Comments on Covariance Plots for Gd, Tc, Ir and Y Isotopes

(Plots Posted on NNDC Website on 29 August 2006)

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General Comments

The brief comments below for each individual reaction are subjective and based on a relatively cursory examination of the plots downloaded from the website posted by Dimitri Rochman on 29 August 2006. I didn't do any further digging to examine supportive background information (e.g., EXFOR) this time around.

Generally, the results for the fast region based on the EMPIRE-KALMAN approach look reasonable. However, there are some exceptions to be mentioned below. In particular the magnitudes of the given errors seem to be somewhat large near the lower end of the energy range in a number of instances, even for the total cross section. Perhaps this is an extrapolation effect in the KALMAN analysis. Also, the (n,2n) errors seem to be a bit too small for cases where no data exist and a bit on the large side for the (n,p) and (n,a) reactions in such cases. A challenge for the future will be to better define the uncertainties for those parameters that have the greatest influence on these cross sections. This will involve an examination of systematic trends in these cross sections. In the absence of results from other approaches to compare with the present values, this is about all one can say about the matter at this point.

It is disturbing that there are often such large differences between the various results shown for the beta-2 and beta-3 retroactive results as well as the ATLAS-KALMAN results for the resolved resonance (RR) and unresolved resonance (URR) regions. While one should certainly anticipate some method related differences, the large differences often observed between these three approaches are unacceptable since all should be working from more or less the same resonance information base. At this late date it will not be possible to resolve these issues, so when in doubt as to which result to accept for ENDF/B-VII.0 I would be inclined to select the approach that gives the larger errors (to be on the safe side). Of course, there may be exceptions based on additional knowledge not apparent from the plots alone. Clearly, a lot of work is needed in the future to resolve these differences before undertaking a large-scale project of generating covariances for other isotopes in the periodic table. The work of WPEC Subgroup 20 to examine the various methods to generate covariances and resolve differences between them for the RR and URR regions represents a start. However, it is clear that a lot remains to be investigated in this area. In the fast neutron range WPEC Subgroup 24 will have the opportunity to compare the various methods used there to insure that all facets of the issue are well understood.

Concerning the RR and URR regions, I note that in a number of cases very small uncertainties emerge from the process. These are often 1% or even less. No matter what the codes say, this is unrealistic and here is why that is so. Consider for a moment how total cross sections are measured: transmission through parallel plate samples. If a sample is 1 cm thick (not atypical), then one would need to know the thickness to better than 0.1 mm and assume perfectly uniform density of the material and parallelism of the sample plate to achieve 1% systematic error from this source. This might be possible for a few metals (e.g., Cu), but for more exotic materials I would not believe it. This is only one component of uncertainty. In the case of capture measurements the samples are often thinner with even more potential for sample related systematic uncertainty.

Comparison of ENDF/B-VIIbeta2 and ENDF/B-VIIbeta3

^{152}Gd(n,tot)

I would be inclined to accept the beta3 results for the RR and URR regions. The results for the fast region look reasonable.

^{152}Gd(n,el)

I would be inclined to accept the beta3 results for the RR and URR regions. The results for the fast region look reasonable.

^{152}Gd(n,g)

One could chose either the beta3 or ATLAS-KALMAN results for the RR and URR regions, depending on one's preference. The results for the fast region look reasonable.

^{153}Gd(n,tot)

Surprisingly, the beta2 results appear much too large and the beta3 results, if anything, a bit too small for the RR and URR region. The beta3 results are more reasonable at thermal, so perhaps that would be the one to choose in this instance. The results for the fast region appear to be reasonable above 100 keV but seem rather large at lower energies.

^{153}Gd(n,el)

Actually, the beta2 results appear to be more reasonable for the RR and URR regions. The results for the fast region appear to be much too large for the 100 eV to 10 keV range.

^{153}Gd(n,g)

The large difference in results for the RR and URR regions leave me in a quandary. In this instance the ATLAS-KALMAN results would appear to be the most conservative choice. However, the beta2 results represent a compromise. The beta3 results for this region seem too small. Why do these results differ so much for the thermal region? The results for the fast region look reasonable.

^{154}Gd(n,tot)

One should probably accept the beta3 results for the RR and URR regions although they don't differ too much from beta2 except around 1 eV. The results for the fast region look reasonable.

^{154}Gd(n,el)

If the ordinate is properly labeled (%), then all these results are way too small. I suspect that the plot really represents fractional errors with the ordinate scale mislabeled. If so, then one should probably accept the beta3 results for the RR and URR regions although they don't differ too much from beta2 except around 2 eV. The results for the fast region would then appear to be reasonable.

