Nomenclature guidelines for abstracts, posters and presentations

Radioactivity measurement
SI units for radioactivity measurement, i.e. Bq (MBq, GBq etc.) should be used. If it is felt necessary to use pre-SI units (e.g. imperial units) (e.g. mCi, Ci), these can be placed in parentheses after the stated SI units.
The jargon "hot" and "cold" must not be used in place of the correct terms "radioactive" and "non-radioactive", respectively in scientific manuscripts and public presentations.

Specific (radio)activity and molar (radio)activity
According to SI convention, the term 'specific' refers to a physical property as a function of the mass of the material in question; e.g. the specific heat capacity is the heat capacity of an object per kg weight.
Since in chemistry 'mass' is often denoted in moles, related chemical properties are indicated in 'molar' units; e.g. molar volume.
Because of this possible source of confusion the following terms should be used:

Specific (radio)activity - the measured radioactivity **per gram** of compound; measured in Bq/g or GBq/mg.
This measure should only be used in special cases. For example, when the molecular weight of the labelled compound is not accurately defined, e.g. in the case of large proteins such as antibodies and antibody fragments. However, the term 'molar radioactivity' or 'molar activity' is preferred if the molecular weight of the labelled compound is known:

Molar (radio)activity - the measured radioactivity **per mole** of compound; measured in Bq/mol or GBq/µmol, etc.

Due to radioactive decay, the measurement time for specific (radio)activity or molar (radio)activity determination must be stated; e.g. 'the specific radioactivity was 50 GBq/mg' or 'the molar radioactivity was 50 GBq/µmol' 2 h after the end of nuclide production, at the end of synthesis, at time of administration, etc.

Apparent molar (radio)activity and apparent specific (radio)activity
The terms apparent molar (radio)activity and apparent specific (radio)activity take into account the mass of non-radiolabelled compound(s) (using moles, or weight, respectively) which have similar physical, physiochemical or (bio)-chemical properties to the radiotracer of interest (e.g. [^{11}C]methylspiperone and its labeling precursor spiperone. The latter is a chemically different, but related compound with similar chromatographic and receptor binding characteristics to the radiotracer itself).

The term "pseudo-specific activity" must not be used.
'No-carrier-added', 'carrier-free' and 'carrier added'

The non-quantitative terms “carrier-free” (c.f.), “no-carrier-added” (n.c.a.) and “carrier-added” (c.a.) can be used as a general indication of the level of specific/molar activity being used. These terms have already been adequately defined by A.P. Wolf (J. Label. Compd. Radiopharm. **18**, 1-2 (1981)).
(N.B: The term “carrier-free” should only be used in cases where an analytical verification has proven this state, i.e. the theoretical specific or molar activity.)

Radionuclide and radioisotope descriptors

The enrichment of a chemical compound with an isotope (stable or radioactive) of one or more of the elements of which it is constituted, is indicated by the symbol of the element, together with its mass number, in square brackets immediately preceding (i.e. without a hyphen or space) the compound’s name or chemical formula; e.g. [^{2}H,^{14}C]benzene, or [^{2}H,^{14}C]$C_6H_{6,}$ for benzene (enriched or) labelled with stable deuterium and radioactive carbon-14.
For example, L-[^{11}C]methionine or [^{11}C]L-methionine are correct, however L-^{11}C-methionine or L-[^{11}C]-methionine are incorrect!
Rules for designating labelling positions (e.g. L-[*methyl*-^{11}C]methionine or L-[*carboxyl*-^{11}C]methionine), are described in the IUPAC document: http://goldbook.iupac.org/index.html.

In the case of “fluorobenzene” labelled with fluorine-18, [^{18}F]fluorobenzene is correct, while [^{18}F]benzene is incorrect, since benzene does not contain a fluorine atom.

Furthermore, [^{11}C]compound, [^{125}I]-substitution, or [^{18}F]-derivative and [^{68}Ga]conjugate, are incorrect terms, since these nouns are not names of “chemical compounds”. These should instead read as follows: ^{11}C-compound, ^{125}I-substitution, ^{18}F-derivative and ^{68}Ga-complex (note: with hyphen), or preferably: ^{11}C-labelled compound, substitution with iodine-125, ^{18}F-tagged derivative, and ^{68}Ga-labelled conjugate, or ^{68}Ga-complex of a chelator.

Similarly, some incorrect terms are still commonly found in literature such as [^{11}C]labelling, [^{64}Cu]-labelling, or [^{18}F]-(radio)fluorination. These are erroneous because ‘labelling’ and ‘radiofluorination’ are verbs and of course do not contain “chemical elements”. These should instead read: ^{11}C-labelling, ^{64}Cu-labelling and ^{18}F-fluorination, while the prefix ‘radio’ is redundant here.

In a published chemical text, fluorine-18, indium-111, etc., should be used, rather than “^{18}F” and “^{111}In” (at least not without definition). Generally, terms such as 18F, F18, F-18, or 99mTc, Tc99m,Tc-99m must not be used.
Likewise, ^{18}F^{-} (the fluorine-18 anion) is more accurately described by the terms [^{18}F]fluoride ion or [^{18}F]F^{-}.

