DOCUMENTATION OF STATION/AGENCY MAGNITUDE PROCEDURES

(Modified from the SUMMARY OF IASPEI MAGNITUDE WORKING GROUP RECOMMENDATIONS ON DETERMINING EARTHQUAKE MAGNITUDES FROM DIGITAL DATA, updated version 2011; see <u>http://www.iaspei.org/commissions/CSOI/Summary WG-Recommendations 20110909.pdf</u>)

This document is to outline the procedures adopted by seismological agencies to compute magnitudes of seismic events.

Please list the magnitudes computed and corresponding phase type analyzed in the table below (example provided). Add as many rows as required.

Magnitude type (nomenclature used at the agency)	Full name	Wave type analyzed
mb	Short-period body-wave	P-waves
	magnitude	
MN	Nuttli magnitude	Lg waves

For each magnitude type computed at the agency, please specify:

1. The equations that are used for calculating each magnitude type and a: specify if distance is measured as epicentral distance or hypocentral distance;

b: specify the distance range for which the equation is applied; c: specify restrictions on hypocentral focal-depth, if any.

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Nuttli equation for greater than 4 degrees is used at all distances
MN = 3.30 + 1.66log(dist) + log(A/T)
a. epicentral distance
b. minimum distance 50 km; maximum 30 degrees
c. no restrictions
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2. Is any signal-to-noise ratio criterion applied to the analyzed signal? No

3. Specify the software used (such as SeisComp, