

American National Standard Data Format for Radiation Detectors Used for Homeland Security

Accredited by the American National Standards Institute

Sponsored by the
National Committee on Radiation Instrumentation, N42



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3 Park Avenue
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USA

15 April 2013

ANSI N42.42-2012
(Revision of
ANSI N42.42-2006)

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Sponsor

National Committee on Radiation Instrumentation, N42

Accredited by the

American National Standards Institute

Secretariat

Institute of Electrical and Electronics Engineers, Inc.

Approved 17 July 2012

American National Standards Institute

Abstract: The data format that shall be used for both required and optional data to be made available by radiation measurement instruments for homeland security applications is specified. The performance for these types of instruments is described in other standards; such as ANSI N42.32, ANSI N42.33, ANSI N42.34, ANSI N42.35, ANSI N42.38, ANSI N42.43, ANSI N42.48, ANSI N42.49A, and ANSI N42.53.

Keywords: ANSI N42.42, data format, DHS standards, homeland security, radiation detectors, radiation instruments, radiation measurement instruments

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PDF: ISBN 978-0-7381-8308-4 STDGT98176
Print: ISBN 978-0-7381-8309-1 STDPD98176

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Introduction

This introduction is not part of ANSI N42.42-2012, American National Standard Data Format for Radiation Detectors Used for Homeland Security.

This standard is the responsibility of the Accredited American Standards Committee on Radiation Instrumentation, N42. The standard was approved on N42 letter ballot.

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American National Standard Data Format ~~Standard~~ for Radiation Detectors Used for Homeland Security

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1. Overview

1.1 Scope

This standard specifies the data format that shall be used for both required and optional data available at the output of radiation measurement instruments that are used for ~~U.S.~~ homeland security applications. The performance requirements for these types of radiation measurement instruments are described in other standards such as ANSI N42.32¹, ANSI N42.33, ANSI N42.34, ANSI N42.35, ANSI N42.38, ANSI N42.43, ANSI N42.48, ANSI N42.49A, and ANSI N42.53.

¹ Information on references can be found in Clause 2.

² ~~The ANSI N42 publications included in this clause are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08855-1331, USA (<http://standards.ieee.org/>).~~

The output consists of measurement data and results of any analysis performed by the radiation measurement instrument.

This standard does not address instrument control, data transmission protocols, or the physical media used for communications.

1.2 Purpose

The purpose of this standard is to provide a uniform format for data to be output ~~facilitate manufacturer-independent transfer of information~~ from radiation measurement instruments ~~to a standard file format~~ for use in ~~U.S.~~ homeland security applications. This enables interpretation of data without reference to manufacturer's documentation. ~~It specifies the format of data provided by radiation instruments used for homeland security. The purpose of this data is for analysis and storage of the radiation measurements. The data may consist of raw or unprocessed data, analysis results, device parameters or settings, or other measurements needed or applicable to the further analysis or to verify the quality of the results produced by the instrument.~~

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). ~~This standard shall be used in conjunction with the following publications.~~ For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

NOTE—Internet URLs are provided for convenience only; while accurate at the time of printing, these addresses may be changed by the information provider.²

² Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

[ANSI N13.11, American National Standard for Dosimetry—Personnel Dosimetry Performance—Criteria for Testing.](#)³

ANSI N42.32, American National Standard Performance Criteria for Alarming Personal Radiation Detectors for Homeland Security.³

ANSI N42.33, American National Standard for Portable Radiation Detection Instrumentation for Homeland Security.

ANSI N42.34, American National Standard Performance [Criteria](#) ~~Requirements~~ for Hand-Held Instruments for the Detection and Identification of Radionuclides.

ANSI N42.35, American National Standard for Evaluation and Performance of Radiation Detection Portal Monitors for Use in Homeland Security.

ANSI N42.38, American National Standard Performance Criteria for Spectroscopy-Based Portal Monitors Used for Homeland Security.

[ANSI N42.42-2006, American National Standard Data Format Standard for Radiation Detectors Used for Homeland Security.](#)

[ANSI N42.43, American National Standard Performance Criteria for Mobile and Transportable Radiation Monitors Used for Homeland Security.](#)

[ANSI N42.48, American National Standard Performance Requirements for Spectroscopic Personal Radiation Detectors \(SPRDs\) for Homeland Security.](#)

³ [ANSI publications are available from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA \(<http://www.ansi.org/>\).](#)

³ ~~The ANSI N42 publications included in this clause are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08855-1331, USA (<http://standards.ieee.org/>).~~

[ANSI N42.49A, American National Standard for Performance Criteria for Alarming Electronic Personal Emergency Radiation Detectors \(PERDs\) for Exposure Control.](#)

[ANSI N42.53, American National Standard Performance Criteria for Backpack Based Radiation Detection Systems Used for Homeland Security.](#)

[Debertin, K. and R. G. Helmer, *Gamma- and X-Ray Spectrometry with Semiconductor Detectors*, Elsevier, 1988.](#)

EPSG Map Datum Codes.⁴

[Extensible Markup Language \(XML\) 1.0, Third Edition, W3C Recommendation, 04 February 2004.](#)⁵

[ICRU Report 10b, Physical Aspects of Irradiation.](#)⁶

[ICRU Report 33, Radiation Quantities and Units.](#)

[ICRU Report 39, Determination of Dose Equivalents Resulting from External Radiation Sources.](#)

[ICRU Report 47, Measurement of Dose Equivalents from External Photon and Electron Radiations.](#)

⁴—Available at <http://www.epsg.org>.

⁵ Available at <http://www.w3.org/TR/2004/REC-xml-20040204>.

⁶ ICRU publications are available from the National Council on Radiation Protection and Measurements, 7910 Woodmont Avenue, Suite 400, Bethesda, MD 20814, USA (<http://ncrponline.org/>).

