GUIDELINES FOR EVALUATORS

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CONTENTS

GUIDELINES FOR DECAY AND REACTION DATA SETS

A. Extraction of Data

1. In any experiment, the author's basic measured quantities should be quoted, unless these data can be converted to more usual or convenient forms by applying known numerical factors (for example, mean-life to half-life, BE2(sp) to BE2).

Quote what was actually measured in an experiment and not necessarily what the authors quote, in cases where these are different.

> Note: A measurement of $I\gamma/\Sigma I\beta$ might be quoted by an author as $I\beta$(gs), which, for the author's decay scheme should be equivalent to the absolute $I\gamma$ determination, but is not as fundamental a quantity. If the decay scheme is changed, the $I\beta$(gs) could change, whereas the absolute $I\gamma$ measurement should still be valid. Failure to make such an important distinction is a particularly common source of confusion when normalization conditions are being stated.
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> A measurement of $I\gamma^{+-}/I\gamma$ might be quoted by an author as $I\beta^{+}/I\gamma$. The ratio should be expressed in terms of the annihilation radiation, since $I\beta^{+}/I\gamma$ could imply that the positron spectrum was measured.

2. Document any and all changes made in data quoted from an author. When correcting an author's value for a quantity, for example an error due to a misprint, give the corrected value in the appropriate field, and mention the uncorrected value in a comment. Do not give the uncorrected value in the field, and rely on the comment to define and explain the correct value.

3. When extracting data from an author's paper, note any assumptions, standards, or constants that enter into a derived value, and correct the data for any changes in these assumed values. For example, an ε/α ratio for one nucleus might depend on the value assumed for another nucleus, or a conversion coefficient might be normalized to a standard value. Such data should be presented in such a way that the effect of changes in any of the assumed values is clearly displayed; thus, "α_k = 0.0324 12 if α_k = 0.0324 12 if $\alpha_k(^{137}Cs)$-……". Better values for the assumed quantities might be available at the time the mass chain is being revised.

4. Check the bibliography in each article against the reference list provided by BNL. This action is a valuable cross-check to help ensure that references have not been overlooked. Also, authors will sometimes quote data received as private communications; these data should be tracked down if possible if they seem important.

5. Do not rely on an author to extract older data correctly. Even if an author collects such data in a table, the original article should be checked. This checking procedure is especially important in view of 3, above.

6. Be sure to distinguish between values measured by an author and those deduced by the same author. For example, in a transfer reaction, an author might adopt L values for some transitions based on known $J\pi$ in order to extract values for other levels. Such a distinction should be made clear.

B. Manipulation and Presentation of Data

1. Comments

(a) For data sets in which the data appear in two or more separate sections in the data sheets output, namely decay data sets and reaction data sets involving gammas, the comments should always be written in such a way that they are clearly separated into general comments, comments on levels, comments on gammas etc. This "separation" of comments avoids the problem of having comments appear where they are not appropriate (of course these comments can be edited out where they are not appropriate, but this is a step that should be avoided).

> Note 1: A single comment such as "the level scheme is that of . . . based on. . . The Eγ and Iγ are from …, with Iγ normalized so that... The Iβ are from the I(γ+ce) imbalance at each level" should be rewritten as separate general comments on levels, gammas and betas, or as specific data-type comments on Eγ, Iγ, Iβ, as appropriate.
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> Note 2: Comments on γγ(θ), γγ(t), γ(θ,H,T) etc. in a given data set should normally be given with levels rather than with gammas since it is usually under the levels listing that one wants to see comments on the values of J, T½, or μ etc., deduced in that data set from measurements of these types. If the γγ(θ) data also yield δ values, the comment on δ in the gamma listing can simply state that the relevant γγ(θ) data are discussed in the levels listing.

(b) General comments of a descriptive nature at the head of individual data sets should be kept to a minimum. In particular, comments for each keynumber that describe what was measured (such as Eγ, Iγ), or what detection method was used (such as semi, Ge(Li)) are not required, but can be given at the evaluator's discretion. The only required comments are the specification of bombarding energy and energy resolution for reaction data sets. Projectile energy and experimental resolution should be given for each reference from which data are quoted, even if not a major source. Such information may also be useful for other references. For grouped reactions, such as (HI, xnγ) or Coulomb excitation, the bombarding particle would of course also need to be specified for each keynumber. In addition, for Coulomb excitation, the distinction between particle detection, (x, x'), and gamma detection, (x, x'γ) should be made. Examples are given in (e) below.

> Note 1: The bombarding energy and resolution for reference "A" are of interest in a case where, although most of the excitations energies are from some other source, reference "A", whose data are not otherwise included, reports a level not seen by the other sources, and the evaluator chooses to include this level. In many cases, evaluators refer to reference "A" only in a comment on the specific level in question; however, reference "A" should be included explicitly with the other references in the heading.
>
> Note 2: The specification of "s" for spectrometer is an example of the additional type of information that is probably not worth giving, since such an entry conveys only partial information on the experimental setup while giving the analyzer the fact that photographic plates and aluminum absorbers, for example, were used may be of equal importance. In most cases it would be very difficult to write exhaustive comments such that the reader would not have to look at the paper to obtain the necessary experimental details, so there is no strong reason for giving just part of the picture. The specification of "semi" or "Ge(Li)" is also not really needed. Few modern papers contain "scin" data. Probably useful to specify "cryst", since such measurements can be very precise, and the calibration uncertainties are then known to be proportional to Eγ.

Note 3: Specific comments such as "Eγ are weighted averages from 77Sc02 and 79Fell. Others: 72Go04, 78Hi23" specify the important references for Eγ, and are more informative than a set of keywords presented uncritically.

Note 4: The specification of the angular range might be useful in a case such as the assigning of L = 0 as opposed to L = 2 in (α, α') for a giant resonance. This assignment requires knowledge of the angular yield variation at angles near zero. An indication that this range was measured lends credence to an author's conclusion that L = 0. However the same information could be given instead in a comment discussing the author's conclusion.

c) Do not put E = … on the ID record, except when needed to distinguish otherwise identical data sets, for example, (n, γ) E = th and (n, γ) E = res. The bombarding energy should be put in a comment; see examples in (e) below.

d) Except for even-even targets, Jπ(target) should be given for particle transfer reactions in which L values were determined. A general comment such as "Jπ(^{139}La) = 7/2^{+}" is recommended; see examples in (e) below.

e) For readability of the comments referred to above, each keynumber followed by the appropriate comments should be given on a separate line with the keynumber first. The following are some examples.

^{208}Pb Levels from ^{208}Pb(d, d'), (pol d, d')

71Un0l E = 13 MeV, FWHM = 3-10 keV, θ = 125°-150°
80Mo18 E = 86 MeV, FWHM = l x l0^{-3}
80Wi12 E = 108 MeV, θ = 4°-14° (partial data also reported in 80Dj02)
Others: 62Jo05, 68Hi09

^{208}Pb Levels from Coulomb Excitation

69Ba51 (x, x') X = α, E = 17-l9 MeV; x = ^{16}0, E = 69.1 MeV
71Gr3l (x, x'γ) x-α, E = 15,18 MeV

^{208}Bi Levels from ^{207}Pb(^{3}He, d), (α, t) 71Al05

E(^{3}He) = 30 MeV, FWHM AP 20 keV, θ = 10°-70°
E(α) = 30 MeV, θ = 20°, 50°
Jπ(^{207}Pb) = 1/2^{-}

^{208}Bi Levels from ^{208}Pb(p, n), (p, np') IAS

(p, n)	74Fi14	E - 25.8 MeV
	80Ho21	E = 120 MeV, FWHM AP 670 keV; 160 MeV, FWHM AP 1200 keV
	Others:	72Wo23, 71Wo04
(p, np')	73Wo04	E = 30.5 MeV
	77Bh02	E = 25 MeV, n-p' coin
	Others:	79LiZU, 71Wo04

2. Combining data sets

Do not combine reactions that are of fundamentally different character, for example (p, p') and (n, n'), or one-and two-particle transfer reactions.

Except for Coulomb excitation, separate data sets should be created for particle and gamma reactions, for example (d, p) and (d, pγ), or (p, p') and (p, p'γ). Attempting to combine the different types of information usually presented in the two reactions leads to confusion in the presentation. Typically, one wants to present the L (and/or J) and S information from the particle work, and adopted Jπ for the gamma drawings.

The reaction (X, X') is intended to include (X, X); there is no need to include explicitly the special case of elastic scattering.

> Note: In general, we do not include in the data sheets the type of information extracted from elastic scattering, so it is rare that the reaction (X, X) would appear alone. One exception is the case of resonance work, where information on resonances in the compound nucleus can be obtained and may be of importance (see Section F, below). Information on nuclear shapes and charge densities, etc., deduced from elastic scattering can be given, or referred to, in adopted levels without the need for the (X, X) source data set.

3. Sources of data

Sources of data for all headings, for example E(level), Iγ, δ, L, S, should be given unless "obvious". The final decision as to whether a source is obvious or not will reside with the editors. Keep in mind that each evaluator has the responsibility to ensure that the data presented are traceable to their source.

When more than one keynumber is included on an ID record, the keynumber from which the individual pieces of data are taken should be stated. If a reader wants to check an E, Iγ, or S, for example, that reader should be able to go directly to the relevant reference or references.

> Note: A comment on Iγ, stating "from X" or "weighted average of data from X and Y" is preferable to requiring the reader to deduce the sources of data based on the keywords in the general comments described in (1) above.