^{154}Gd(n,g)

I really don't know what to say about the results for the RR and URR regions. The three distinct results don't differ by very much in the thermal region but elsewhere the differences are huge. The compromise choice would be beta3, but I would not have much confidence in these results. The results for the fast region look reasonable.

^{155}Gd(n,total)

I would accept the beta3 results for the RR and URR regions. The results for the fast region look reasonable.

^{155}Gd(n,el)

I would accept the beta3 results for the RR and URR regions. The results for the fast region look reasonable for the most part, but the errors seem a bit large for the 100 eV to 10 keV region.

^{155}Gd(n,g)

The large differences between the results for the RR and URR regions present a dilemma. My choice would be the ATLAS-KALMAN results as a compromise. The beta3 results predict much larger errors in the thermal region. The results for the fast region look reasonable.

^{156}Gd(n,total)

Not much choice here. The results may be reasonable although I wonder why the RR and URR beta2 results are generally large for this isotope and often much smaller for other Gd isotopes.

^{156}Gd(n,el)

The results in the vicinity of 100 eV seem very large. The results in the fast neutron region seem somewhat small.

^{156}Gd(n,g)

The results in the RR and URR regions seem quite large but it is interesting that two distinct methods give rather similar results. This increases confidence in these results. The results in the fast neutron region look reasonable.

^{157}Gd(n,tot)

The beta3 results for the RR and URR region may be reasonable. The results for the fast neutron region look reasonable over much of the range but could be a bit large in the 1 keV to 100 keV range.

^{157}Gd(n,el)

Even the beta3 results for the RR and URR regions seem rather small, but what choice is there to consider? The results for the fast neutron range look reasonable over most of the range.

^{157}Gd(n,g)

The results for the RR and URR vary all over the map. The beta2 results appear too small so the choice between beta3 and ATLAS-KALMAN results will depend on one's preferences. I find no basis to select one over the other. The results for the fast neutron range look reasonable.

^{158}Gd(n,tot)

If the ordinate is truly supposed to be %, then all these values are much too small. I suspect that it is mislabeled and should be fractional error. If this is the case, then the indicated errors are reasonable over much of the energy range except possibly a bit low in the vicinity of 1 keV.

^{158}Gd(n,el)

If the ordinate is truly supposed to be %, then all these values are much too small. I suspect that it is mislabeled and should be fractional error. If this is the case, then the

indicated errors are reasonable over much of the energy range except possibly too low in the vicinity of 1 keV. The results for the fast neutron range look reasonable.

^{158}Gd(n,g)

I would be inclined to select the ATLAS-KALMAN result for the RR and URR regions as the more conservative choice. The results for the fast neutron range look reasonable.

^{160}Gd(n,tot)

If the ordinate is truly supposed to be %, then all these values are much too small. I suspect that it is mislabeled and should be fractional error. If this is the case, then the indicated errors are reasonable over much of the energy range except possibly too low in the vicinity of 1 keV. The results for the fast neutron range look reasonable.

^{160}Gd(n,el)

If the ordinate is truly supposed to be %, then all these values are much too small. I suspect that it is mislabeled and should be fractional error. If this is the case, then the indicated errors are reasonable over much of the energy range except possibly too low in the vicinity of 1 keV. The results for the fast neutron range look reasonable.

^{160}Gd(n,g)

All of these results look reasonable. The choice between the beta3 and ATLAS-KALMAN results for the RR and URR regions is a matter of one's preference. I have no basis to favor one over the other.

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I assume these results are derived from beta3. It is difficult to comment on the correlation patterns so the following very brief comments are confined to the indicated uncertainties.

^{152}Gd

(n,tot): Results look reasonable.
(n,el): Results look reasonable.
(n,inel): Results look reasonable.
(n,2n): Results look reasonable.
(n,g): Results look reasonable.
(n,p): Results look reasonable.

^{153}Gd

(n,tot): Errors seem small in the RR and URR and somewhat large in the 100 eV to 100 keV region.
(n,el): Errors seem far too small in the RR and URR and somewhat large in the 100 eV to 100 keV region.
(n,inel): Results look reasonable.
(n,2n): Results look reasonable.
(n,g): Errors seem too small in the RR and URR regions but look reasonable in the fast neutron region.
(n,p): Errors seem rather large.