⁴—~~The Map Datum codes are contained in a database that may be downloaded from <http://www.epsg.org>.~~

[IEC 60050-393, International Electrotechnical Vocabulary—Part 393: Nuclear Instrumentation—Physical Phenomena and Basic Concepts.](#)⁷

[IEC 60050-394, International Electrotechnical Vocabulary—Part 394: Nuclear Instrumentation—Instruments, Systems, Equipment and Detectors.](#)

[IEC 62244, Radiation Protection Instrumentation—Installed Radiation Monitors for the Detection of Radioactive and Special Nuclear Materials at National Borders.](#)

[IEC 62327, Radiation Protection Instrumentation—Hand-Held Instruments for the Detection and Identification of Radionuclides and for the Indication of Ambient Dose Equivalent Rate from Photon Radiation.](#)

[IEC 62401, Radiation Protection Instrumentation—Alarming Personal Radiation Devices \(PRD\) for Detection of Illicit Trafficking of Radioactive Material.](#)

[IEC 62484, Radiation Protection Instrumentation—Spectroscopy-Based Portal Monitors Used for the Detection and Identification of Illicit Trafficking of Radioactive Material.](#)

[IEC 62533, Radiation Protection Instrumentation—Highly Sensitive Hand-Held Instruments for Photon Detection of Radioactive Material.](#)

[IEC 62534, Radiation Protection Instrumentation—Highly Sensitive Hand-Held Instruments for Neutron Detection of Radioactive Material.](#)

[IEC 62618, Radiation Protection Instrumentation—Spectroscopy-Based Alarming Personal Radiation Devices \(SPRD\) for Detection of Illicit Trafficking of Radioactive Material.](#)

⁷ IEC publications are available from the Sales Department of the International Electrotechnical Commission, 3 rue de Varembe, PO Box 131, CH-1211, Geneva 20, Switzerland (<http://www.iec.ch/>). IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org>).

[IEC 62694, Radiation Protection Instrumentation—Portable Radiation Scanners \(PRS\) for Detection of Illicit Trafficking of Radioactive Material.](#)

IETF RFC 1590, Media Type Registration Procedure⁸, ~~March 1994.~~⁵

IETF RFC 2045, Multipurpose Internet Mail Extensions (MIME) Part One: Format of Internet Message Bodies.⁹

[IETF RFC 2396, Uniform Resource Identifiers \(URI\): Generic Syntax.](#)¹⁰

[IETF RFC 2732, Format for Literal IPv6 Addresses in URL's.](#)¹¹

IETF RFC 3275, (Extensible Markup Language) XML-Signature Syntax and Processing.¹²

[Internet Assigned Numbers Authority \(IANA\).](#)¹³

[Internet Assigned Numbers Authority \(IANA\) MIME Media Types.](#)¹⁴

⁸ Available at: <http://www.ietf.org/rfc/rfc1590.txt>.

⁹ Available at: <http://www.ietf.org/rfc/rfc2045.txt>.

¹⁰ Available at: <http://www.ietf.org/rfc/rfc2396.txt>

¹¹ Available at: [http:// http://www.ietf.org/rfc/rfc2732.txt](http://http://www.ietf.org/rfc/rfc2732.txt).

¹² Available at: <http://www.ietf.org/rfc/rfc3275.txt>.

¹³ Available at: <http://www.iana.org>.

¹⁴ Available at: <http://www.iana.org/assignments/media-types>

⁵ ~~Internet Engineering Task Force. <http://www.ietf.org/rfc.html>.~~

[ISO 4037-3, X and Gamma Reference Radiation for Calibrating Dosemeters and Doserate Meters and for Determining their Response as a Function of Photon Energy—Part 3: Calibration of Area and Personal Dosemeters and the Measurement of their Response as a Function of Energy and Angle of Incidence.](#)¹⁵

ISO 8601, Data Elements and Interchange Formats—Information Interchange—Representation of Dates and Times⁶.

ISO/IEC 10646-1, ~~Information Technology~~—Universal Multiple-Octet Coded Character Set (UCS)—Part 1: Architecture and Basic Multilingual Plane.¹⁶

~~NOTE—The Unicode Consortium’s Unicode Standard 4.0 is equivalent to the ISO document.~~

ISO/IEC 11578, Information Technology—Open Systems Interconnection—Remote Procedure Call (RPC).¹⁷

[ISO/IEC 11179-4, Information Technology—Metadata Registries \(MDR\)—Part 4: Formulation of Data Definition.](#)

[ISO/IEC 11179-5, Information Technology—Metadata Registries \(MDR\)—Part 5: Naming and Identification Principles.](#)

¹⁵ ISO publications are available from the ISO Central Secretariat, [1, ch. de la Voie-Creuse, CP Case Postale 56, 1-rue de Varembe,](#) CH-1211 Geneva 20, Switzerland/~~Suisse~~ (<http://www.iso.org/>). ISO publications are also available in the United States from the Sales Department, American National Standards Institute, [25 11 West 43rd 42nd Street, 4th 13th Floor, New York, NY 10036, USA](#) (<http://www.ansi.org/>).

¹⁶ [The Unicode Standard 4.0 is equivalent to the ISO/IEC 10646-1.](#)

¹⁷ [IETF RFC 4122, A Universally Unique IDentifier \(UUID\) URN Namespace, an equivalent standard covering the format of the UUID, is available at: http://www.ietf.org/rfc/rfc4122.txt.](#)

[ISO/IEC 19757-3, Information Technology—Document Schema Definition Languages \(DSDL\)—
Part 3: Rule-Based Validation—Schematron.](#)

[IUPAC, *Nomenclature of Inorganic Chemistry*, Blackwell Science, 1990.](#)

[N42 XML Schema.](#)¹⁸

[N42 XML Schematron.](#)¹⁹

[National Information Exchange Model \(NIEM\) Naming and Design Rules, Version 1.3 \(In
particular, the CBRN domain is relevant to this standard.\).](#)²⁰

[National Nuclear Data Center, Brookhaven National Laboratory, Chart of Nuclides.](#)²¹

~~NOTE—W3C RFC 4122, A Universally Unique Identifier (UUID) URN Namespace, is an
equivalent standard covering the format of the UUID~~

~~National Institute of Science and Technology (NIST) ANSI N42.42 XML Schema.~~⁷

~~*Nomenclature of Inorganic Chemistry, Recommendations 1990, Blackwell Scientific Publications,
1990.*~~

¹⁸ Available at: <http://physics.nist.gov/N42/2011/n42.xsd>.

¹⁹ Available at: <http://physics.nist.gov/N42/2011/schematron/n42.sch>.

²⁰ Available: <https://www.niem.gov/documentsdb/Documents/Technical/NIEM-NDR-1-3.pdf>.

²¹ Available at: <http://www.nndc.bnl.gov/chart/>.

⁷ The ANSI N42.42 schema can be obtained from <http://physics.nist.gov/Divisions/Div846/Cp4/ANSIN4242/xml.html>.

[XML Encryption Syntax and Processing](#), W3C Recommendation, [10 December 2002](#).²² ~~Extensible Markup Language (XML) 1.0, Third Edition, 4 Feb 2004.~~⁸

[XML Schema Part 0: Primer Second Edition](#), W3C Recommendation, 28 October 2004.²³

XML Schema Part 2: Datatypes Second Edition, W3C Recommendation, 28 October 2004.²⁴

3. Definitions, acronyms, and [abbreviations](#)

3.1 Definitions

[For the purposes of this document, the following terms and definitions, as well as those given in IEC 60050-393 and IEC 60050-394 apply. The IEEE Standards Dictionary Online should be consulted for terms not defined here.](#)²⁵

[air-kerma](#): The kerma in a small volume of air.

²² [Available at: http://www.w3.org/TR/xmlenc-core/.](http://www.w3.org/TR/xmlenc-core/)

²³ [Available at http://www.w3.org/TR/2004/REC-xmlschema-0-20041028.](http://www.w3.org/TR/2004/REC-xmlschema-0-20041028/)

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²⁴ Available at <http://www.w3.org/TR/2004/REC-xmlschema-2-20041028>.

²⁵ [IEEE Standards Dictionary Online](#) subscription is available at:
http://www.ieee.org/portal/innovate/products/standard/standards_dictionary.html.

ambient dose equivalent $H^*(10)$: Dose equivalent at a point in a radiation field, produced by the corresponding aligned and expanded field, in the ICRU sphere at a depth of 10 mm, on the radius opposing the direction of the aligned field (see ICRU Report 39 and 47); [IEC 60050-393-14-95]

NOTE 1—In defining these quantities, it is useful to stipulate certain radiation fields that are derived from the actual radiation field. The terms “expanded” and “aligned” are used to characterize these derived radiation fields. In the expanded field, the fluence and its angular and energy distribution have the same values throughout the volume of interest as in the actual field at the point of reference. In the aligned and expanded field, the fluence and its energy distribution are the same as in the expanded field but the fluence is unidirectional.

NOTE 2—The ICRU sphere (see ICRU Report 33) is a 30-cm diameter, tissue-equivalent sphere with a density of $1\text{ g}\cdot\text{cm}^{-3}$ and a mass composition of tissue equivalent material (see IEC 60050-393-14-78).

NOTE 3—The recommended depth d , for environmental monitoring in terms of $H^*(d)$ is 10 mm, and $H^*(d)$ may then be written as $H^*(10)$.

NOTE 4— An instrument that has an isotropic response and is calibrated in terms of $H^*(d)$ will measure $H^*(d)$ in radiation fields that are uniform over the dimensions of the instrument.

NOTE 5— The definition of $H^*(d)$ requires the design of the instrument to take account of backscatter.

~~The following definitions apply to this standard, which has been developed at the request of the U.S. Department of Homeland Security (DHS) for instruments to be used by DHS and emergency responders.~~

~~**3.1.1 absolute efficiency:** The ratio of the total count rate of pulses recorded by the detector to the number emitted by the source.~~

~~3.1.2 absolute full-energy efficiency:~~ The ratio of the net count rate of pulses recorded by the detector in the full-energy peak to the number emitted by the source.

~~NOTE—~~ Net count rate is the total count rate minus the continuum count rate.

~~3.1.3 absorbed dose:~~ The energy imparted by ionizing radiation per unit mass of irradiated material.

~~NOTE—~~ The units of absorbed dose are the rad and gray (Gy).

~~3.1.4 alarm:~~ An audible, visual, or other signal activated when the instrument reading or response exceeds a preset value or falls outside of a preset range.

attribute: An eXtensible Markup Language (XML) “name-value” construct contained in an XML element start tag. [Details are available in](#) ~~NOTE—See W3C Recommendation,~~ Extensible Markup Language (XML) 1.0, [Third Edition](#).

channel: [A bin of a spectral histogram. Typically, a multichannel analyzer will increment the bin corresponding to the height of each recorded pulse. The contents of each bin are referred to as the “counts” in the channel \(also referred to as the channel “value”\). Because these histograms can be reprocessed in a variety of ways, the counts in each channel may be a real number \(i.e., the counts need not be an integer\).](#)

channel position: [A real number representing the position in a spectral histogram along the channel axis in terms of channels and their fractional parts. The channel number of the left edge of the first channel in a histogram of N channels is 0.0, and the channel number of the right edge of the last channel is N. Note that one can correlate a particular energy with a channel position; for example, energy 1173.2 keV may correspond to a channel position of 3437.61.](#)

~~3.1.6 calibrate:~~ To adjust and/or determine the response or reading of a device relative to a series of conventionally true values.

~~3.1.7 calibration: A set of operations under specified conditions that establishes the relationship between values indicated by a measuring instrument or measuring system and the conventionally true values of the quantity or variable being measured.~~

confidence indication: A measure provided by the [radiation measurement](#) instrument of the reliability assigned to the radiation source identification, [with a range from 0.0% to 100.0%](#); higher values indicate a higher likelihood of the presence of the [radionuclide](#).

[double escape peak: In a gamma ray spectrum, peaks due to pair production in the detector and escape, from the sensitive part of the detector, of two photons of 511 keV resulting from annihilation.](#)

~~3.1.9 covariance: A statistical measure used in computing the correlation coefficient between two variables; the covariance is the mean of $(x - \bar{x})(y - \bar{y})$ over all pairs of values for the variables x and y , where $\bar{x}$ and $\bar{y}$ are the mean values of x and y .~~

~~3.1.10 data: A formalized representation of facts or concepts suitable for communication, interpretation, or processing by people or automated means.~~

~~NOTE—The term “data” is often used to refer to the information stored in the computer.~~

~~3.1.11 default: A computer setting or preference that a program designer or user can set, showing what he or she wants to have happen automatically in the event that no other action is deliberately chosen.~~

~~3.1.12 detector: A device or component designed to produce a quantifiable response to ionizing radiation normally measured electronically.~~

~~3.1.13 dose equivalent: The energy absorbed by tissue from ionizing radiation.~~

