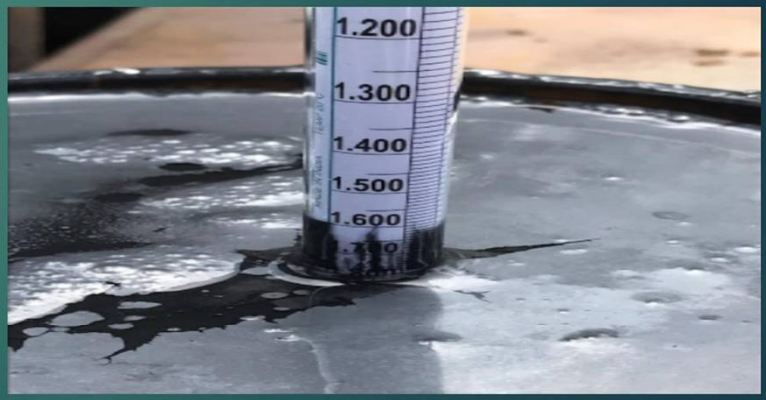
Installation Images

APPLICATION FOR PROCESS INDUSTRIES

PROBLEM:

Measurement of Lead(Pb) Slurry density in Pb-Zn Beneficiation Plant at pump discharge line of lead thickener for filter feed stock tank





SOLUTION:

EPT Nucleonic Density and Level Measurement with Na-22 Source

**RADIATION LEVEL-
NOT HARMFUL TO HUMAN
BODY**

1) Device do not generate a radiation background;
2) Do not require a special radiation shield;
3) Do not pollute the environment;
4)Do not require specially prepared and certified premises and personnel;
5) Do not create problems during dismantling of the equipment
6) Do not require any special radiation control body approval;

FOR FURTHER INFORMATION PLEASE VISIT BOOTH F-9&10

PRODUCT SILOS

REAL TIME INVENTORY MEASUREMENT

Product Silos/ Warehouses

Need for Inventory Measurement

- Measure the Urea/ NPK Fertilizer Stocks at all time
- Identify the ullage
- Allocation of different products
- **Plan inventory**
  - **Reduce the Safety Stock requirements**
  - **Increase the inventory turn overs for the same yearly requirement**
    - Reduces Inventory Carrying Cost
    - Reduces cash invested in Inventory

How increase in accuracy leads to effective planning

- Example
  - 100 million tons of urea used from a warehouse/ product silo each year
  - Inventory turn over is 4 times, means at a time 25 million tons is stored and gets rotated 4 times in a year
  - Cash is blocked in 25 million tons stocked and the inventory carrying cost of 25 million tons of urea
  - If accurate inventory planning, the inventory turnover can be made 5 times, meaning at a time 20 million tons is stored and gets rotated 8 times in a year
  - Cash is blocked in only 20 million tons stocked and the inventory carrying cost of of only 20 million tons of urea

All this is only possible by having an
ACCURATE INVENTORY MEASUREMENT IN PLACE

How increase in accuracy leads to effective planning

- Example

Total Urea Sold in a year

Average Inventory at any Point in Time
is 25 Mil. Tons

Inventory Turnover
is 100/25 = 4 Times in a Year

ASSOCIATED COST

- Inventory Cost Hold Up = 25 x Rs. 1 Crore = Rs. 25 Crores
  (if 1 Mil. Ton Urea is Rs. 1 Crore)

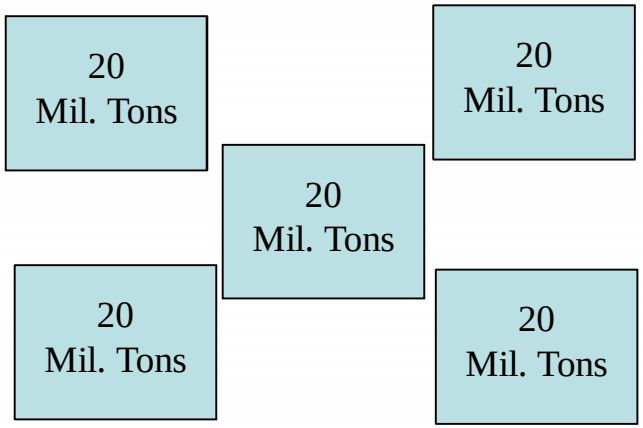
- Inventory Carrying Cost = .25 x Rs 25 Crores = Rs. 6.25 Crores
  (if Inventory Carrying Cost is 25%)