4. Placement of gamma records

Gammas should be placed in order of increasing energy following each level for consistency in presenting drawings (and for convenience in reading data bank listings). This same order should be followed in the unplaced gammas listing.

5. Significant digits

When converting values from one set of "units" to another (for example, half-life to mean-life, or renormalizing Iγ values), enough digits should be retained so that the inverse operation will reproduce the original values. Note that in some cases this exercise will result in more digits being quoted in the converted value than in the original value. This procedure is especially important when dealing with quantities determined with fairly high precision. For example, from BE2 = 0.384 4, one should report T1/2 = 7.27 ps 8, not 7.3 ps 1, and from a mean-life of 32 ps 1, one should report T1/2 = 22.2 ps 7, not 22 ps 1. Another way of stating this principle is that the fractional uncertainty in the original value should be preserved (to the same number of significant digits) in the converted value.

When taking a weighted or unweighted average, quote a sufficient number of digits to correspond to our round-off procedure; that is, whenever possible, quote two digits for uncertainties up to 25. For example, a weighted average of 6.0 1 and 6.1 1 should be quoted as 6.05 7.

6. Multiplets

(a) Unless a complex peak in a reaction spectrum is resolved in a given experiment, a single "level" entry should be made. For example, in the case of a peak suspected of being made up of two levels with Jπ = a and Jπ = b, respectively, on the basis of work from other experiments, a single level with "Jπ = a and b" in the Jπ field should be introduced. Inclusion in this data set of two levels involves making an explicit assumption that is not necessary. The probable level association can be adequately explained in a comment; this same approach should be used with gammas. A multiply-placed transition seen as a single peak in the spectrum should appear in the output as one transition with multiple placements. Do not introduce additional transitions (with artificially altered energies, or energies taken from the level scheme).

> Note: If the intensity of a gamma multiplet is not divided among the several placements, the full intensity, with uncertainty, should be given for each placement, along with "&" in column 77. Do not enter the intensities as limits in source data sets; converse is true in adopted gammas, where multiply-placed Iγ should be entered as upper limits; see Note under Section E. 2. in GUIDELINES FOR ADOPTED LEVELS. If the intensities are divided, for example on the basis of γγ, "@" should be entered in column 77. These entries will automatically generate footnotes explaining that the transitions are multiply placed and that the intensities are not divided (for "&"), or are suitably divided (for "@").

(b) If a gamma transition or a peak in a reaction spectrum is claimed to be a multiplet, the basis for this claim should be given. For example, the gamma peak might be broad, or coincidence data might suggest that a peak is a multiplet. In the case of a peak in a reaction spectrum, experimental arguments such as "peak is broad" should be distinguished from theoretical arguments such as "C2S is too large for a single level on the basis of shell model expectations".

(c) Consider gamma-ray multiplets where Iγ (peak) in a specific data set cannot be decomposed on the basis of data available in that data set, but branchings involving one or more of the members of the multiplet are available from other data sets; Iγ for members of the multiplet should be deduced where possible using such branchings. Appropriate comments, such as "Iγ: From Iγ(326γ)/Iγ(432γ) in Adopted Gammas", are of course required, and "@" should be entered in column 77.

d) A multipolarity determined for a multiplet will not necessarily be correct for each, or perhaps even any, member of the multiplet. For example, depending on the relative strengths of the components, I(γ) and I(cek) for a doublet consisting of an El and Ml component could yield mult = E2. The multipolarity for the doublet should be given in a comment, but should not be entered in the multipolarity field of the individual components, unless additional information is available that justifies the assignments.

> Note: When I(γ) but not I(cek) (or vice-versa) is resolved, and the multipolarity of one component of a doublet is known from other sources, the multipolarity for the other component may possibly be deduced.

7. Cross sections and analyzing-power should not be given explicitly - sufficient simply to mention that such measurements were made, in the context of justifying any conclusions based on such data. The conclusions themselves should be given.

Note: If an evaluator feels that the angular distribution coefficients do need to be given, they should be defined in the form A2, A4, not A2/Ao, A4/Ao; i.e., we define the angular distribution function as W(θ) = 1+ A2P2(cos θ) +..., not as Ao + A2P2(cos θ) +...

8. (γ, γ') experiments

Some confusion and a lack of consistency in the presentation of data exists in experiments on resonant fluorescence. Scattering experiments are the most common type of measurement that, for the case of photons scattered elastically from a thin target, yields the quantity $gW(\theta)\Gamma(\gamma 0)^2/\Gamma$, where g = (2J + 1)/(2Jo + 1), with J-resonance level spin, Jo = gs spin, and W is the usual angular correlation function. For inelastic scattering, the term $\Gamma(\gamma 0)^2$ in the numerator should be replaced by Γ(γ0)Γ(γi) where Γ(γi) refers to the de-exciting transition to an excited level with J = Ji. The quantity $gW\Gamma(\gamma 0)^2/\Gamma$, or just $\Gamma(\gamma 0)^2/\Gamma$, should be given in this type of experiment. When J and W are known, the adopted value for Γ(γ0)/Γ (= I(γ0)/ΣI(γ) in the case of bound states) should be used where available to deduce the level width (or T1/2). For the inelastic case, the corresponding intensity ratio I(γi)/ΣI(γ) would be needed.

> Note 1: Measurements are usually undertaken at 127° where W = 1 for all dipole transitions, independent of Jo, J, or Ji (P2(cos θ) = 0 at this angle). For mixed transitions, W depends on the mixing ratio and on the J values.
>
> Note 2: Occasionally, self-absorption experiments are performed to yield gWΓ(γ0)/Γ.

The quantity $\Gamma(\gamma 0)^2/\Gamma$ can be given in the “S" field, with the field suitably relabelled (see Section G. 1. below). This procedure eliminates considerable typing at the input stage. The quantity Γ(γ0)/Γ can be given in the RI field for the relevant γ or as a comment on the corresponding level.

9. BEλ and βλ

Consider Coulomb excitation and (e, e'), where electromagnetic excitation probabilities can be determined, in which the quantities BE2, BE3, etc. , should be quoted on continuation level records. Data quoted as matrix elements should be converted to BE2 etc. A matrix element has been determined and this fact could be added as a comment. Note that $BE\lambda = (2Jo + I)^{-1}|<ME\lambda>|^2$, where <MEλ> is the matrix element, and Jo is the target spin.

> Note: Do not give BEλ data with the gammas. BEλ(down) data, given by an author for gammas, should be converted to BEλ(up) and given with the corresponding level. The appropriate place for BEλ(down) data is in adopted gammas where we give such values in single-particle units based on adopted T1/2, branching, etc., data.

For inelastic reactions other than those governed by the electromagnetic interaction, the appropriate interaction strengths to quote are the deformation parameters, βλ or βλR. Authors sometimes convert the deformation parameters to BEλ, but this is a model-dependent procedure and unless the authors quote only BEλ the deformation parameters should be entered into ENSDF.

10. Delayed gammas

For an in-beam reaction in which both prompt and delayed Iγ from level X are available, there are two methods of accounting for the data.

(a) If only one reaction (or more than one but grouped together such as in (HI, xnγ) contains data on the delayed transitions from level X, two data sets can be created: one labelled with the modifier "prompt gammas" and the other with the modifier "delayed gammas".

(b) Preferred method is to create an IT decay data set for level x.
This alternative is especially recommended if there is more than one source of data. A single IT data set which combines the results from all the relevant reactions is preferable to creating several delayed-gamma data sets from the several reactions for the same level X.

> Note: The prompt data should always be presented; however, the separation into prompt and delayed data sets can be particularly useful when the delayed-gamma intensities are used to obtain multipolarities based on intensity balance arguments.

If the delayed data are rather sparse, and the results from the data, such as multipolarity information or T1/2, can be conveniently quoted in the prompt data set, (for example "Mult: from α deduced from intensity balance in the delayed spectrum"), the evaluator may choose to combine all the data in a single data set.

11. Data sets without level information

Separate data sets for reactions studied, but for which no specific level information is given, can be included at the evaluator's discretion if the experiment yielded some useful information. Such a data set would consist only of comments. The following are examples.

^{208}Po from ^{204}Pb(^{16}O, ^{12}C) 76Da18

E = 93 MeV
The authors deduce Γ(α) for the ^{208}Po ground state and compare with the corresponding α-decay value via R-matrix theory using the same target-plus-α nuclear potential.

^{208}Pb from ^{208}Pb(p, n) 74Sc0l,74Sc3l

E = 25.8 MeV
Authors deduce rms neutron/proton radius ratio = l.07 3

> Note: The information contained in such data sets in many cases could also be included as comments in adopted levels. This is especially true for the second example; however, unless a data set is created for a reaction, there is no convenient way to search and retrieve that reaction and thus to indicate to the reader that such a reaction was studied. If a reaction was studied but no "useful" information is available, the best approach would be to simply list the reaction under "Other reactions" in a comment on adopted levels.

12. β- and ε + β + feedings, and logft

Logft values should be made consistent with the deduced β^- or $\varepsilon + \beta^+$ feedings. In particular,
when I ± ΔI is consistent with zero (for example 3% 3), the corresponding logft should be expressed as a lower limit corresponding to a feeding of I + ΔI(6% in this case). Branches that overlap zero (for example, - 3% 6), should be shown with the feeding given as an upper limit (<3%), with the corresponding logft given as a lower limit.