The rules described for covalently (radio)labelled compounds above should also be used in the descriptive nomenclature of chemical formula and names of metal compounds and ligand complexes, e.g. [^{223}Ra]$RaCl_2$, [^{99m}Tc]$NaTcO_4$, [^{99m}Tc]Tc-MDP, and [^{99m}Tc]Tc-MIBI. Examples of radiometal-labelled conjugates are:

"[^{68}Ga]Ga-chelator-Z", where "Z" is a place holder for a molecule to which the [metal(ligand(s))$_n$] complex is attached, e.g., a peptide or antibody such as [^{68}Ga]Ga-DOTA-TATE and [^{89}Zr]Zr-DFO-trastuzumab.

It should be noted that square brackets are also used to denote metal complexes, and care should be taken to avoid confusion with radionuclide descriptors. (see: Nomenclature of inorganic chemistry, IUPAC Recommendations 2005: www.**iupac**.org/fileadmin/user_upload/databases/Red_Book_2005.pdf) Illustrative examples include [^{99m}Tc][$Tc(CO)_3(OH_2)_3]^+$, [^{111}In][$In(DTPA)]^{2-}$, [^{111}In][$In(oxyquinoline)_3$] ([^{111}In]In-oxine), or [^{64}Cu][Cu(ATSM)].

The terms '(radio)isotope' and '(radio)nuclide' are often used incorrectly in texts (e.g. inferring that "isotope" means "radioactive nuclide" or even "labelled compound").

For the sake of clarification, the definition of these terms are given below:

- 'Nuclide' indicates an atom, characterised by its number of protons (identifying its elemental nature) and of nucleons (indicating its mass).
- 'Isotopes' are nuclides of the same element (same proton number), but having different numbers of neutrons (hence different atomic mass). Isotopic nuclides of different energy state are called isomeric nuclides, isomeric isotopes or isomers, such as technetium-99g and -99m.
- Nuclides and isotopes exist in stable and radioactive form; i.e. radionuclides and radioisotopes, such as ^{1}H, ^{2}H (stable), ^{3}H (radioactive).

Radiochemical yield (RCY)

Radiochemical yield (RCY) *(Definition)*
Radiochemical yield is the amount of radioactivity in the product expressed as the percent of related starting radioactivity used in the corresponding synthesis (step). The **quantity of both must be decay corrected to the same point in time** before the calculation is made.
For clarity, measures of RCY should indicate whether the product is isolated or non-isolated.

By comparison, colloquial terms for "radio-yield" found in literature are neither necessary nor helpful: e.g. expressions such as 'radiochemical conversion', 'analytical radiochemical yield', 'radio-HPLC yield' must not be used as a surrogate for the accepted terms 'radiochemical yield' or the 'radiochemical purity', respectively.

The following are examples of good practice when describing radiochemical yield:
'The radiochemical yield was 67 % (based on HPLC analysis of the crude product)."
'The radiochemical yield* was 67 %", with the following comments as a footnote:
- "*determined by radio-HPLC analysis of the crude product", or

- "*non-isolated, estimated by radio-HPLC),
or, in the general experimental section: "All radiochemical yields were determined by HPLC of the crude product, unless stated otherwise.",
or alternatively use: 'The radiochemical purity of the crude product was 67 %."
"The analytically determined radiochemical yield from aliquot samples amounted to ..."
or: "The radiochemical yield of crude "X "was 32% based on the amount of radioactivity eluted from the HPLC column.

Expressions such as 'conversion' or 'incorporation' may, however, be used in a semantic sense and even be indispensable in context of mechanistic discussions to avoid repetition of the same phrase in a text. For example: "The 'conversion' (or 'incorporation') proceeded with a 50 % yield. Here it is clear from the context, that the radiochemical yield of the conversion or incorporation is intended. In this case, the prefix "radio" is to be avoided.

Radioactivity yield
Radioactivity yield is the amount of radioactive product expressed in Bq (MBq, GBq) which is obtained from a starting amount of radioactivity (e.g. produced from a cyclotron) and is not corrected for decay.
This term is useful, or necessary to indicate the efficiency of a labelling procedure and is dependent on the technical manipulations used, and on their duration, in addition to the yield of the labelling reaction.

Definitions of purity

Chemical purity
Chemical purity is the absence of other chemical compounds/species.
Measures of chemical purity should be accompanied by a description of the method of detection: e.g. 'compound X was obtained in 98% radiochemical purity determined by analytical HPLC by UV absorption at l = 254 nm'.

Radiochemical purity
Radiochemical purity is the absence of other radiochemical compounds/species.

Radionuclidic purity
Radionuclidic purity is the absence of other radionuclides.

Radioisotopic purity
Radioisotopic purity is the absence of other radioisotopes.
(This refers to radioisotopes of the same element, but not to radionuclides of other elements!)

A working group (WG) on 'Nomenclature' in Radiopharmaceutical Chemistry and related areas, was assembled in 2015 with the aim to generate a consensus for the utilization of a standardized nomenclature for the field. The initiative was triggered by the 'Drug Development Committee' of the 'European Association of Nuclear Medicine' (EANM) together with experts active at a host of relevant scientific societies (the EANM, the 'Society of Radiopharmaceutical Sciences', the 'Society of Nuclear Medicine', the 'Society of Radiopharmacology', and several national societies).