How increase in accuracy leads to effective planning

- Example

If we make Inventory Turnover
= 5 Times in a Year,
Then Average Inventory required is
100/5 = 20 Mil. Tones

Total Urea Sold in a year



Average Inventory at any Point in Time
is 20 Mil. Tons

ASSOCIATED COST

- Inventory Cost Hold Up = 20 x Rs. 1 Crore = Rs. 20 Crores
  (if 1 Mil. Ton Urea is Rs. 1 Crore)

- Inventory Carrying Cost = .25 x Rs 20 Crores = Rs. 5 Crores
  (if Inventory Carrying Cost is 25%)

How increase in accuracy leads to effective planning

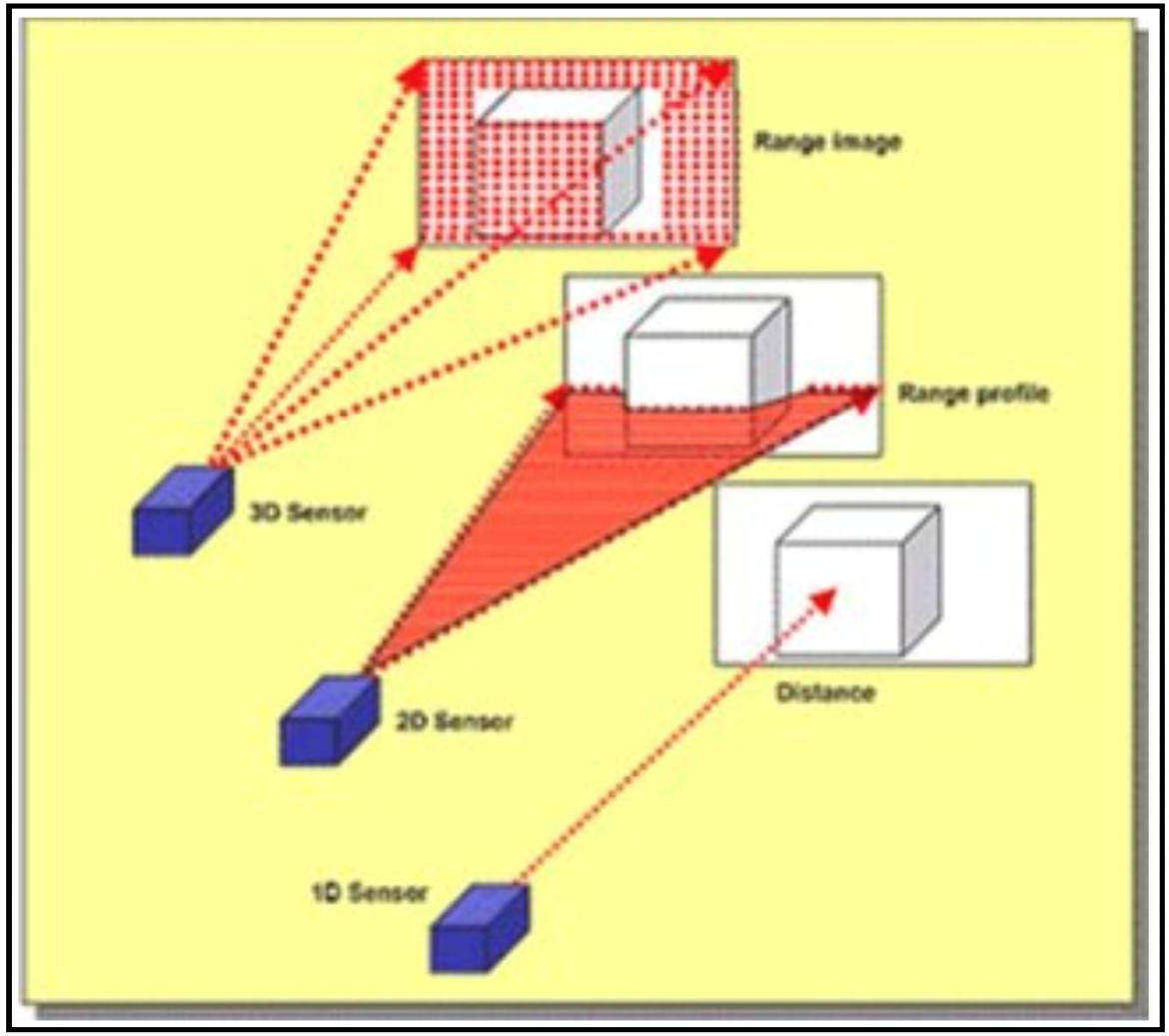
- Example
  - Total Cost with 4 Inventory Turnovers is Rs. 31.25 Crores
  - Total Cost with 5 Inventory Turnovers is Rs. 25 Crores
  - Total Savings is Rs. 6.25 Crores