> Note 1: The above holds for cases where the feeding can be expected to be non-negligible, i.e., where the transition is ΔJ = l, Δπ = yes or no, or ΔJ = 2, Δπ = yes. Where Jπ change implies negligible feeding, feeding should be set to zero. Any deduced feeding not consistent with zero should be commented on and an explanation for the inconsistency given if possible.

An exception to this policy of omitting "unphysical" branches occurs when the initial or final Jπ is in question; there is no clear evidence whether Jπ or the feeding is in error. Under such circumstances , the β^- or $\varepsilon + \beta^+$ branch should be shown, perhaps with "?", and the problem should be pointed out in a comment.

Note 2: Summed feeding to two levels connected by a transition whose TI is not known, or is known only as a limit, can sometimes be determined even though the feeding cannot be divided between the two levels. Such combined feedings should be given in a comment.

13. Normalization

The normalization condition should always be given. Be sure to account for both NR and BR.

Note 1: If the normalization condition involves a measured quantity for which no uncertainty is quoted by the authors (for example, I(β^- gs) = 30%), try to assign an uncertainty. If you can not do so, or choose not to do so, the resulting NR (or NR x BR) should be given as approximate. If NR is given with no uncertainty, GTOL will generate level feedings, and MEDLIST will generate absolute intensities that reflectonly the uncertainties in the relative intensities. If ΔI(β^-) is assigned in the given example, the uncertainty can be explicitly added to I(β^-) in the listing, with an appropriate comment, or simply referred to in the normalization statement, for example, "NR:...the evaluator hasassigned an uncertainty of x% to the intensity of the gs β^- branch in order to get an overall uncertainty for NR". The former approach is recommended. Note that when the gs branch has a small intensity (say a few percent), even a large assigned uncertainty can result in a rather precise NR as calculated from ΣTI(gs) = 100 - Iβ^-(gs).

Note 2: When Iγ in the RI field already include all the uncertainty appropriate for absolute intensities, such as when an author determines and quotes absolute values (including absolute uncertainties), NR and BR should introduce no additional uncertainty and should be given on the "N" record with no uncertainty (there is no requirement that the uncertainty in BR, as given in adopted levels, be carried over to the "N" record in a decay data set, although the value must be the same).

14. Parent records

Fields where data are known should be completed in the parent record, and the data should be the same as in the adopted data set. Comments on the "P" record should not be given unless necessary. The appropriate place for comments on any of the quantities appearing on the "P" record is in the adopted data set for the parent nuclide.

15. Miscellaneous

(a) The symbol "/" should not be used when proportionality of more than two values is defined The expression K/L/M is mathematically equivalent to KM/L, even though few readers would interpret the term in this way. Use ":" instead: to give K:L:M.

(b) Do not replace numerical values with large uncertainties by approximate values.

Note: An "isomer" energy of 230 300 keVallows for the possibility that the isomer may lie below the "ground state" by 70 keV. If the energy is replaced by ~230 Kev, this possibility (while not ruled out) will not be conveyed to most readers.

(c) Try to resolve discrepancies - if they cannot be resolved, state this lack of resolution.

> Note: If $\delta = +0.38$ is adopted for a certain transition, the value $\delta = +2$ appears in one of the source data sets, and the reason for the discrepancy cannot be determined, the evaluator should comment on the discrepancy. These comments can be logged in the source data set by pointing out that the value differs from the adopted value, or in adopted γs where the discrepant value can be mentioned in a comment. If something of this nature is not done, the reader might think that the discrepant value had been overlooked and may question the adopted value. If there are several such "discrepant" δ values in a certain data set, a general comment rather than a comment on each case could be given.

(d) Use the word "uncertainty" rather than "error" to refer to what we call the standard deviation in a measuredquantity. The word "error" should be reserved for mistakes, such as in the sentence "The authors apparently made an error when they ...".

(e) Note that TI is translated as I(γ+ce), not $I(\varepsilon+\beta^+)$, even though the fields have the same name in ENSDF. When $I(\varepsilon+\beta^+)$ is meant, this definition must be spelt out.

(f) A level designated as an isomer in one data set should be treated as an isomer in all data sets (that is, columns 78 and/or 79 should be completed).

(g) Do not comment on correction factors for a quantity when such correction factors are negligible relative to the uncertainty quoted for the quantity. For example, μ = +3.8 5 does not require a comment stating “diamagnetic correction has not been applied".

(h) Avoid the use of "CA" in the uncertainty field when a numeric uncertainty can be calculated.

> Note: If Iγ is calculated from TI and α, the uncertainty in Iγ (from the uncertainty in TI and α), rather than "CA", should be placed in the uncertainty field.

(i) When calculating or correcting quantities that depend on other properties (for example, calculating conversion coefficients which depend on Eγ, calculating T1/2 from BE2 which depends on Eγ, branching, δ, and α, or correcting g factors for their dependence on T1/2), adopted values of all other relevant quantities should be used.

(j) When working with an author's proposed decay scheme, the evaluator should make a search for possible alternative gamma placements between known levels.

(k) Enter data in E(ε) or $E(\beta^-)$ fields only when they are of sufficient accuracy that in the evaluator's judgement they should be considered as input to the mass adjustment. Values that are of somewhat lesser accuracy but still "significant" could be mentioned in comments. Very imprecise values are probably not worth recording. All the network analysis programs that require these energies obtain them from the appropriate Q-value and level energy.

> Note: A measurement of β^+ endpoint must be entered as $E(\varepsilon) = E(\beta^+) + 2mc^2$. For example, a comment such as "E(ε): From $E(\beta^+)$=...(keynumber)" would be appropriate.

(l) Alpha-decay data sets: if the energies of the daughter levels being fed are not known, E(level) = 0 + X style should be used rather than listing the alphas as unplaced. With this procedure, relative level energies can be presented in the daughter-nucleus mass chain. Alternatively, a level energy from systematics can be given (see Section C. c), below). Note that there is no such thing as an unplaced alpha, unless one is referring to an alpha with uncertain parent assignment.

(m) Measurements of $P_k\omega_k$ (= I(K-x ray)) should be given. Adopted values can be entered on a continuation "E" record. These quantities are of direct interest to some researchers, and provide a direct measurement of the K-x rays, either for ε branches to individual levels, or an average for the whole decay scheme. When possible, $P_k\omega_k$ should be compared with I(K-x ray) as calculated by RADLIST.

(n) If numerical data are quoted in comments, the uncertainty should be included unless the value is only being used as a label; thus, "T1/2: From BE2 = 0.240 6", or "μ: From g = 1.62 3 in (α, 2nγ)". Even though the actual numerical value is not needed in all cross references, the uncertainty should be included.

(o) When changing the sign of a mixing ratio which has an asymmetric uncertainty, note that
δ = A + a-b becomes δ = -A + b-a (not -A + a-b).

(p) The ground state should be included in all data sets of the type (X, X'), i.e., inelastic scattering.

C. Systematics

Use should be made of systematics whenever possible, the extent to which they can be applied in any given case being determined by their reliability. The evaluator is usually in a better position to know how and when to apply systematics of a given quantity than the typical reader who is generally looking at just one or perhaps a few mass chains at a time.

> Note: Network evaluators make extensive use of systematics. Strong arguments for Jπ assignments which rely on logft values, strong arguments for multipolarities that rely on RUL, and extrapolations from the measured data in the mass adjustment (which are called systematics values) are prime examples.

One area in which systematics are particularly valuable is the estimation of ground and isomeric state branching ratios.

(a) Plots of Log T1/2(α) vs log E(α) for nuclides with the same Z are usually linear. For a nuclide whose alpha branching has not been experimentally determined, use of T1/2(α) vs E(α) systematics can sometimes yield a reliable estimate of T1/2(α) which, along with the measured total T1/2, yields the alpha branching. On more than one occasion, such an estimate has been invoked to show that an experimental value must be incorrect; see also (c), below.

(b) Gross beta decay T1/2(β^-) and T1/2($\varepsilon + \beta^+$) estimates from (for example) Takahashi et al., Beta-Decay Half-lives Calculated on the Gross Theory, At. Data Nucl. Data Tables 12 (1973) 101, can be used to estimate β^- or $\varepsilon + \beta^+$ branching fractions. These estimates are considered to be reliable to better than a factor of approximately 3; thus, while an estimate of %β^- ≈50 and branching for the alternate modes of ≈50% should be considered as very approximate, an estimate of %β^- ≈ 0.1 can be used to assign the alternate mode(s) as essentially 100% with a high degree of reliability.

Additional areas where systematics arguments should at least be explored include the following.

(c) Systematics of alpha-decay hindrance factors can be used to deduce a variety of quantities (depending on what is known about the decay branch). These include Jπ and configurations, total alpha branching and branchings of individual groups, and the excitation energy of the level fed in the daughter nucleus. Each evaluator (or centre) responsible for a mass region in which alpha decay occurs is encouraged to build up such a set of systematics. See Schmorak, Systematics of Nuclear Level Properties in the Lead Region, Nucl. Data Sheets 31 (1980) 283; and Schmorak, α-Decay Hindrance Factors in the ENSDF procedures manual for further discussion of these and other types of systematics.

(d) When a certain pair of shell- or Nilsson-model orbitals gives rise to the appearance of an isomeric transition over a reasonably large mass range, the reduced transition probabilities for the isomeric transition usually fall within a narrow range of values. Such data can be used to estimate properties for the "same" transition where one piece of information is missing, such as T1/2, IT branching, or Eγ.

