Glossary of Terms

Nondestructive Assay (NDA) From the talk Erwin Kuhn gives the following explanation for what someone from the IAEA views as the definition of NDA, "… we finally agreed upon the definition (of NDA). That any measurement, which is done on an item without destroying the integrity of the item or on a sample taken from an item but the sample is returned to the item; this is called NDA." It is generally carried out by observing the radiometric emission or response from the item and by comparing that emission or response with a calibration based on essentially similar items whose contents have been determined through destructive analysis.

Bias defect/Protracted divergence: Within the context of the dialogue of this talk, these terms apply to the effect of every individual measurement's error on the cumulative effect of the quantity being investigated. For example, each measurement that is taken to verify the amount of plutonium in a solution has an accepted range of precision or associated variance. This range is likely to be very small, for this example it can be assumed to be less than plus or minus 1.0 percent. Clearly, if the result from the measurement is found to be outside of the accepted range, then this raises an issue and steps will be taken to find out the cause. A problem can arise if each measurement is only looked at independently and not together with all of the measurements for the solution content. Each measurements' error should be an independent uniformly distributed value between negative and positive 1. So, if just the error is plotted it is expected to see about the same number of positive errors as negative ones. Fitting a trend line to the error data will show whether this is true or not because it should have a slope near zero. If the slope is positive the solution more frequently contains more plutonium than it should and vice a versa if the slope is negative. Looking at all the measurement errors together can reveal subtle, but very important discrepancies in important quantities or processes. Bias defect or protracted divergence represents a systems oriented approach rather than standalone measurement analysis.

Aliquot: Pronounced "ăl'ĭ-kwŏt', -kwət" Denoting an exact divisor or factor of a quantity. In this case, aliquot, refers to the introduction of a known quantity of material(s) into a process stream. The introduction of a known quantity of material into a process stream allows inspectors and operators to check for the presence of this sample at points along the operation. The presence of the material in the aliquot further down a process stream helps to establish that the system is indeed continuous and there are no unseen diversions. The process of using aliquots was/is used extensively at the Rokkasho reprocessing facility as well as many other sites. See, Spiked, below, which is a similar process.

Spiked: When a well characterized solution or material is added to a material or process stream. If a process stream has been spiked, then samples taken further down the stream can be used to verify both that the stream still contains the characterized solution and that the solution matches the predicted composition or isotopics.

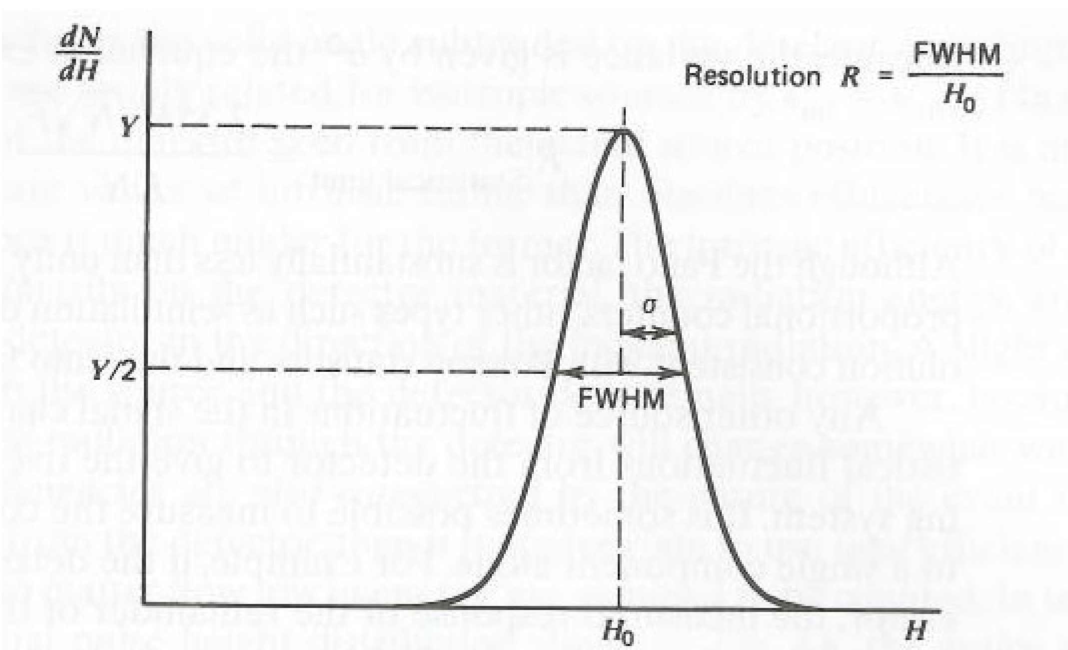
Significant Quantity (SQ): Refers to designated amounts of fissile material specified by the IAEA. The definition listed on the IAEA website is: "The approximate quantity of nuclear material in respect of which, taking into account any conversion process involved, the possibility of manufacturing a nuclear explosive device cannot be excluded."

Neutron Moderation: In this context moderation refers to the slowing down of neutrons born from fission. Each time they collide with other particles neutrons are slowed down and their kinetic energy is decreased*. This slowing down process can also be called, thermalization. Nearly all of the world's nuclear power reactors are designed to preferentially use thermalized neutrons for inducing fission in Uranium-235.

**This assumes the impinging particle has less kinetic energy than the neutron.*

Helium-3 (He-3): A naturally occurring, non-radioactive, form of helium that contains 2 protons and 1 neutron. He-3 is used in a variety of niche scientific and industrial applications. He-3 is extremely important to the radiation detection community. It is the best material to date for detecting thermal neutrons and neutrons resultant from fission. Detectors made with He-3 gas are extremely reliable and have very good resolution. Failure rates in He-3 detectors have been shown to be less than 1 failure per 10,000 years. Recent supply shortages have driven the price for He-3 up from around 200 dollars per liter to over 6000. Long-term supply is uncertain, but likely to be far short of expected demand.

Full Width Half Maximum (FWHM): In this application the FWHM is used for quantifying the effective resolution of a signal received by a radiation detector. The FWHM refers to the precision of the radiation measurement. The shorter (height in the Y-direction) and wider (width in the X-direction) the signal or pulse is, the worse the resolution is. Below is a picture and accompanying equation, which shows how the resolution is calculated from the FWHM.



Knoll, Glenn F. Radiation Detection and Measurement 3rd ed. Pp 113-116, 1999, John Wiley and Sons

Glovebox: A heavily shielded, atmospherically isolated, workspace whereby an operator can perform operations on substances that are radioactive and/or chemically hazardous. These boxes are generally constructed out of lead and steal with viewing windows made from leaded glass and organic oils. Operators perform work by placing their arms into thick rubber gloves that are connected and totally sealed into the box. Gloveboxes are used extensively in the nuclear industry for many applications involving nuclear materials.

Mixed Oxide Fuel (MOX): The combination of more than one type of fissile or fertile oxide fuel into a single fuel material. This term is technically applicable for any mixture of fissile oxides into a single fuel element, but it more generally refers to the mixture of uranium oxide and plutonium oxide. Burning plutonium-uranium oxide fuel is one method used to destroy excess Plutonium-239 stockpiles. Combining oxides of Plutonium and Uranium, as opposed to metallic or other material forms is done because of the extremely high melting point of the oxide. The desire to have a very high melting point versus all other fuel performance parameters is to guard against fuel failure during very severe accident scenarios i.e. loss of coolant accidents, main steam line shear events.

Rokkasho Reprocessing Plant: A nuclear reprocessing plant located in northeast Japan. This plant has several functions, but the most important and controversial is the reprocessing of fuel removed from a nuclear reactor for the recovery of uranium and plutonium. The once through fuel cycle, which most of the world employs, is extremely wasteful. Approximately every two years about one third of the fuel in a nuclear reactor is removed. The fuel that is removed from the reactor still contains a large amount of usable nuclear fuel material. To utilize this leftover fuel it must be separated from the very radioactive fission products, which were generated during reactor operations. The amount of energy in this usable nuclear material is equivalent to around 1 million tons of coal. Typically this spent fuel is disposed of, or at least, treated as waste. If reprocessed, however, this recovered nuclear material can be reintroduced into the fuel cycle. The issue with this and other reprocessing plants is that verifying material is not being diverted to other clandestine operations can be exceedingly difficult, requiring very large amounts of man hours for oversight. Reprocessing spent fuel greatly reduces the volume of radioactive waste that needs to be disposed. Depending on the methods used to reprocess, the overall volume of radioactive waste resultant from commercial light water nuclear fuel can be reduced by over 95 percent!

Minor Actinides (MA): The actinide series of elements present in used nuclear fuel, but not Uranium or Plutonium. The minor actinides are neptunium, americium, curium, berkelium, californium, einsteinium, and fermium*. The MA and the different isotopes of plutonium are responsible for the majority of the radiotoxicity present after a few hundred years through twenty to thirty thousand years. This is one reason why reprocessing spent nuclear fuel is so beneficial because these very radioactive compounds can be removed and isolated. The isotopic composition of spent nuclear fuel is typically 96 percent Uranium, and 4 percent MA, plutonium, and fission products. Therefore reprocessing eliminates over 96 percent of the mass that will be disposed of as nuclear waste.

DUPIC Fuel Cycle: Using reprocessed once-through LWR uranium in new fuel, likely with additional plutonium, MOX, or fresh uranium.

European Safeguards Research and Development Association (ESARDA): A European organization involved in addressing issues and concerns relevant to nuclear safeguards. Their main objective is to assist the European safeguards community with the advancement of safeguards, enhancing the efficiency of systems and measures, as well as investigating how new techniques can be developed and implemented. –ESARDA mission statement.

Vitrification Plant: A facility that takes radioactive waste and combines it with various materials, which are melted together and upon cooling forms a very water resistant glass-like material. The molten substance is either poured directly into a container or allowed to cool in a mold first, then placed into a container. Usually, the containers are made from high strength, corrosion resistant metals. These final sealed containers are thought to remain stable for many thousands of years. The final containers are then generally sent to long term storage, for example the Waste Isolation Pilot Plant in southeastern New Mexico.

Precision: The degree that a given set of measurements taken on the same quantity agree with the set's mean. See Accuracy for an example of the difference between precision and accuracy.

Accuracy: The degree a measurement matches the actual, or accepted value of the quantity being measured. It is important to recognize the difference between accuracy and precision. A physical interpretation of accuracy and precision can be discussed by using a dartboard analogy. Assume a set of darts have been thrown at the bull's-eye and are distributed in some fashion on the board. The accuracy of the thrown darts refers to how physically close the darts are to the bull's-eye. The precision of the darts refers to how closely the darts are grouped to one another on the board. If the darts are widely separated they are considered to be imprecisely thrown. If the darts are all grouped together, regardless of where they are on the board, then they are considered to have been thrown precisely.

Depleted Uranium (DU): Uranium where the isotopic concentration of Uranium-235 has been reduced below the natural level of 0.72 atom percent. The most reported use of DU is in ordinance. DU is used in a variety of projectiles because its' very high density makes it well suited for armor penetration. DU is typically used in lieu of other materials where extra high densities are required, for example sailboat keels, neutron reflectors and radiation shields.