~~NOTE—The Sievert (Sv) and rem are the units of dose equivalent.~~

element: An XML construct consisting of a start tag contained in angle brackets, optional data, and an optional end tag. [Details are available in Extensible Markup Language \(XML\) 1.0, Third Edition](#)
~~All XML documents must contain a single, unique tag pair to define the root element.~~

energy calibration: Describes the relationship between energy and channel number.

environmental background: Signals of origin other than the radiation to be detected. This may refer to:

- a) [signals caused by radiations from sources inside or outside the radiation detector other than those of interest in the measurement](#)
- b) [signals resulting from the short-comings of the electronic circuits of the detecting system and their power supplies](#)

exposure: The quotient of dQ by dm , where dQ is the absolute value of the total charge of the ions of one sign produced in air when all the electrons and positrons, liberated by photons in air of mass dm are completely stopped:

$$X = dQ/dm$$

The special unit of exposure used in this standard is the milliroentgen, abbreviated as mR (see [ICRU Report 10b](#)).

eXtensible Markup Language (XML): XML is a system and hardware independent language for expressing data and their structure within an XML document. An XML document is a text object that contains the data together with markup that defines the structure of the data. [Details are available in Extensible Markup Language \(XML\) 1.0, Third Edition.](#)

full-energy peak efficiency: The ratio of the number of photons detected in the total absorption peak for a given detection assembly and photon energy per unit time to the emission rate of a source in a specified geometry.

full-width at half-maximum (FWHM): In a distribution curve comprising a single peak, the distance between the abscissa of two points on the curve whose ordinates are half of the maximum ordinate of the peak.

full-width at half maximum (FWHM) calibration: Describes the relationship of FWHM as a function of energy.

~~NOTE 1—All other elements (or parent elements) must be nested within the root element. All parent elements can have sub elements (or child elements). The child elements must be in pairs and correctly nested within their parent element.~~

~~NOTE 2—A detailed definition can be found in W3C Recommendation, Extensible Markup Language (XML) 1.0.~~

~~**3.1.15 exposure rate:** The measure of ionization produced in air by x- and gamma ray radiation.~~

~~NOTE 1—The special unit of exposure rate is the Roentgen per hour, abbreviated in this standard as R/h.~~

~~NOTE 2—In this standard, the International System (SI) units Sievert (Sv) or Gray (Gy) follow in parentheses the Roentgen value R, though the two units are not physically equivalent.~~

gross counts: The total number of counts recorded ~~events detected~~ by the radiation measurement instrument.

Internet Assigned Numbers Authority (IANA): IANA is responsible for the registration of globally unique internet domain names and namespaces.

intrinsic full-energy peak efficiency: The ratio of the number of photons detected in the total absorption peak for a given photon energy to the number of photons that are incident on the radiation detector in the same time interval.

item: The object being measured by the radiation measurement instrument. This object may or may not produce a radiation field.

kerma: The quotient of dE_{tr} by dm , where dE_{tr} is the sum of the initial kinetic energies of all the directly ionizing particles liberated by indirectly ionizing particles in a material of mass dm :

$$K = dE_{tr} / dm$$

The units of kerma are the gray (Gy).

live time: Duration during which a detection assembly is sensitive to the input signal.

manufacturer: A person or company that manufactures hardware or software.

Multipurpose Internet Mail Extension (MIME): is a standard which defines the encoding of non-text data, such as images and sound, in text format. For details see IETF RFC 1590.

Multipurpose Internet Mail Extension (MIME) type: Identifies the format of data; MIME types are maintained by the IANA.

N42 document: A collection of data represented in XML, formatted according to this standard.

precision: As used in this document, the number of digits that are used to express a numeric value in text form.

radiation detector: A sensor component of a radiation measurement instrument designed to produce a quantifiable response to ionizing radiation.

radiation measurement instrument: A complete system ~~comprising~~ ~~consisting of~~ one or more radiation detectors and other possible components ~~assemblies~~ designed to quantify one or more characteristics of ionizing radiation or of the radioactive material producing the ionizing radiation.

real time: True operational time of measurement. [IEC 60050-394-39-29]

single escape peak: In a gamma ray spectrum, peaks due to pair production in the detector and escape, from the sensitive part of the detector, of one photon of 511 keV resulting from annihilation.

~~**3.1.18 intrinsic full-energy peak efficiency:** The ratio of gamma or x rays recorded in the full energy peak to those striking the detector.~~

~~**3.1.19 intrinsic total efficiency:** The ratio of gamma or x rays recorded to those striking the detector.~~

~~**3.1.20 live time:** The total time during a measurement that the system is available for the acquisition of events.~~

~~**3.1.21 location:** The geographic coordinates where a measurement is performed.~~

~~**3.1.22 manufacturer:** A person or company that manufactures hardware or software.~~

~~**3.1.23 MIME type:** Identifies the format of data; MIME types are maintained by the Internet Assigned Numbers Authority.¹⁰~~

¹⁰ See www.iana.org/assignments/media-types.

~~3.1.24 **monitoring**: Means provided to continuously indicate the state or condition of a system or assembly.~~

~~NOTE— May also be used for the real time measurement of radioactivity or radiation levels.~~

~~3.1.25 **multichannel analyzer (MCA)**: A device designed to measure the differential pulse height spectrum from a radiation detector.~~

~~3.1.26 **multichannel scaler (MCS)**: A device designed to count pulses from a radiation detector without amplitude discrimination.~~

~~3.1.27: **multipurpose Internet mail extension (MIME)**: Defines the encoding of non-text data, such as images and sound, in text format.~~

~~NOTE— MIME is a standard, RFC-1590 [see IETF RFC 1590].~~

~~3.1.28 **precision**: Degree of agreement of repeated measurements of the same parameter.~~

~~3.1.29 **pulse height analyzer (PHA)**: A device designed to sort successive signal pulses from a radiation detector into parallel amplitude channels.~~

~~3.1.30: **radiological dispersal device (RDD)**: An improvised device used to disperse radioactive material.~~

~~3.1.31 **range**: All values lying between the lower and upper detection limits.~~

~~3.1.32 **reading**: The indicated or displayed value of the instrument readout.~~

~~3.1.33 **readout**: The portion of the instrument that provides a visual display of the response of the instrument or the displayed value, with units, displayed and/or recorded by the instrument as a result of the instrument's response to some influence quantity.~~

~~3.1.34 real time:~~ The duration (i.e., elapsed clock time) of the measurement.

~~3.1.35 response:~~ Ratio of the instrument reading to the conventionally true value of the measured quantity.