^{154}Gd

(n,tot): Results look reasonable.
(n,el): Results look reasonable.
(n,inel): Results look reasonable.
(n,2n): Results look reasonable.
(n,g): Errors from 10 eV to 1 MeV seem rather small. Otherwise, results look reasonable.
(n,p): Results look reasonable.
(n,a): Results look reasonable.

^{155}Gd

(n,tot): Except for the broad peak in the uncertainty near 1 keV, the results look reasonable.
(n,el): The errors seem a bit small in the RR and URR region and perhaps too large around 1 keV. Otherwise they look reasonable.
(n,inel): Results look reasonable.
(n,2n): Uncertainty seems a bit low, especially since the values are larger for some of the other isotopes of Gd.
(n,g): Results look reasonable.
(n,p): Results look reasonable.

^{156}Gd

(n,tot): Results look reasonable with the possible exception of the large spike in uncertainty near 1 keV.
(n,el): Results look reasonable in the RR and URR range with the possible exception of the large spike in uncertainty near 1 keV. The uncertainties above 10 keV may be a bit small unless, of course, considerable accurate experimental data exist.
(n,inel): Results look reasonable.
(n,2n): Uncertainties seem to be a bit small.
(n,g): Uncertainties seem to be too large below 1 keV, possibly too small from 1 keV to 1 MeV, and reasonable at higher energies.
(n,p): Uncertainties are rather large but probably reasonable if no experimental data exist.
(n,a): Uncertainties are rather large but probably reasonable if no experimental data exist.

^{157}Gd

(n,tot): Uncertainties look reasonable except possibly in the vicinity of 1 - 10 keV where they seem to be rather large.
(n,el): Uncertainties seem rather small in the RR and URR regions. Otherwise, they look reasonable except possibly in the vicinity of 1 – 10 keV where they may be somewhat large.
(n,inel): Results look reasonable.
(n,2n): Results may be a bit low.
(n,g): Errors seem rather small up to about 1 MeV. At higher energies they look reasonable.
(n,p): Uncertainties are rather large but probably reasonable if no experimental data exist.

^{158}Gd

(n,tot): Results look reasonable except possibly from 100 eV - 1 keV where the uncertainties appear to be rather small.
(n,el): The uncertainties appear to be too small below 5 keV and reasonable at higher energies.
(n,inel): The results look reasonable.
(n,2n): The uncertainties seem to be a bit small since apparently no experimental data exist.
(n,g): The errors seem too small from 10 eV to 10 keV. Elsewhere the results look reasonable.
(n,p): The results look reasonable.
(n,a): The results are probably reasonable although the errors at the lower energies seem quite large.

^{150}Gd

(n,tot): The results look reasonable.
(n,el): The results look reasonable assuming that there are no elastic data available in the MeV range.
(n,inel): The results look reasonable.
(n,2n): The errors seem fairly small given that apparently no experimental data exist.
(n,g): The results look reasonable.
(n,p): The errors seem somewhat large but then there apparently are no experimental data.
(n,a): The results may be reasonable if no experimental data are available.

^{191}Ir

(n,tot): Results look reasonable.
(n,el): Results look reasonable.
(n,inel): Results look reasonable.
(n,2n): Results look reasonable.

(n,g): Results look reasonable.
(n,p): Errors are rather large in the MeV range but perhaps are not unreasonable if no experimental data are available.

^{193}Ir

(n,tot): Results look reasonable.
(n,el): Results look reasonable.
(n,inel): Results look reasonable. There must be some experimental data in the MeV range.
(n,2n): Results look reasonable.
(n,g): Results look reasonable.
(n,p): Errors are rather large in the MeV range but perhaps are not unreasonable if no experimental data are available.

^{99}Tc

(n,tot): Results look reasonable.
(n,el): Results look reasonable.
(n,inel): Results look reasonable up to a few MeV but they seem rather small at higher energies.
(n,2n): Uncertainties appear to be somewhat large.
(n,g): Results look reasonable.
(n,p): Errors are rather large in the MeV range but perhaps not unreasonable if no experimental data are available.

^{89}Y

(n,tot): Results look reasonable.
(n,el): Results look reasonable.
(n,inel): Results look reasonable.
(n,2n): Uncertainties appear to be somewhat large.
(n,g): Errors may be a bit low in some regions below 1 MeV but at higher energies they look reasonable.
(n,p): Errors are rather large in the MeV range but perhaps not unreasonable if no experimental data are available.
(n,a): Errors are rather large in the MeV range and noticeably lower above 10 MeV. This is somewhat counterintuitive.