(e) When a ground-state β^- branch is not known and there is no other way to determine the gamma normalization, logft values for similar transitions may exhibit local systematics. Even if the evaluator decides not to give an explicit normalization factor, a comment would be of value to the reader that points out what this factor would be if the transition had a logft value similar to other such transitions in the same region.

> Note: From $\log f^{1u}t > 8.5$ one might derive $I\beta^-(gs) < 10\%$. While this estimate might be the best one can do, systematics of $\log f^{1U}t$ values for other transitions of similar type (i.e., transitions between similar configurations) might suggest that the probable intensity is < 5%, or even close to zero. In such cases, the evaluator can adopt the systematics value for the limit on the β^- feeding in order to obtain the normalization. Justification for the chosen value must be stated. The systematics value could also be entered directly in the Iβ field, with an explanation for the source of that parameter instead of (or in addition to) the value derived from the normalization factor.

D. Uncertainties

1. Estimation of uncertainties.

When an experimental value is quoted by an author without an uncertainty, the evaluator should attempt to estimate and assign an uncertainty to that quantity if that quantity is required in further calculations, or if that value is a quantity that needs to be adopted and no other value is available.

> Note 1: The normalization of a decay scheme may sometimes involve a measurement quoted with no uncertainty; see Note 1 in Section B. 13, above for a discussion of a ground-state beta transition with no quoted uncertainty that is needed for the normalization of the decay scheme.
>
> Note 2: When one or more excitation energies in a reaction data set (quoted with no uncertainty) need to be included in the adopted levels, the evaluator should attempt to estimate the uncertainty for these excitation energies. Uncertainties can sometimes be estimated by comparing the author's values with adopted energies in regions where there is overlap. Occasionally, comparison with data for other nuclei included in the paper can also be helpful.

2. Adoption of uncertainties

Weighted average program GTOL and all other analysis programs that calculate uncertainties when individual values with uncertainties are combined, treat the individual uncertainties as statistical in nature. When the uncertainties are known to have a significant systematic component, the output from the above programs should be modified as necessary, particularly in cases where the quoted uncertainty is mainly and clearly systematic (due to a calibration uncertainty) so that the adopted uncertainty should be no smaller than the smallest of the input uncertainties. No result obtained from a weighted or unweighted average program or by any other method can have an uncertainty smaller than the uncertainty (or uncertainties) in the calibration standard(s) used to determine the input values.

3. All uncertainties in extracted data (for example, Eγ, Iγ, E(level) and T1/2) should be accounted for, either explicitly or in comments. Authors occasionally quote peak-fitting uncertainties and then

state that an additional x% should be included to account for other sources of uncertainty, or they quote the value for some quantity relative to a standard value.

> Note I: Consider Iγ in which these additional uncertainties, if independent of Eγ or Iγ, can either be included in NR, or explicitly combined for each transition with the partial uncertainties given by the authors. Since the intensity ratios of transitions close in energy may be nearly independent of the additional uncertainties, there may be an advantage in accounting for these through their inclusion in NR, although additional uncertainties that have been folded in can always be folded out if necessary.
>
> Note 2:, Additional uncertainties should be included explicitly in the case of data describing other quantities, at least for quantities that are used in adopted levels and gammas. Neither network analysis nor listing programs are capable of making use of a comment such as "an additional uncertainty of x eV should be added in quadrature to the Eγ to account for uncertainties in the calibration". If an author quotes a value of T1/2 or a g factor relative to a standard, the uncertainty in the standard should be included when the value is adopted or combined with other measurements.

4. When undertaking calculations, the evaluator should attach an uncertainty to all theoretical α values (3% is recommended). For example, calculations of TI = Iγ(l+α) (or Iγ = TI/(l+α) or T1/2 from BE2) should include this uncertainty. The contribution of this uncertainty to the total uncertainty is negligible in many cases, but in normalizing 100% IT decay to Iγ(l+α) = 100, or normalizing a decay scheme in which only a single transition feeds the ground state and Iγ for this transition is given by the authors with no uncertainty, the uncertainty in α will be the only uncertainty in the normalized Iγ (assuming that the decay scheme is known with confidence). A comment should be included to explain what was done, and this uncertainty should not be entered in the Δα field. Our analysis programs already assign 3% uncertainty to α when performing calculations involving this quantity.

5. Numerical uncertainties larger than 25 should, normally be rounded off.

> Note: Data should be quoted in units such that this round-off convention can be applied. For example, T1/2 = 250 ps 50 should be quoted as 0.25 ns 5, and a set of Iγ data given by an author normalized to $I_{\gamma I}$ = l000 70 should be renormalized to $I_{\gamma i}$ = 100 7. Energies: since the standard energy unit is keV, values such as Q^- = 2000 150, or E(β^-) = 2450 80 do not have to be converted to 2.00 15 MeV, or 2.458 MeV.

E. Resonances

Although the data coverage in ENSDF is limited to the bound-state region, any properties of the bound levels deduced from resonance work should be included. Eγ and 1γ data from (p, γ) and (n, γ) reactions do not need to be included in ENSDF except as noted below.

> Note: A typical case of interest involves the study of average resonance neutron capture in which Jπ values have been deduced on the basis of reduced transition intensities. The resulting data set needs to contain only the bound levels fed from the resonances, along with the deduced Jπ values; Iγ presented typically as Iγ/Eγ are not required. In fact, they should not be given since they are just average quantities, and are only significant from the point of view of ENSDF for their use in deducing Jπ (in this sense, they are analogous to angular distribution coefficients).

Resonance data should be included in the following cases.

> a) Isobaric analog resonance data should be included; they should also be included in adopted levels.
>
> b) Giant resonance data should be included, although data of this type are available for only a few nuclides.
>
> c) Eγ, Iγ (and other relevant data) from thermal neutron capture should be included.
>
> Note: Excitation data for isobaric analog resonances should appear with the nucleus in which the resonances occur. Branchings to daughter levels (for example, in (p, np')), should also be given. Comments that include the deduced energies of the parent states (energies relative to E = 0 for the analog of the ground state), or comments labelling the resonance with the appropriate parent level are useful.

Other situations may arise where the inclusion of resonance data is important (for example, near closed shells where the resonances occur at excitation energies low enough that they may "overlap" adjacent bound states that have been studied). The inclusion of data in this and other special cases is at the evaluator's discretion.

> Note: Energies for resonance data can be entered in the form SN+X, SP+X, where X is the neutron- or proton-resonance energy, usually given in laboratory units (lab, or c.m. coordinates should be specified in either case). These resonances should be converted to excitation energies in the adopted levels.

F. L Transfers

1. A brief comment is required on the method used for obtaining L values; for example, L values "from DWBA analysis" should be distinguished from L values obtained "from comparison of σ(θ) with shapes for levels with known Jπ".

2. Parentheses are used to denote questionable or uncertain values. As described in the introductory section, square brackets can be used to indicate an assumed value, i.e., a value adopted by an experimenter (or by an evaluator) on the basis of known Jπ. This procedure might be adopted for the purpose of extracting S, or for determining empirical angular distribution shapes so that L values for other levels can be determined.

> Note: When quoting L values, the evaluator has the option of quoting the author's values and then applying his/her own judgement as to their reliability when incorporating them into Jπ assignments, or of quoting the author's values as modified by the evaluator. For example, an author's L = 2 which in the evaluator's judgement should be L = (2), could appear as L = 2 in the source data set, but as L = (2) if used as a J1I' argument. Alternatively, a value of L = (2) could be entered in the source data set. In either case, a comment is required explaining that the evaluator feels that the L assignment is tentative.

G. Spectroscopic Factors

1. The exact label for the given quantity should be defined by using the "LABEL=name" format described in the manual; thus, "LABEL = C2S".

2. An explicit definition of S should be given if there is any ambiguity about what is meant; thus, "S is defined by “dσ/dΩ(exp) = Nsdσ/dΩ(DWBA) with N=..."

3. The method for obtaining the scale of S should be given, and it is important to distinguish between absolute and relative values. Thus, a comment such as "from DWBA", which implies that the values are "absolute", or "from DWBA normalized to X for the y level" for relative S values, should be given.

4. The shell-model (or other) orbital involved in the transfer should be specified if needed for the extraction of S.

> Note: This orbital can usually be specified in terms of a general comment such as "L-l, 2, and 3 are assumed to be p3/2, d5/2, and f5/2 except where noted otherwise". An alternative method is to give Jπ for the relevant levels along with a comment such as "Jπ: value assumed by the authors for the extraction of S"; the former approach is preferred when practical.

5. When Jπ adopted by an author differs from the evaluator's value, the S value (which will be incorrect) should not be entered in the S field, but given only in a comment. The reason for recommending that the incorrect value be given at all is that a knowledgeable reader can often estimate the value for the correct orbital from the value calculated for the incorrect orbital .

H. Jπ

1. Jπ values from adopted levels should be included where known; the introductory section states that this is our standard policy. For reaction data sets with no gammas, Jπ values should not be given unless they are determined in the reaction in question, or unless they are important in explaining some other aspect of the experiment. Jπ values should be given in reaction data sets with gammas. Note that the introductory section states that Jπ values appearing in the γ reaction data set are adopted values unless noted otherwise.