All this is possible only by having an ACCURATE INVENTORY MEASUREMENT IN PLACE

Drawback of Raw In and Out Calculations

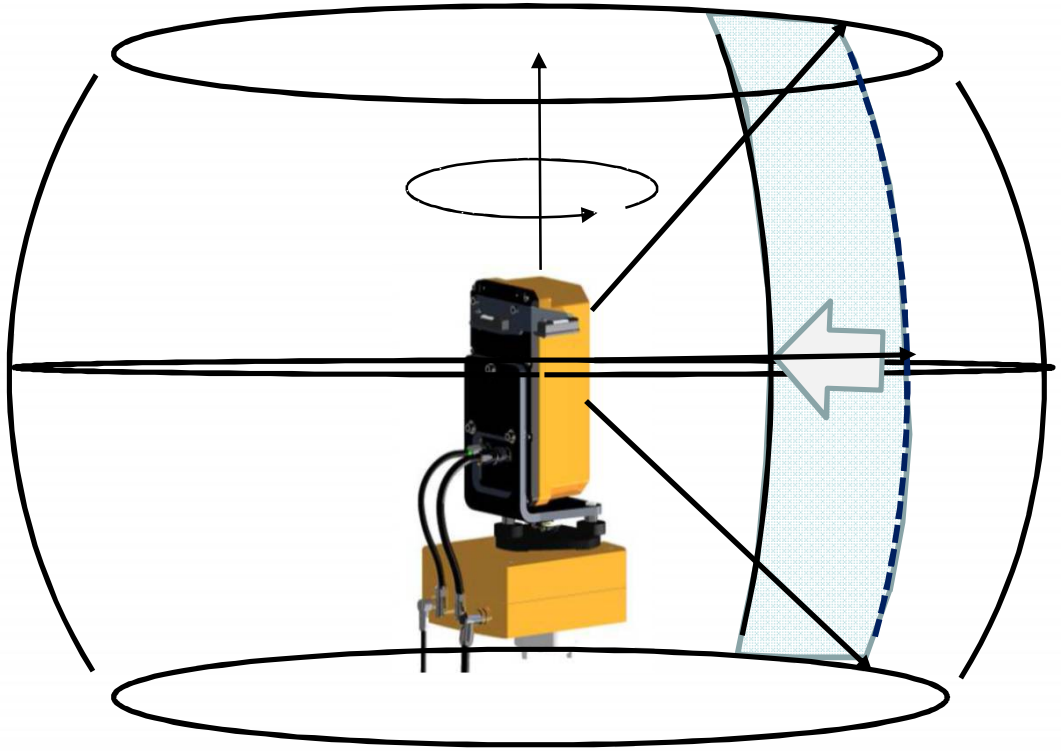
- Fertilizer Product brought in and out of a product silo are measured
- However, the quantity is small and that measurement has its own inaccuracies
- Those inaccuracies accumulate over time without an exact estimate as the Silo/ Warehouse does not get empty for a long period of time
- Hence : A REAL TIME INVENTORY MEASUREMENT IS REQUIRED TO GIVE BETTER PICTURE OF THE INVENTORY