~~3.1.36 response time:~~ The time interval required for the instrument reading to change from 10% to 90% of the final reading or vice versa, following a step change in the radiation field at the detector.

software: Sets of instructions or data that tell a computer what to do. Software is often divided into two categories: system software, which includes the operating system (e.g., Windows ¹¹, MacOS ¹²), and all utilities that enable the computer to function, and applications software, which includes programs that perform specific tasks (e.g., word processors, spreadsheets, and databases).

spectrum: A series of monotonically increasing energy bins in which radiation counts are tallied. The energy of each successive bin begins at the energy at which the previous bin ended.

state data: Information regarding the state of an object, e.g., a radiation measurement instrument, detector, or item. This information may include location, orientation, speed, and mode of operation.

tag: A piece of text that describes a unit of data, or element, in XML. A detailed definition can be found in Extensible Markup Language (XML) 1.0, Third Edition.

¹¹ ~~Windows 95 is a registered trademark of Microsoft Corporation. This information is given for the convenience of users of this standard and does not constitute an endorsement of these products. Similar products may be used if they can be shown to lead to the same results.~~

¹² ~~MacOS is a registered trademark of Apple Computer, Inc. This information is given for the convenience of users of this standard and does not constitute an endorsement of these products. Similar products may be used if they can be shown to lead to the same results.~~

~~NOTE The tag is distinguishable as markup, as opposed to data, because it is surrounded by angle brackets (< and >). For example, the element <name>My Name</name> has the start tag <name>, the end tag </name>, which enclose the data "My Name". Tags are case sensitive; i.e., <Start> is not the same as <start>.~~

~~**3.1.39 uncertainty:** The estimated bounds of the deviation from the conventionally true value, generally expressed as a percent of the mean, ordinarily taken as the square root of the sum of the square of two components: 1) random errors that are evaluated by statistical means; and 2) systematic errors that are evaluated by other means.~~

UCS Transformation Format 8 (UTF-8): This encodes a character in the repertoire of ISO/IEC 10646-1 using between 1 and 6 octets.

uncertainty: A parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand.

uniform resource identifier (URI): A string of characters used to identify a name or a resource on the Internet. Defined by IETF RFC 2732.

uniform resource locator (URL): A Uniform Resource Identifier (URI) that specifies where an identified resource is available and the mechanism for retrieving it. Defined by IETF RFC 2396.

Universally Unique Identifier (UUID): A string of characters used to uniquely identify each N42 document. The format of a UUID is described by ISO/IEC 11578.

World Wide Web Consortium (W3C®)²⁶: The main international standards organization that maintains the definitions for XML and associated standards.

²⁶ W3C is a trademark or registered trademarks of the W3C®, (registered in numerous countries) World Wide Web Consortium. Marks of W3C are registered and held by its host institutions: Massachusetts Institute of Technology (MIT), European Research Consortium for Information and Mathematics (ERCIM), and Keio University, Japan.

~~NOTE—See ISO/IEC 10646-1.~~

~~3.1.41 variance (σ^2): A measure of dispersion, which is the sum of the squared deviation of observations from their mean divided by one less than the number of observations.~~

$$\sigma^2 = \frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2$$

~~3.1.42 XML (eXtensible Markup Language): XML is a system and hardware independent language for expressing data and its structure within an XML document.~~

~~NOTE 1—An XML document is a text object that contains the data together with markup that defines the structure of the data.~~

~~NOTE 2—See W3C Recommendation, Extensible Markup Language (XML) 1.0.~~

XML Schema: Provides a means for defining the structure, content and semantics of XML documents through XML itself. [Details are available in](#) ~~NOTE—See W3C Recommendation,~~ XML Schema Part 2: Datatypes, Second Edition.

3.2 Acronyms [and abbreviations](#)

[DU](#) [Depleted Uranium](#)

[FWHM](#) [Full-Width at Half Maximum](#)

[HEU](#) [Highly Enriched Uranium](#)

LEU Low Enriched Uranium

~~IANA: Internet Assigned Numbers Authority~~

~~NOTE—IANA is responsible for the registration of globally unique internet domain names and namespaces.¹³~~

~~MCA: Multichannel Analyzer~~

~~MCS: Multichannel Scaler~~

MIME Multipurpose Internet Mail Extension

NIEM National Information Exchange Model

NIST National Institute of Standards and Technology

OCR Optical Character Recognition

RGPU Reactor-Grade Plutonium

RID Radionuclide Identifier

RPM Radiation Portal Monitor

~~OSI: Open Systems Interconnection~~

~~NOTE—Defined by ITU-TS Recommendation X.200.~~

~~PC: Personal computer~~

¹³~~For more information on IANA, see <http://www.iana.org>.~~

URI Uniform Resource Identifier

~~NOTE—Defined by IETF RFC 2732.~~

URL Uniform Resource Locator

UTF-8 UCS Transformation Format 8

~~NOTE—Defined by IETF RFC 2396.~~

UUID Universally Unique Identifier

~~NOTE—The format of a UUID is described by ISO/IEC 11578.~~

W3C World Wide Web Consortium

WGPu Weapons-Grade Plutonium

XML eXtensible Markup Language

~~NOTE—Maintains the definition for XML and associated standards.~~

3.3 Quantities and units

Quantities associated to elements and attributes have well defined units. This standard uses the International System of Units (SI). Multiples and submultiples of SI units will be used, when practicable, according to the SI system.

This standard also uses the following units:

- [For energy: kilo-electron-volt \(symbol keV\), 1 keV = \$1.602 \times 10^{-16}\$ J](#)
- [For ambient dose equivalent: microsievert \(symbol: \$\mu\$ Sv\).](#)
- [For exposure: milliroentgen \(symbol: mR\), 1 mR/h = \$2.58 \times 10^{-7}\$ C/kg/h](#)
- [For multimedia file size value: kilobytes \(symbol: kB\)](#)

[SI units should be used for those elements whose values require the indication of the associated “unit” attribute; the unit used should be appropriate for the recorded or measured value.](#)

[As this standard addresses data format, decimal numbers, real number, date, time and time duration require the use of a period, “.”, instead of a comma, “,”, to express a value.](#)

[The conversion of exposure to ambient dose equivalent is discussed in Annex J.](#)

3.4 Standard word usage

In this document, the following word usage applies:

- The word “shall” signifies a mandatory requirement (where appropriate, a qualifying statement is included to indicate ~~that~~ there may be an allowable exception.)
- The word “should” signifies a recommended specification or method
- The word “may” signifies an acceptable method or an example of good practice

4. General characteristics

4.1 Design principles used in ~~Goals for~~ this standard

The design principles used in the standard are the following:

~~It is the intent of this standard to facilitate the use of radiation data with particular regard to homeland security, emergency response, and common data-sharing needs by achieving the following goals:~~

- a) *Readability*: data should be in a format that can be easily accessed and understood by analysts without the need for proprietary software.
- b) *Compatibility*: data should be in a format that is compatible with accepted international standards for data representation to the broadest extent possible.
- c) *Extensibility*: the data format should provide for unforeseen future needs and for as-yet unknown requirements particular to the specific needs of individual manufacturers of radiation measurement instrumentation.
- d) *Impartiality*: the data format should not favour any particular commercial interest by adopting a particular manufacturer's or organization's practices.

4.2 Characteristics of the data format

With the design principles ~~these goals~~ in mind, the data format, henceforth referred to as the “~~ANSI-N42.42~~ data format,” defined by this standard is based upon ~~the XML specification (see W3C Recommendation,~~ Extensible Markup Language (XML) 1.0. Specifically, this standard requires the data from the ~~that all~~ radiation measurement ~~data~~ instrument shall comply with the following data formats ~~discussed in the following list:~~

a) The data shall be rendered in an XML document in conformance to the ~~W3C XML V1.0 standard [see W3C Recommendation, Extensible Markup Language XML 1.0 and W3C Recommendation, XML Schema Part 2 standards, Datatypes, Second Edition]~~. In this standard, an XML document is considered identical to an XML file and the terms will be used synonymously.

b) Documents produced according to this standard shall be capable of being validated against the master N42 schema, as well as any other schemas required by that document.

~~b) The data format is to be compatible with the master ANSI N42.42 schema maintained by NIST (see ANSI N42 schema and Annex A).~~

c) Data authentication, when required, shall be provided via XML-Signature (see IETF RFC 3275).

d) Data encryption, when required, shall be provided via XML Encryption (see XML Encryption Syntax and Processing).

NOTE—Document compression ~~Data encryption~~ is not addressed in this standard.

This standard has the following general characteristics ~~discussed in the following list~~:

a) Radiation measurement instrumentation information is expressed as a hierarchical structure of data items.

b) The data format employs XML tagging as defined by XML 1.0, Third Edition, and follows the guidelines of XML Schema Part 0, ISO/IEC 11179-4, and ISO/IEC 11179-5.

c) Mixed content is not allowed, i.e., insertion of tags inside of content is not allowed. Non-printing character data are permitted between closing and opening tags.

- ~~b) These data items are formatted as XML elements and attributes [see W3C Recommendation, Extensible Markup Language (XML) 1.0].~~
- d) In order to allow the data to be accessed using simple text editors, only ~~the UTF-8~~ (see ISO/IEC 10646-1 character encoding shall be used.
- e) The structure of the [information data](#) is described by the [N42](#) XML Schema document (see ~~ANSI N42.42 schema and~~ Annex A). This schema defines the standard names for data elements and attributes, ~~whether or not they are optional or required for each class of instrument~~, and the hierarchical relationships between them. The schema document will be updated in concert with any revision to this standard.
- ~~e) For new types of radiation instruments, or radiation instruments not specifically addressed in this standard, the ANSI N42.42 data format shall be used to the extent possible. If additional data for those instruments is required, these shall be defined in the performance standard for that type of instrument via a namespace extending the ANSI N42.42 data format. A schema describing the new data in the new namespace shall be created and made available along with the ANSI N42.42 schema, found at the location defined in the ANSI N42.42 schema.~~
- f) ~~If data elements or attributes are needed by a particular instrument that have not been defined in the ANSI N42.42 data format schema, then the manufacturer of the instrument shall use a unique namespace prefix for the elements and attributes not defined in the ANSI N42.42 data format schema; see the example fragment in Annex G.~~ Customized elements and attributes shall not supplant use of standard elements and attributes [defined in this standard](#).
- g) When data in this format are recorded in a file, the data filename extension shall be “N42,” either uppercase or lowercase, to allow for automated recognition.

The standard gives implementers flexibility in deciding what information to include or omit. However, implementers shall provide all data their radiation measurement instruments or accompanying software generates if there is an element in the N42 specification that matches their data. Implementers shall provide the minimum data and analysis results as specified in the standards associated with the specific radiation measurement instrument. Provision for extending the N42 schema to address new data elements has also been provided; see Annex L for details.

- ~~h) The standard allows values to be expressed in a variety of units. Use of SI units is encouraged.~~
- ~~i) The standard gives implementers a great deal of flexibility in deciding what information is to be included or omitted. Implementers should be sensitive to the needs of the users of this information; in particular, providing sufficient raw measurement data to substantiate analysis results.~~

4.3 General description of the **ANSI N42.42** data format

4.3.1 Basic concepts

This standard considers radiation measurement instruments to have several types of components. Radiation detectors are the primary components. They generate the raw measurement data in response to a radiation field. A radiation measurement instrument may include one or more radiation detectors. A particular radiation detector can only belong to one radiation measurement instrument.

Occupancy sensors, position sensors, and multimedia devices are other possible components of a radiation measurement instrument. Information provided by these components can provide additional context to the measured items producing a radiation field.

Measurements can include data collected by the different radiation measurement instrument components (i.e., the radiation measurement instrument's individual radiation detectors, occupancy sensors, position sensors, and multimedia devices) over a specific period of time. Contributions from a particular component may or may not be present in all radiation measurement instrument measurements.

An N42 document provides data from only one radiation measurement instrument. This implies that systems with more than one radiation measurement instrument must produce separate documents for each instrument (e.g., if the system is composed of an RPM and a RID, each of these radiation measurement instruments shall produce a separate document).

The <RadInstrumentData> element is the parent element for all N42 data in a document that complies with this standard. Note that ANSI N42.42-2006 uses the parent element <N42InstrumentData>; this difference in parent elements can serve as a key to distinguish which standard is applicable to the current document. Note also that the namespace in this standard is different from the namespace in ANSI N42.42-2006.