> Note 1: Reactions that do not involve gammas - Jπ values, such as from L values and analyzing powers in (d, p) reaction, should be given in the Jπ field along with a comment stating how they were determined. Jπ values that come directly from the L values, such as J = L ± 1/2 for single-particle transfer on an even-even nucleus, or L = J in (p, t) on an even-even target, are redundant, and should not routinely be given. Exceptions occur, for example, where the evaluator wishes to indicate the Jπ value used to extract the spectroscopic factor, or to show explicitly the band structure.
>
> Note 2: Reactions involving gammas, e.g., average resonance neutron capture - deduced Jπ values can be given in the Jπ field, or in comments. The latter procedure is recommended since adopted Jπ can then be placed in the Jπ field, in line with the accepted policy of including adopted Jπ values for any reaction data set involving gammas.

2. Arguments used in the Jπ assignments in adopted levels must be documented in the source data sets. The following represent a few examples.

	Jπ	argument
a)	3/2-	L(d, p) = l, 392γ to 5/2- is Ml
b)	1-	Average Resonance (n, γ), γ to 0+
c)	3+	El γ to 2-, γγ(θ)
d)	(5/2)+	L = 2, C2S in (d, p)

(a) (d, p) data set should contain the relevant L value, with any explanation deemed necessary to justify or explain the adoption. Recommended γ data set should contain the justification for the Ml assignment to the 392γ.

(b) Average Resonance (n, γ) data set should contain the value deduced in that data set (Jπ = 0-, l- in the present case), given in either the Jπ field, or as a comment; see also Note 2 under 1, above.

(c) enough detail of the γγ(θ) experiment should be given in the source data set to justify the conclusions. Briefly, this section should mention the assumptions (i.e., what J values for other levels and what δ values for relevant gammas in the cascade were adopted, and should clearly state which values of J are allowed and which are ruled out. For the above example: only necessary to state that γγ(θ) is consistent with J = 3, and rules out J = l and 2.

(d) (d, p) data set should contain L and C2S values for the level in question, and a comment justifying the basis for the C2S argument. For example: "d3/2 strength exhausted by known 3/2+ levels. C2S for the L = 2, E=...level suggests d5/2".

I. Iγ, TI

1. Relative TI data (or absolute, for example, for (n, γ) in preference to branching ratio data) should be given when available.

> Note: If both relative Iγ and branching ratios are available, and if the branching ratios are more accurately known than the relative TI, both sets of data should be given. Relative Iγ should be given in the RI field, and the branching ratios can be given as comments on the relevant levels.

2. Reaction γ s: projectile energy and angle at which the quoted Iγ were measured should be specified unless obvious from the keywords given in the general comments. Relative Iγ values measured under different experimental conditions, such as at a different bombarding energy or angle, should not be combined in the RI field, except where an Iγ from level "X" is deduced from branchings relative to other transitions from level "X".

3. Gamma intensities reported as upper limits are important data measurements; and should be included (a comment to the effect that the transition was not seen could be included). Iγ given as "weak" by an author should be noted as such in a comment; also important to distinguish between cases where a missing Iγ is weak, and where such an emission is obscured by an impurity (and therefore could be strong).

> Note: One could distinguish between observed and unobserved transitions expressed as limits by the use of "≤" for the former, and "<" for the latter; however, the distinction between these two non-numeric uncertainties is not universally agreed upon, and is probably too subtle a distinction.

4. The TI field should be used only if TI, rather than Iγ, is the quantity measured or deduced. Two common cases where this occurs are when TI is deduced from intensity-balance arguments, or TI is given by summing I(ce). When TI is given and α is known, the corresponding Iγ should be calculated and entered into the Iγ field, unless the value is negligibly small. The uncertainty given for Iγ should include the uncertainties in both TI and α; a comment should be given stating that Iγ comes from TI and α.

Note 1: Iγ deduced from TI and α may be given in the RI field even when a direct measurement of Iγ is available, if the evaluator concludes that the deduced value is more reliable than the measured value.

Note 2: When TI rather than Iγ is the basic measured or deduced quantity, K/T(= αk/(l+α)) =... etc. , rather than αk-... etc. format on the continuation record should be used. For example, K/T operates directly on TI to generate the cek intensity (via MEDLIST) and the resulting x-ray intensities. This format avoids including some uncertainties twice, since Iγ (if calculated from TI and α) will already have an uncertainty combined from these two quantities.

5. Do not put TI values in the RI field, even if a comment is included to explain what is being done, and even if all the entries are TI values. RI and TI must not be mixed in the same field.

6. RI (or TI) field should be left blank for a transition which de-excites a daughter nucleus isomer whose T1/2 value is such that the intensity is time-dependent. A computer-retrievable comment should be included that defines % feeding of the isomer, and a comment is also required to explain why the intensity is missing.

7. I(x ray) and I(γ±) data of good quality should be given as comments in the form I(x ray)/Iγ(γi), where γi is the transition to which the γs are normalized. This procedure avoids the necessity of changing the comments if the Iγ are renormalized. The program MEDLIST should be run to compare the measured x ray and γ± intensities with those calculated on the basis of the adopted decay scheme. If the I(x ray))/Iγ or I(γ±)/Iγ measurements are needed to obtain decay scheme normalization, note that MEDLIST can be used in an iterative fashion to deduce NR.

8. Internal conversion intensities are not needed, and they should not be given except in the following cases.

a) I(ce) ratios measured to a precision of better than about 3% should be included. At this level of precision, it is useful to compare such values to the theoretical data.

b) Where no Iγ is given, or where I(ce) are more precise, the I(ce) values should be quoted.

c) I(ce) are needed for E0 transitions, and should also be given for anomalously converted transitions.

9. A limit on a transition intensity (I < A) should be converted to I = 1/2A ± 1/2A for the purpose of calculating quantities that require the intensity of this transition, such as normalization factors, β^- and $\varepsilon + \beta^+$ feedings, or branchings (for branchings, see Note 4 under G. in GUIDELINES FOR ADOPTED LEVELS).

Note 1 : Where $I\beta^-$(gs) is determined to be < 6% and the evaluator has no further information to suggest that this value should be closer to 0 than to 6, the intensity should be expressed as 3% 3 for the purpose of obtaining the gamma intensity normalization; one should set sum TI(gs) = 97 3 and explain what is being done. This procedure is preferable to any of the alternatives, namely setting ΣTI(gs) = 100, or ΣTI(gs) > 97. There is no justification for adopting the first alternative, and adopting the second alternative leads to lower limits being given for all the intensities. The usefulness of the procedure depends on the value of the limit - if $I(\beta^-)$ is known only to be < 50%, perhaps normalizing the decay scheme is not worthwhile, although setting sum TI(gs) - 75% 25 is still better than doing nothing (if no normalization is adopted, a comment could be given stating what the normalization factor would be for the extreme cases, namely for Iβ^- = 0, and Iβ^- = 50). Note that the intensity of the gs β^- group should still be given as a limit in the β^- listing.

> Note 2: Iγ values given as limits should be converted to 1/2Iγ ± 1/2Iγ for the purpose of obtaining β^- and/or ε feedings from intensity imbalances. This procedure may lead to some feedings with rather large uncertainties, but this approach reflects correctly the state of knowledge of the decay scheme. The procedure is analogous to setting mult = [Ml+E2] for a highly converted transition in order to estimate the total intensity. Again, there is no implied suggestion that the intensities themselves should be changed from their limit form in the Iγ field. GTOL program has been modified to treat limits automatically in this manner.

If the evaluator feels that the limit in a given case should not be treated in this fashion, a comment should be given justifying whatever approach is taken.

10. For the purpose of obtaining β and/or ε feedings, gamma transitions whose placements are uncertain (that is, transitions that have a "?" in column 80) should be handled in the same manner as for transitions given as limits discussed in Note 2 under 9, above. One should take Iγ = ΔIγ = 1/2(A + ΔA), where Iγ = A ± ΔA is the measured value. GTOL has been modified to treat uncertain transitions in this manner, but the evaluator will also be responsible for ensuring that the input to GTOL is modified as discussed here.

J. Mult, δ, α

1. As stated in the introductory section, the multipolarity and δ entries (and thus α) for decay data sets should be adopted values. The inclusion of such data is mandatory, while for reaction gamma data sets such information should be included as needed or if measured.

> Note: TI values are not needed in many reaction data sets, nor δ and α. However, the multipolarity should be defined. If TI values are required, adopted values for multipolarity and δ should also be used.

2. When multipolarity and/or δ values are determined, the basis for such determinations should be stated. Sources for the multipolarity data used by the evaluator (such as γ(θ), αk), along with the normalization required in αk data determined from relative Iγ and I(cek), should be given whether or not the experimental data (e.g., A2 and A4, αk, etc.) are explicitly given. Multipolarity assignments from ce data should originate from the evaluator based on the output from HSICC. Multipolarities deduced by the authors (or by the evaluator) on the basis of "stretched" γ(θ) should be noted as a comment in the style of "ΔJ = 1, or ΔJ = 2".

> Note I: γ(θ) data determine only the L component of the gamma character (i.e., mult = D, D + Q, etc). Further assumptions are needed to establish the change in π, and should be stated when D is converted to M1, or D + Q to M1 + E2, etc. In particular, Q = E2 should not be considered an "obvious" conclusion. If T1/2 is known, RUL can sometimes be invoked to eliminate specific possibilities, particularly Q = M2, and D + Q = E1 + M2 when δ is known. If known values of Jπ are used to establish any part of the character of a gamma, that part should be placed in parentheses. Remember that one of the implied uses of a non-parenthesized multipolarity is as a strong argument to assign Jπ values, so one must avoid circularity.