3D Laser for Inventory Planning



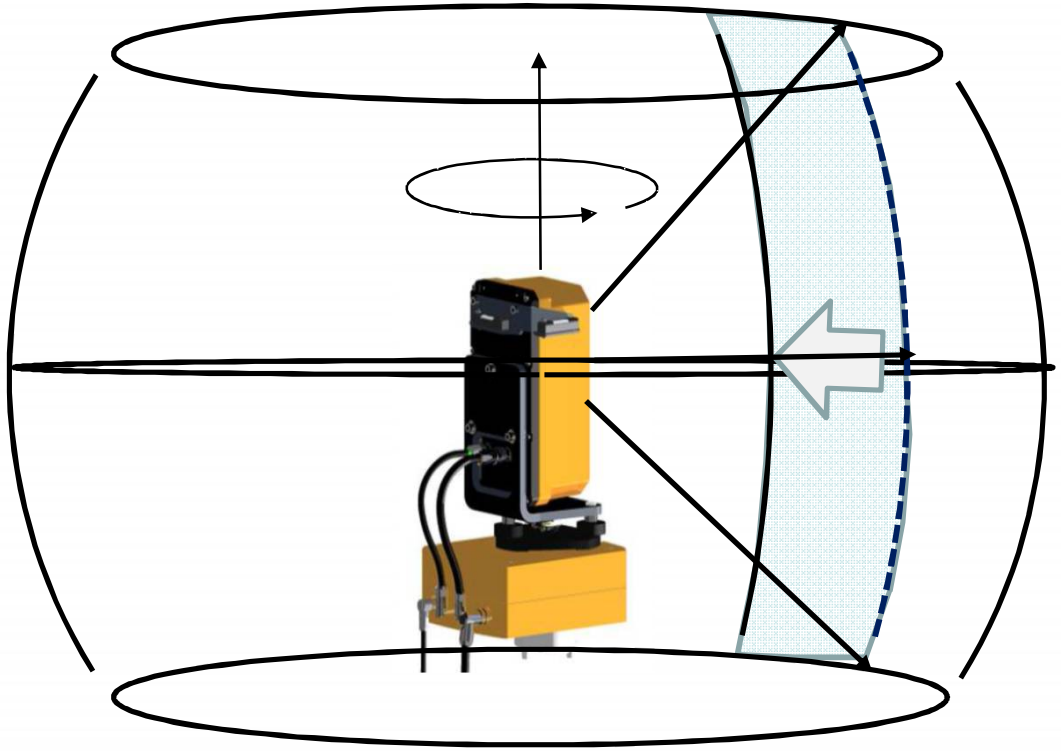
3D Laser for Inventory Planning

3D Laser Scanner Moves 360 Degrees to Scan the whole Pile

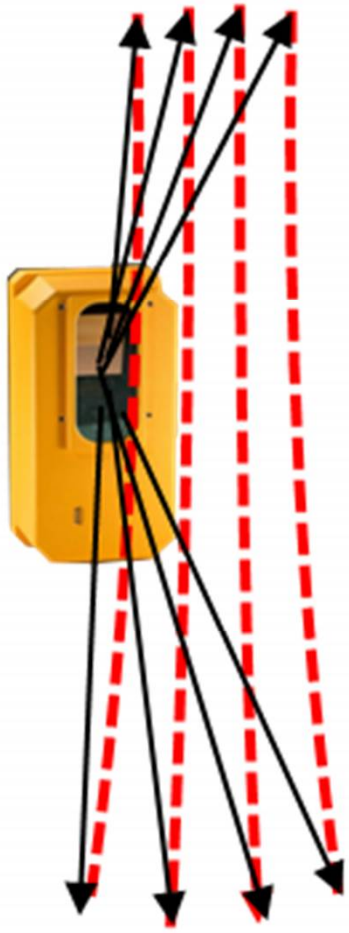


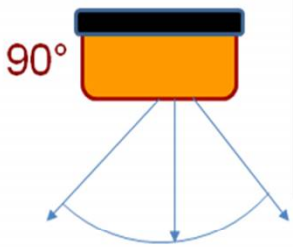
3D Laser for Inventory Planning

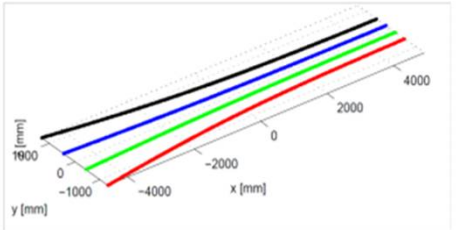
Can be mounted on a moving tripper to take measurement with only 1 Scanner for the complete warehouse