A radiation measurement instrument may produce many N42 documents over its operational life. To distinguish between these documents each should include a unique universal identifier as an attribute in its <RadInstrumentData> parent element.

The primary, high-level, child elements of <RadInstrumentData> are as follows:

- <RadInstrumentInformation>: This element describes the characteristics of the radiation measurement instrument that performed the measurements. Child elements indicate the radiation measurement instrument's manufacturer, identification, model, class, description, and version as well as quality control information. Though there can be only one radiation measurement instrument (with many components) per each N42 document, other elements may need to refer to it; therefore, the <RadInstrumentInformation> element includes an attribute that uniquely identifies the radiation measurement instrument locally within an instance of the N42 document.

- <RadDetectorInformation>: This element describes the characteristics of a radiation detector. Radiation detectors are the components of the radiation measurement instrument that actually generate the raw measurement data in response to a radiation field. The radiation measurement instrument may include one or more radiation detectors; each radiation detector must have its own <RadDetectorInformation> element. A specific radiation detector can only belong to the one radiation measurement instrument. Child elements indicate the radiation detector's name, category, kind, description, and physical dimensions as well as user-defined characteristics. A <RadDetectorInformation> element includes an attribute that uniquely identifies a specific detector locally within an instance of the N42 document.

- <RadItemInformation>: This element describes the characteristics of a specific item the radiation measurement instrument measured; this document often refers to it as "measured item" or just "item." Since a radiation measurement instrument may consist of multiple radiation detectors, the radiation measurement instrument can measure one or more measured items simultaneously. If there is a means to uniquely identify a measured item, this element captures information about the measured item; each measured item then must have its own <RadItemInformation> element. Child elements indicate the measured item's description and measurement geometry as well as user-defined quantities. A <RadItemInformation> element includes an attribute that uniquely identifies a specific measured item locally within an instance of the N42 document.

- <xxxCalibration>: This element contains calibration information. xxx can be Energy, FWHM, FullEnergyPeakEfficiency, IntrinsicFullEnergyPeakEfficiency, or TotalEfficiency. Child elements are xxx-dependent and may detail energies, energy boundaries, coefficients, windows, and uncertainties. A <xxxCalibration> element includes an id attribute that uniquely identifies a specific calibration locally within an instance of the N42 document.

— <RadMeasurement>: This element includes the data a radiation measurement instrument collects over a specific period of time from its individual radiation detectors and components such as occupancy and position sensors. The <MultimediaData> element includes the data from a radiation measurement instrument's multimedia components, see below. The radiation measurement instrument may acquire data from all or a combination of these components during a specific period of time. The data from distinct time intervals require separate <RadMeasurement> elements. Each instance of a <RadMeasurement> element shall include an attribute that uniquely identifies it in an N42 document.

When there is a means for the radiation measurement instrument to identify the measured item or items (e.g., shipping container, package, and vehicle), a <RadMeasurement> element can also include a list of the measured items as an attribute.

A <RadMeasurement> element can belong to one or more radiation measurement groups (see the next dashed paragraph below that explains the concept of a <RadMeasurementGroup> element); an element's radMeasurementGroupReferences attribute provides the mechanism to identify each <RadMeasurementGroup> element associated with the element.

<StartDateTime> and <RealTimeDuration> child elements identify the specific period of time in which the <RadMeasurement> applies. The <RealTimeDuration> child element also represents the time resolution of associated measurement data.

Child elements, with tag names to reflect the kind of radiation measurement, detail the radiation measurement instrument's detector data. The available child elements are <Spectrum>, <GrossCounts>, <DoseRate>, <TotalDose>, <ExposureRate>, and <TotalExposure>. Each of these child elements includes an attribute that uniquely identifies a specific radiation measurement locally within an instance of the N42 document. Each element also includes an attribute that identifies the radiation detector responsible for the measurement and an attribute that references the appropriate <xxxCalibration> elements.

An <Occupancy> child element identifies the presence or non-presence of a measured item during the specific period of time the <RadMeasurement> covers.

The <RadInstrumentState>, <RadDetectorState>, and the <RadItemState> child elements indicate the state of the radiation measurement instrument, each of the radiation measurement instrument's radiation detectors, and each item the radiation measurement instrument measured, respectively. State data include location, orientation, direction of motion, and speed. For the radiation measurement instrument the state data also include the mode of operation. Radiation measurement instruments equipped with position sensors using a geolocation system is one means of capturing location data (see EPSG Map Datum Codes).

The radiation measurement instrument acquires the <RadxxxState> state data during the time interval denoted by the <StartDateTime> and <RealTimeDuration> child elements of <RadMeasurement>. These states are valid until their next update in a subsequent <RadMeasurement> element. For example, if the time resolution of a radiation measurement instrument's position must be higher than other data from the radiation detectors or other components (e.g., gross counts, spectrum, dose rate), the <RadxxxState> element can be included in a separate <RadMeasurement> element from those that include data from the radiation detectors or other components.

- <RadMeasurementGroup>: This element provides a means to identify a set of radiation measurements as a single group; for example: a sequence of radiation measurements indicative of a vehicle's traversal through a portal monitor. The <RadMeasurementGroupDescription> child element describes the group. A <RadMeasurementGroup> element includes an attribute that uniquely identifies a specific radiation measurement group locally within an instance of the N42 document.

The <RadMeasurementGroup> element also includes a unique universal identifier as an attribute. This optional identifier provides a means to distinguish a group of radiation measurements among those the radiation measurement instrument can produce in multiple documents over its operational life.

- <MultimediaData>: This element provides a means to identify data from a multimedia device such as camera, OCR, or license plate reader that supplement the radiation measurement instrument's radiation measurements. If there is more than one device, the document must include a separate <MultimediaData> element for each device. Child elements identify the device, describe the device, indicate its MIME content type, and, detail the device data, or if the device data are not included in the document, reference their location via a URI.

Data from a multimedia device are applicable to a specific slice in time. Data collection time intervals may not directly coincide with those from any particular <RadMeasurement> element or other multimedia devices. Therefore, there are additional child elements of the <MultimediaData> element that indicate data capture start date/time and duration.

A <MultimediaData> element includes an attribute that uniquely identifies multimedia data from a specific device and time locally within an instance of the N42 document. When there is a means to associate a device's data with one or more measured items, the element provides an attribute that identifies the measured items. A device may collect more than one set of data during a specific time; a sequence number attribute provides a means to correctly order the data sets.