> Note 2: If any multipolarity = D, D + Q, etc. can be assigned as M1, M1 + E2, etc., only by the use of level scheme arguments, the designation mult = D should be retained in the source data set unless the complete designation (mult = (MI)) is needed to determine α. The

mult = (M1) assignment can be adopted when choosing the multipolarity for the adopted γs section. The main advantage in following this procedure (other than the such assumptions should be made onlv when necessary) is that a transition known to have mult = D (strong assignment) may be more useful in defining a Jπ value than having only the parenthesized mult = (M1) (weak assignment). When such an argument is used, the reference for the multipolarity should be to the source data set, and not to adopted γs if the adopted value is mult = (M1).

3. Entries in the multipolarity, δ and α fields should be mutually consistent, and the following guidelines should be followed.

(a) If a single multipolarity is adopted, the δ field should be blank.

(b) If only a limit on δ is available and this limit is significant and worth giving, there are two options.

(i) Give the dominant multipolarity with corresponding α, and give the δ limit in a comment.

(ii) Give both multipolarities and the δ limit in the δ field. The value of α should correspond to 1/2δ(max), with an uncertainty chosen to overlap the 0 to δ(max) range.

Note: Option (i) is recommended when (in the evaluator's judgement) the admixed component is likely to be smaller than the experimental limit; thus, E2 + M3 with δ <0.5 should probably be entered as E2, while M1 + E2 with δ < 0.5 should probably be retained as a mixed multipolarity entry.

(c) If two multipolarities are given but no δ is known, the corresponding α value should be the value calculated as described in 7(a), below.

(d) If the multipolarity field contains more than two multipolarities (e.g. E0 + M1 + E2), the E2/M1 or E2/E0 etc., mixing ratios should be given if known on a continuation record rather than in the δ field.

(e) If δ overlaps zero or infinity, the corresponding multipolarity component should be in parentheses. For δ values with experimental limits that do not overlap zero or infinity, the evaluator may still choose to adopt the corresponding component in parentheses if they feel that the difference from zero or infinity is not significant (equivalent to interpreting the author's uncertainty as being somewhat larger than quoted).

4. The mixing ratio notation (M1 + x%E2) used occasionally by authors should be converted to δ.

5. Mult = M1, E2 is not equivalent to mult = M1 + E2. The first designation refers to the case where the experimental data overlap the theoretical values for both multipolarities. The second designation refers to the situation where the experimental data lie between the theoretical values for the two multipolarities. The designation M1 (+E2) is an intermediate case where the experimental data overlap M1 but not E2 values.

6. If αk, etc. data or conclusions from such data are included, the bases for the adopted values should be given. Thus, the basis for the normalization of the relative scales should be stated for relative I(ce) and 1γ, and the multipolarity for any transition used in this scale normalization should be independently established.

7. When internal conversion is significant but the multipolarity is unknown (apart from level scheme considerations) and TI is otherwise unobtainable and required, the following procedures can be followed.

(a) If ΔJ, Δπ are known, one can enter mult = [M1], [E1 + M2], etc., in the multipolarity field and choose α accordingly. For example if mult = [M1 + E2], one should enter $\alpha = 1/2[\alpha(M1) + \alpha(E2)]$ and $\Delta\alpha = |\alpha-\alpha(M1)| - |\alpha - \alpha(E2)|$.

(b) If ΔJ and/or Δπ are not known, one can still follow the procedure described in (a) and set mult = [D, E2] (or mult = [E1, M1, E2]). Mult = M2 or higher are assumed to be less probable, but can be included.

The usefulness of either (a) or (b) depends on the range of α values for the possible multipolarities.

> Note 1: If ΔJ = l, Δπ = no, mult = [M1 + E2] should be adopted rather than mult = [M1] or mult = (E2] , unless there are good arguments for believing that one of the two possible multipole components dominates. Thus, α from M1 + E2 is always "correct" even with a large uncertainty, whereas α(M1) may lead to misleading conclusions. The possible large uncertainty in α for M1 + E2 when δ is not known reflects the correct state of knowledge concerning the total intensities.
>
> Note 2: The use of the mult = [ ] convention should be restricted to cases in which the internal conversion is significant. Do not assign mult = [ ] simply because the mult can be deduced from the level scheme; see also F. 5. in GUIDELINES FOR ADOPTED LEVELS, below.

8. Experimental αk, etc., and ce ratios that are used to determine multipolarities can be given at the evaluator's discretion; however, values measured with a precision of better than approximately 3% should be given, as well as values for transitions within 2 keV of the binding energy (and thus outside the range of values given by Hager and Seltzer). Except in these cases, the evaluator should state that "Mult and δ are from αk(exp) calculated from relative Iγ, and I(ce) normalized so that ..."; also important to point out when conversion electron intensity ratios rather than just αk have been used, since αk data alone do not always uniquely define a single multipolarity or combination of multipolarities. The references used as sources for the I(ce) data must be given, either in the footnote explaining the source for the multipolarity and δ, or in the general comments.

9. Note the distinction between ( ) and [ ] for multipolarities. These are discussed in the introductory section. Parentheses are used when there are some experimental data, but the data are not conclusive. The square brackets are used to denote a value deduced solely from level scheme considerations. Note that for the case where γ(θ) determines mult = D + Q and the level scheme is used to assign M1 + E2 rather than E1 + M2, the multipolarity should be in parentheses, mult = (M1 + E2), with a comment stating that "mult: D + Q from γ(θ) in ... Δπ = no from the level scheme". Square brackets are not appropriate for this case, since the level scheme argument forms only part of the assignment.

10. Do not define α with a lower limit; Iγ(l + α) could then appear incorrectly as a lower limit whereas there must be an upper bound. The situation arises almost exclusively in connection with transitions that have an E0 component in their multipolarity. Basic data are usually measured I(cek) and an upper limit on Iγ which leads to TI = I(ce) + < Iγ, where $I(ce) = \Sigma_i(cei)$, i.e., TI has an upper bound. This situation is best addressed by giving I(cek) in a comment, along with the Iγ limit in the RI field. TI should be also be defined, and αk can be given in a comment. Only TI = I(ce) will be given for a transition adopted as pure E0.

> Note: Recommended procedure for obtaining TI will depend on the relative magnitude of I(ce) and the limit of Iγ . The most useful quantity to quote for I(ce) >> Iγ is TI = I(ce) ± 1/2Iγ, with an uncertainty calculated in the usual way from ΔI(ce) and ΔIγ = 1/2Iγ; TI < [Iγ + I(ce)] is an appropriate choice for I1 >> I(ce); the first alternative is recommended for the intermediate case,.

K. g Factors, μ, Q

Values of μ should be taken from 78LeZA/2001StZZ where possible and entered directly into adopted levels. The μ values, or the corresponding values of the g factor, do not need to be repeated in the source data set. However, when the value of T1/2 used in 78LeZA is different from your adopted value, the value of μ should be corrected for this difference if possible. A comment should be included if not readily corrected, giving the T1/2 value to which μ in 78LeZA corresponds.

More recent g-factor data should be given in the appropriate source data sets with the corresponding value of μ given in adopted levels (based on the adopted g factor). These values should be corrected for the adopted T1/2 where necessary. When corrected, adopt a comment such as "g: For T1/2=... The authors report g=... for T1/2=... ". A comment is also required stating whether or not the diamagnetic and Knight-shift corrections have been applied (if the data are accurate enough to be affected by these corrections); this comment should be given both in the source data sets and in adopted levels.

Similarly, Q values should be taken from 78LeZA/200StZZ where possible, and quoted in adopted levels. More recent values should be given in the appropriate source data sets, with the adopted value also given in adopted levels. A comment should be given stating whether or not the Sternheimer correction (or some other polarization correction) has been applied, if the accuracy of the measured value warrants such a correction.

GUIDELINES FOR ADOPTED LEVELS, GAMMAS DATA SETS

A. General

1. All distinct levels that are observed in any of the individual data sets and the evaluator feels are firmly established should be included in adopted levels. Uncertain levels (shown with "?" in one or more of the individual data sets) can be included or not included at the evaluators discretion. Isobaric analog states (resonances) should be included; neutron and proton separation energies should not be included.

> Note 1: The calibration and general trend of energies compared with adopted values should be checked for each data set to avoid the introduction of "extraneous" levels,. Corrections should be made for systematic shifts of energies in one or more data sets when the energies from such data sets are used to obtain the adopted value:
>
> (a)to avoid the assignment of level "a" in one reaction as corresponding to level "b" in another reaction based only on the energy difference, and,
>
> (b) to ensure that the energy adopted for level "a", if seen in only one reaction, is as correct as possible.
>
> Note 2: When levels from two (or more) reactions lie close in energy (values agree within the uncertainties) and the evaluator chooses to adopt both (or all) levels, the justification for

assuming that the levels are distinct should be given, unless obvious from XREF or other adopted level properties.

Consider the following cases:

E = 5000 10, Jπ = 3/2+ and E = 5010 10, Jπ = 5/2+ are known from reactions, and E = 5005.3 2 is known from a gamma reaction; however, there is considerable uncertainties as to which of the two reaction levels this level corresponds, and there is no evidence to suggest that the gamma-reaction level is a separate and distinct level. The reaction levels should be adopted, with a comment on each stating that probably the more accurate value of 5005.3 corresponds to one of the two adopted levels. Note that there is no unambiguous way to include the accurate energy as an adopted energy. The evaluator should not adopt three levels, unless there is definite evidence that the gamma-deduced level is distinct from the others.