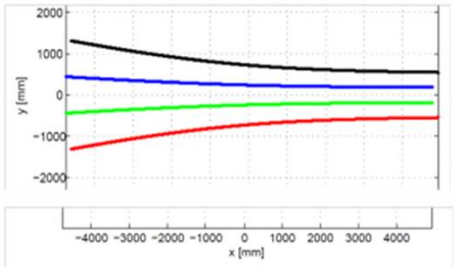


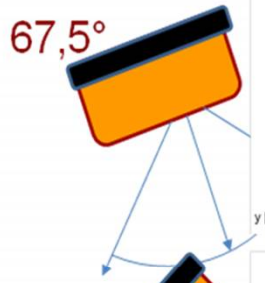
3D Laser for Inventory Planning

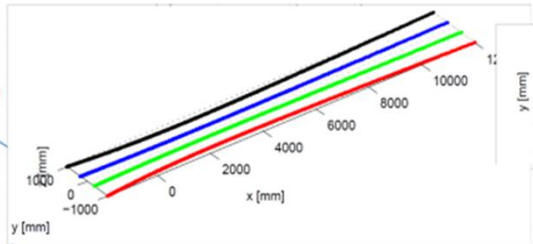


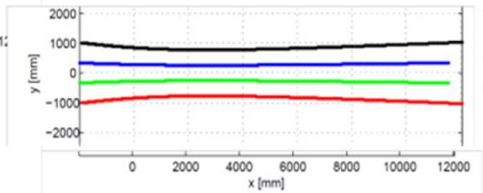