- <DerivedData>: This element provides data derived from radiation measurements. Child elements, representing the kind of radiation measurement, detail the derived data. The available child elements are <Spectrum>, <GrossCounts>, <DoseRate>, <TotalDose>, <ExposureRate>, and <TotalExposure>. An attribute in each of these child elements identifies the specific spectra, gross counts, dose rates, total doses, exposure rates, and total exposures from one or more radiation measurements or other derived data that are the sources of the specific derived data (cf., <RadMeasurement> element).

Derived data are applicable to a specific slice in time. Time intervals do not necessarily coincide with those from any particular <RadMeasurement> element or other <DerivedData> elements. Therefore, there are additional child elements of the <DerivedData> element that indicate the applicable start date/time and duration. A <DerivedData> element includes an attribute that uniquely identifies a specific set of derived data locally within an instance of the N42 document.

- <AnalysisResults>: This element provides the information that is the product of analysis of the radiation measurements or derived data. For example: a spectrometer may provide the radionuclides the radiation measurement instrument identified and its associated confidence indication. Child elements identify source indicators, radiation alarms, nuclides, and the details on the analysis algorithms themselves.

Analysis results are applicable to a specific slice in time. Time intervals do not necessarily coincide with those from any particular <RadMeasurement> element or other <DerivedData> elements. Therefore, there are additional child elements of the <AnalysisResults> element that indicate the analysis start date/time and computational duration. An <AnalysisResults> element includes an attribute that uniquely identifies a specific analysis results locally within an instance of the N42 document, and attributes that list the radiation measurements and derived data that are the subject of the analysis. It is possible to have more than one <AnalysisResults> within an instance of the N42 document.

Since an <AnalysisResults> element references the <RadMeasurement>, <RadMeasurementGroup>, or <DerivedData> elements that are the subject of the analysis, the order of these elements as they appear in an N42 document can vary. Annex D, Annex C, Annex E, and Annex G are examples of sequences of <RadMeasurement> elements followed by one or more <AnalysisResults> elements that reference the applicable preceding <RadMeasurement> elements. Annex I is an example of sequence of <RadMeasurement> elements each immediately followed by their associated <AnalysisResults>.

4.3.2 Example data documents

This standard ~~ANSI N42.42~~ supports several different types of [radiation measurement](#) instruments, each of which customarily have had different data reporting formats. Because this standard supports the requirements of all of these types of instruments, certain aspects of the standard require additional explanation.

Example ~~annotated~~ data [documents](#) ~~files~~ can be found in Annex B [through](#) Annex ~~I C, Annex D, Annex E, and Annex F:~~

Annex B A “spectrometer,” [described by IEC 62327 and ANSI N42.34](#); the [document](#) ~~file~~ contains only a spectrum and energy calibration and demonstrates the minimum required information. [It also provides an alternative energy calibration.](#)

Annex C A “spectrometer;” more complex than the example in Annex B, the [document](#) ~~file~~ contains a spectrum, its calibration, and the results of the analysis of that spectrum.

Annex D A “~~gross-count~~ portal monitor,” [described by IEC 62244 and ANSI N42.35](#); the data are a series of seven count values representing a [short occupancy from a](#) ~~small~~ monitor with two gamma and two neutron [radiation](#) detectors. [It also provides an alternative that shows an alarm occupancy fragment.](#)

Annex E A “spectroscopic portal monitor,” [described by IEC 62484 and ANSI N42.38.](#)

Annex F A “[personal radiation detector \(PRD\)](#),” [described by IEC 62401 and ANSI N42.32 \(note that this example can also apply to survey meters or handheld gamma radiation measurement instruments described by IEC 62533 and ANSI N42.33\)](#); ~~radiation pager~~; the data are a series of four count and dose rate readings.

[Annex G A “mobile” radiation measurement instrument, described by ANSI N42.43.](#)

[Annex H](#) [A handheld neutron radiation measurement instrument, described by IEC 62534. It also provides an example on how to add an extension of a quantity measured by the radiation measurement instrument that is not defined by an element in this standard.](#)

[Annex I](#) [A “spectroscopic personal radiation detector” \(SPRD\), described by IEC 62618 and ANSI N42.48.](#)

Note that [comments in the example documents](#) ~~annotation~~ (given in the form of XML comments) are not required in real [radiation measurement](#) instrument data [documents](#) ~~files~~. Also, the examples are indented for readability; this is desirable in real [documents](#) ~~files~~ but not required.

[The schema](#), these examples, [and other non-normative information](#) can be downloaded from the [N42 XML Schema web page](#). ~~ANSI N42.42 Web site, which is found online at:~~
~~<http://physics.nist.gov/N4242schema>.~~

4.3.1 General organization

~~The <N42InstrumentData> element is the parent element for all data in the file. It shall contain one or more <Measurement> elements, each of which represents a “measurement”; the definition of a “measurement” depends on the type of instrument. The <Measurement> element contains various child elements that describe the instrument, the data collected, and the results of the instrument’s analysis of the data:~~

- ~~— <InstrumentInformation> element: describes the instrument that performed the measurement.~~
- ~~— <MeasuredItemInformation> element: describes the item being measured.~~

- ~~<Spectrum> element: produced by spectrometers, this element contains a PHA or MCS spectrum, the acquisition start and elapsed times, and calibration information. Multiple <Spectrum> elements may be used in a single parent <Measurement> element to represent multiple detectors or background spectra.~~
- ~~<DetectorData> element: typically produced by portal monitors, this element contains a series of gross count and/or spectroscopic "samples" from one or more detectors, along with other information associated with each sample, such as sampling duration and monitor occupancy status. A series of monitor occupancies could be represented by multiple <DetectorData> elements in a single <Measurement> element; alternatively, each occupancy could be represented by a <Measurement> element containing a single <DetectorData> element.~~
- ~~<CountDoseData> element: produced by radiation pagers or survey meters, this element contains a series of count rate, exposure, exposure rate, dose, and/or dose rate values.~~
- ~~<AnalysisResults> element: this element represents the information presented to the operator by the instrument as a result of its analysis of the data. For spectrometers, this consists of the nuclides identified by the instrument and an indication of the confidence that they are present.~~

~~Figure 1 shows the organization of a simple spectrometer file, containing a single spectrum measurement, and all the information associated with that measurement:~~