E-596.7 5 with Jπ = 0+, 1, 2 and E-597.1 3 with Jπ = l+, 2, 3 are known to be different levels, and l(p, d) = 2, leading to Jπ = l-, 2-, 3- with E = 598 2 is also known. Unless there is evidence to suggest that the (p, d) level is distinct, just two levels should be adopted, with a comment on each stating that l(p, d) = 2, Jπ = l-, 2-, 3- for one or both of the levels.

2. Do not unnecessarily adopt values different from those that appear in the literature when the differences are small relative to the quoted uncertainty, and if the literature value has been widely quoted in other sources.

Note: Consider a situation in which an author recommends T1/2 = 6.54 s 22 as an average from several determinations, and this value has subsequently been used by other researchers. The evaluator determines that the value should be 6.56 s 20. Such a small difference does not merit the introduction of a different recommended value into the literature. The slight error in the recommended value should be noted - this warning would be useful in case someone recomputes a recommended value on the basis of some new values, and relies on the earlier quoted recommendation as a single input value representing the old data.

3. Make use of the XREF entries so that unnecessary comments can be avoided. For example, a comment such as "seen only in (d, p)" is not needed since XREF should already convey that information. However, an exception could arise if the evaluator wishes to emphasize some doubt about the level. XREF can also convey "one level corresponds to many levels", so that comments that convey only this information are not needed. However, comments such as "L(d, p) = l for E = 3450" can be given for two or more adopted levels to which the (d, p) level could correspond, and are still needed.

4. Important comments on level properties which appear in source data sets should be repeated in the adopted levels data sets - "doublet", "possible contaminant", "not resolved from X" are usually just as important in adopted levels.

5. If the evaluator adopts a Q value, (Q^-) that is different from the value given in the most recent mass adjustment, the mass adjustment value should be given in a comment for comparison. Furthermore, when the mass links are not too complicated, the other entries on the Q record could be adjusted to reflect the change in Q^- value. Under such circumstances, and if the change in Q^- is significant (considerably outside the limits given by the mass adjustment), listings of the adjusted S(n), S(p), and Q(α) values would represent a valuable contribution. However, the inclusion of these data is left to the discretion of the evaluator.

> Note: When a re-adjustment is not feasible, a comparison between the mass adjustment value and the adopted value allows the reader to judge qualitatively what the effect on the other Q values might be.

6. All available first-card data should be included for gamma-records; however, continuation-record data generated from the HSICC program are not required.

7. Since the data in adopted levels, gammas are the evaluator's recommended values, discrepant data should not be adopted.

> Note 1: If a gamma multipolarity disagrees with the adopted Jπ, and Jπ are considered to be well established, the discrepant multipolarity should not be adopted. The discrepancy should be noted in a comment, and a flagged comment should be used so that a footnote symbol appears in the multipolarity field.
>
> Note 2: Since BE2 and T1/2 are equivalent data (if all quantities needed to convert from one to the other are known) and T1/2 is more basic, adopted values for both quantities should not be shown for the same level. The adopted T1/2 will normally be based on all of the available data, including any reliable BE2 measurements. By definition, the best BE2 value will be that deduced from this adopted T1/2 value and the adopted branchings, Q etc. If T1/2 comes from BE2, quoting both values is a redundant exercise; if T1/2 does not come solely from BE2, quoting both T1/2 and BE2 is essentially adopting two different values for the same quantity. A BE2 or BE3, etc. value is best adopted if T1/2 is not known, and cannot be calculated from these same BE2 or BE3 etc. values.

B. E(level)

The introductory section to Nuclear Data Sheets includes the statement "The excitation energies for levels connected by gamma transitions are taken from a least-squares fit to the adopted gamma energies. Other excitation energies are based on best values from all available reactions". No further comment is needed for any adopted levels section for which this statement is appropriate. When this statement may not be appropriate, the evaluator should add a comment explaining the source for the excitation energies.
Uncertainties should be included where available, and should be estimated if the authors do not provide them (see D. 1. under GUIDELINES FOR DECAY AND REACTION DATA SETS).

C. Jπ

1. Assignments should be based on the fewest and best arguments. There are two main advantages to this "fewest and best" approach:

(a) Jπ arguments are easier to read and follow when redundancy is eliminated,

(b) alternate arguments can be used to build up systematics.

For example, consider the assignment of 1+ to a level based on the arguments "Ml γ to 0+. Logft = 4.4 from 0+". Either argument alone is sufficient: if the multipolarity argument is used, the logft value can be combined with the values from which the logft arguments are derived, thus helping to build up confidence in the application of such systematics to cases where other strong arguments are not available.

> Note: The above approach refers to strong arguments. When only weak arguments are available, the more arguments that can be marshalled, the more valid the assignment. However, no combination of weak arguments constitutes a strong argument.

2. "Direct" measurements of J (e.g., atomic beam) should be referenced as 76Fu06. More recent values should be referenced directly. The method should be stated in either case, thus "atomic beam", "NMR". Note that these methods give J only; a separate argument is required for π.

3. Arguments should be detailed enough to convince the reader that the assignments are reliable, and allow judgement to be made as what the consequences would be if new data were to become available.

(a) The argument "From (α, xnγ)" is not much use, especially if the (α, xnγ) data set contains no details. Statements such as "Excit. in ((α, xnγ)", "γ(θ) in (α, xnγ)" are needed. If such arguments appear frequently, they can be included in a flagged comment on Jπ such as "From (α, xnγ) based on...", or "Member of band X based on energy fit and inertial parameter". An alternative method is to write a Jπ footnote which states "Assignments from (α, xnγ) are based on excit. and 1(0). Assignments from (d, p) are based on L values and analyzing powers. etc". The Jπ argument can then be simply "From (α, xnγ)", "From (d, p)", etc. for the relevant levels. This approach is particularly useful when the arguments are somewhat lengthy.

(b) Gamma-decay arguments should be specific: thus "Ml γ to 2+", "γs to 3/2+, 5/2+", while the gamma energy is optional: thus "326γ to 2+ is Ml". A vague statement such as "JP is based on 'γ-decay modes" is not much use to the reader.

An argument for Jπ = 2-, 3- could be expressed as "L(d, p) = l gives 0- to 3-. γ to 4-". If the γ transition were to be subsequently determined as Ml, the reader can quickly determine that Jπ would be 3-. If the argument had only been given as a general statement such as "From L values in (d, p) and γ feedings", the consequences of the new piece of evidence would not be so transparent.

> Note that Jπ values and γ-ray multipolarities referred to in these comments should be adopted values: "Ml γ to (3/2+)", "(E2) γ to (4)-".

Give Jπ(parent, target) in the specific Jπ arguments when the target is not even-even; for example, "logft = 5.4 from 1/2+", or "L(p, t) = 2 from 9/2+".

4. Jπ arguments for two or more levels can be linked if they are interconnected in such a way that giving separate arguments for each level can be awkward, or can give the appearance of circularity. As an example, consider the sequence 7-(β-)A(Ml)B(El)C(E2)2+: the argument "Logft = 5.1 from 7- and the Ml-El-E2 cascade to 2+ uniquely establishes Jπ(A) = 6-, Jπ(B) = 5- and Jπ(C) = 4+" can be given for one of the relevant levels (say C), and then one can say "Jπ: See C level" for the others.

5. Consider an L = 0 component in a particle-transfer reaction in which S = 0 can be assumed: leads to ΔJ-0, Δπ = no, even if other L components are present, and the same is true of an E0 component in a gamma transition. A level connected via an Ml + E2 γ to a level with J = l/2 must have J = 3/2.

6. Jπ arguments for the ground state of an even-even nucleus are not needed. For example L(p, t) = 0 gives only ΔJ = 0 and relies on the assumption of J = 0 for the even-even target nucleus. The absence of hyperfine structure is also not conclusive, since a small μ or Q value can lead to the same result.

7. Maintain consistency between the source data and the conclusions. For example, L(p, t) = 2 (S = 0 assumed) from an even-even target gives Jπ = 2+, not (2)+ or 2(+); if the L value is considered to

be a strong argument for J, this same argument applies to π. Similarly, if the argument is not considered to be strong for J, such an argument should not be considered strong for π; thus, L(p, t) = (2) gives Jπ = (2+).

> Note: A reaction such as (Q, d) with a measured L value can be used as a strong argument for π, namely, $\pi = (-)^L$, even though J is determined only as J = L-l, L, or L+l.

8. Expressions such as "preferred" or "consistent with" are not strong arguments. Avoid these expressions since they leave open the question of whether other alternative Jπ values have been ruled out; however, such expressions are valid for weak arguments.

9. Configurations

"Conf = 3/2[521]" is not a valid argument for Jπ; this argument only shifts the burden of proof from establishing Jπ = 3/2- to establishing conf = 3/2[521]. The configuration is normally deduced from Jπ, not vice-versa, although sometimes the reverse is true and the same argument for Jπ can be used to assign the configuration (sometimes a measured μ will also determine a specific configuration).

Knowledge of L and the analyzing power in a transfer reaction may give Jπ = 1/2- (and assign this level as a pl/2 orbital), but the Jπ argument should be "From L and analyzing power in (d, p)", not "From conf = pl/2". The configuration should be treated as a separate data type from Jπ, and be placed on a continuation record. Comments on "Conf" should normally be treated as distinct from comments on Jπ.