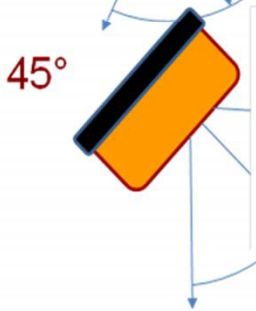


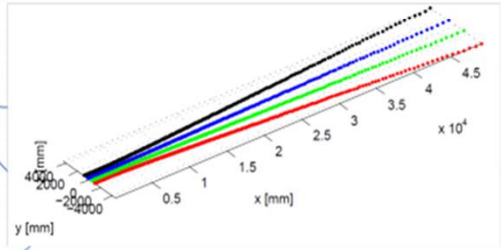


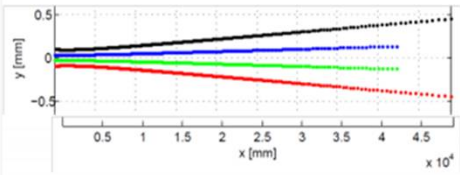




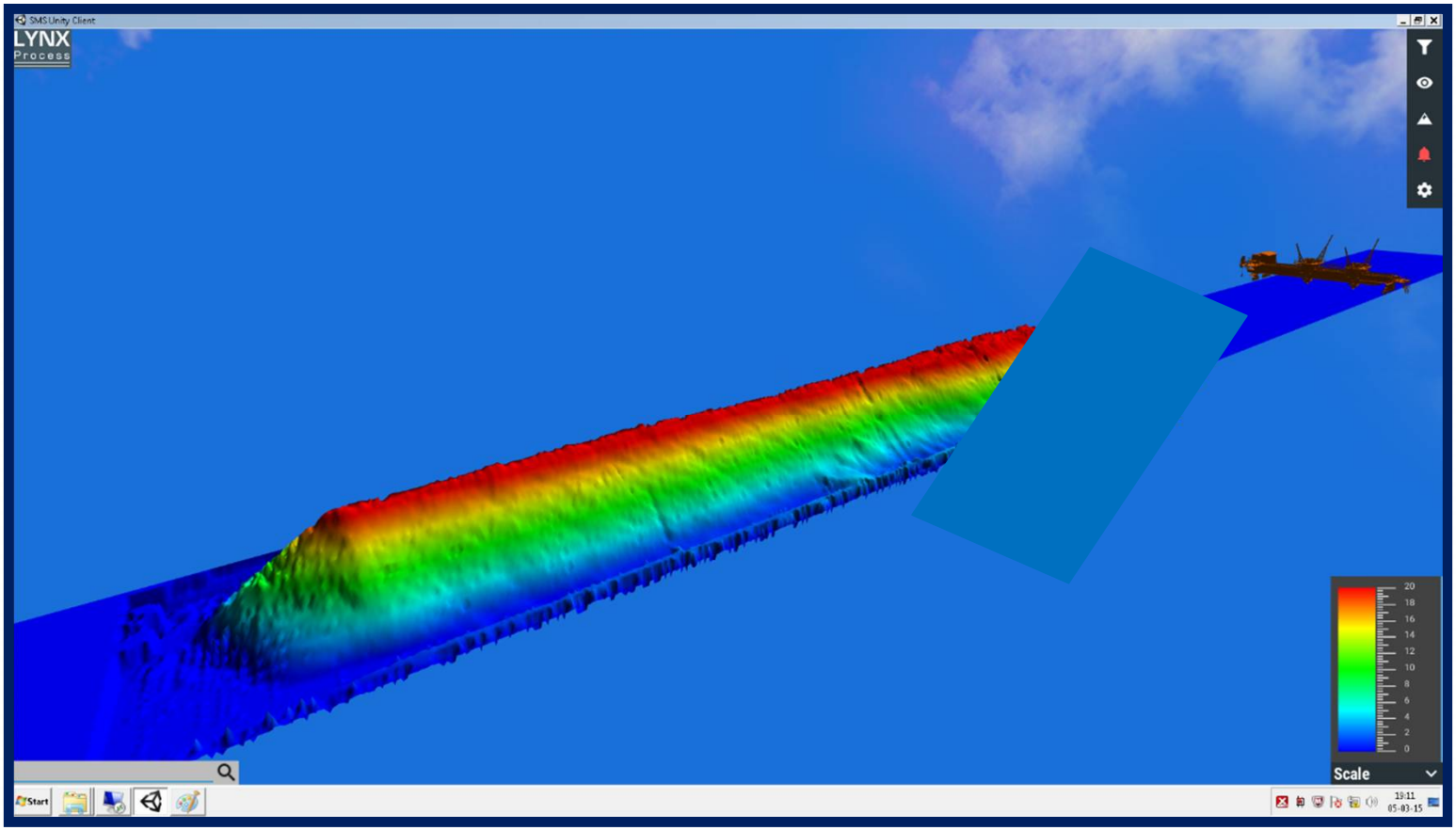








3D Laser for Inventory Planning




Thank you for listening!