> Usually in the deformed regions, the cross sections and cross section ratios (e.g., (d, p) and (d, t) reactions) determine directly the combination JπK[ ], rather than Jπ (such as 5/2- 3/2[521]) or just Jπ = 5/2- alone. Under such circumstances, the configuration must be included in the Jπ argument.

10. Do not use multiply placed transitions in Jπ arguments unless the connection with the level in question is definite.

> Note: A multipolarity determined for a multiplet will not necessarily be the correct multipolarity for each member of the multiplet (see B. 6. (d)) under GUIDELINES FOR DECAY AND REACTION DATA SETS). If part of the multiplet is definitely established as being connected with the level in question, Jπ of the connected level can be used as a Jπ argument in the usual way, (e.g., "γ to 3/2+").

11. When choices of Jπ are limited to three or fewer, they should be clearly specified rather than given as a range; thus Jπ = 5/2-, 7/2-, 9/2- rather than Jπ = 5/2- to 7/2-. There is less chance of values being misinterpreted when they are written out completely, and the extra space required is not significant (which is the only good argument for quoting Jπ values as a range).

12. RUL is an argument for multipolarity, not for Jπ.

13. Note the difference between "Jπ = 5/2+ and 7/2-" (or 5/2+&7/2-) and "Jπ = 5/2+, 7/2-". The first notation indicates the presence of two unresolved levels with Jπ = 5/2+ and 7/2-, respectively; while the second notation indicates two alternate Jπ values for a single level.

D. Other Level Properties

1. Cross referencing of data should give the data set, and not just the keynumber, because the data sources are much easier to locate with this information. The method and keynumber are optional except in the following cases where this information is needed.

(a) μ, Q etc., values for stable or long-lived states should be taken from 78LeZA where possible. The method should be given since these data will normally not appear anywhere else in the mass chain. More recent data can be quoted directly, along with the method and keynumber. For values of μ not taken from 78LeZA and when warranted by the accuracy, a comment stating whether or not the diamagnetic and Knight-shift corrections have been applied should be included. Similarly for Q values, a comment should be given stating whether or not the Sternheimer correction (or other polarization correction) has been applied.

b) If T1/2 is obtained from BE2, this fact should be stated: "T1/2: From BE2 in Coul. ex.".

2. "g factor" quoted in a source data set should be converted to "μ" in adopted levels if J is known.

3. When branching modes are given (e.g., "%IT="), the bases for the values can be given here or in the source data sets. There is no need to repeat the arguments, but they must appear in one place or the other. Also, all possible modes of decay should be accounted for, unless the reason for omitting a mode is obvious.

> Note: Where "%ε+%β+ = 99.0 1; %IT = l.0 l" exists but β^- is also energetically allowed, there should be a comment explaining why the β^- branch is considered negligible; for example, "%β^- is negligible since the only available decay branch has ΔJ = 2, Δπ = yes, for which, from logflut>8.5, one derives %β-<lxl0^{-4}". An experimentally determined limit of this magnitude should be included explicitly in the branching statement. One can state simply "ΔJ = 4 for possible β^- branch so %β^- is negligible" for more obviously negligible branches such as where the only available branch has ΔJ = 4.

4. BEλ values should be included in adopted levels where T1/2 is not independently known and cannot be calculated from BEλ.

E. Eγ, Iγ, TI

1. Sources of data should be stated unless obvious (i.e., if there is only one or possibly two sources (small mass chain)). General comments are usually sufficient; thus, "From X unless noted otherwise" or "Weighted average of values from A, B, and C".

2. The introductory section to Nuclear Data Sheets includes the explanation that I_γ are "photon branchings (normalized to 100 for the most intense transition from each level)". Note that an uncertainty should be included in the value "l00" if there is an uncertainty given for the original intensity; however, when there is only one transition de-exciting the level, the uncertainty has no meaning and should not be given. Any major deviation from this policy should be stated, such as quoting branching ratios in %. There are some situations in which this policy should not be followed (i.e., where a transition other than the strongest should be chosen and for which no explanation is needed):

(a)strongest transition is an unresolved multiplet;

(b)strongest transition is given as an upper limit.

> Note: Iγ for multiply-placed transitions where the intensity has not been divided should be given as limits (Iγ < A + ΔA if Iγ = A ± ΔA), with "&" in column 77.

3. Where possible, TI should be given for transitions that have no measured Iγ, or for which only a limit on Iγ is available. The most common cases would be for E0 transitions or low-energy transitions when I(ce) but no Iγ (or α) are available; see Note under J. 10. in GUIDELINES FOR DECAY AND REACTION DATA SETS .

> Note: When TI is the "measured" quantity from an intensity balance and α is known so that Iγ can be determined, TI as well as Iγ should be given if known more accurately than TI calculated from Iγ(1+α). This approach allows the most accurate branching ratios to be obtained for the transitions from the level in question.

F. Mult, δ, α

1. Data sources should be stated unless obvious. Note that the introductory section states that the α values are theoretically determined on the basis of the given multipolarity and δ. The origins of any α value which is not based on this procedure should be explained in a comment. Sources for multipolarity and δ can usually be quite general: "Mult are based on αk and subshell measurements in and γγ(θ) data in ...". When multipolarities are based on measurements that yield only L, such as γ(θ) or γγ(θ), and M1 + E2 is adopted rather than El + M2, the basis for this choice must be stated.

2. See J. 3. in GUIDELINES FOR DECAY AND REACTION DATA SETS for requirements on consistency among the multipolarity, δ and α entries. α is not needed for transitions with mixed multipolarity and unknown δ, even though such values may have been used in a data source.

3. The relationship between BE2 and T1/2 allows δ (and/or α) to be deduced in cases where BE2 and T1/2 are independently known, and the ground-state branch is known (the ground-state branch could be deduced if all other quantities are known).

4. γ(θ) and γγ(θ) normally lead to two solutions for δ, and both should be noted. In particular, both should be placed in a comment if the correct one is not known; do not adopt one value in the δ field and the alternate value in a comment.

5. As well as using [ ] to indicate multipolarities deduced solely on the basis of the level scheme for transitions for which you want to list α, this convention may also be adopted in cases where α is negligible, but you wish to show the multipolarity because you are recommending a reduced transition probability. However, as noted earlier, do not assign mult=[ ] simply because the multipolarity can be deduced from the level scheme.

G. Reduced Transition Probabilities

Reduced transition probabilities are required whenever calculable, i.e., when T1/2, branching, multipolarity and δ are known. Note that for mixed transitions, values for both multipole components should be given.

> Note 1: When δ is consistent with zero or infinity, the reduced transition probability for only the dominant component is required. The limit for the other component is optional and can be given in certain cases: BE2(W.u.) < 1000 is not of interest, but BE2(W.u.) < 10^{-3} might be significant.

Note 2: Values should be given for transitions that have not been experimentally characterized, but can be determined from the level scheme as $\Delta J = l$, $\Delta\pi$ = yes; $\Delta J = 2$, $\Delta\pi$ = no, or $\Delta J \geq 3$ (i.e., cases where significant mixing is not expected).

Note 3: When one or more of the relevant pieces of information required to calculate reduced transition probabilities is/are missing, the calculation should be carried out if reasonable assumptions can be made that fill the gaps. For example, a branch with a small gamma fraction of known multipolarity should be estimated (if the multipolarity would lead to a relatively small total branching) so that reduced transition probabilities for the other branches can be calculated.

Note 4: When only limits are available for some of the relevant data, special care must be taken.
(a) Transition with mult = Ml + E2 and $\delta < 0.l$: while BE2(W.u.) can only be given only as an upper limit, assigning BM1(W.u.) as a lower limit would be incorrect since an upper bound occurs for $\delta = 0$. BM1(W.u.) should be given as an average of the values corresponding to $\delta = 0$ and $\delta = 0.l$, with an uncertainty chosen to overlap the two values.
(b) Consider a transition with a total intensity known only as an upper limit: provided that this intensity limit is not the dominant branching mode, the branching for this transition should be treated as 1/2TI ± 1/2TI for the purpose of calculating the reduced transition probabilities for the other transitions.
(c) When T1/2 is only available as an upper limit, the resulting lower limits on the reduced transition probabilities should be given. When T1/2 is a lower limit, the resulting upper limits on the reduced transition probabilities are not of much interest, except perhaps as noted in Note 1, above.

Note 5: Consider the reduced transition probability of a transition for which the corresponding Coulomb excitation probability has been determined (BE2 being the most common case): this parameter can be deduced directly from the measurement and the appropriate single particle value. This procedure should be followed when the level T1/2 has been adopted from a measured BE2 (to avoid including the uncertainty in BE2 twice), or where BE2 is known but branches and/or mixing ratios are not known so that T1/2 for the corresponding level cannot be calculated.

Note 6: When $E\gamma$ is poorly known, the factor $E\gamma^{2L+l}x(l + \alpha)$ appearing in the formula for the reduced transition probabilities may exhibit a smaller range of values than the factors $E\gamma^{2L+l}$ and $(l + \alpha)$ taken separately. The correlation in $E\gamma$ and α should always be taken into account when calculating uncertainties for BEλ(W.u.) and BMλ(W.u.).

Note 7: BEλ(W.u.) and BMλ(W.u.) are not needed for mixed multipolarities when δ is not known. However, if an evaluator chooses, these parameters can be given as upper limits.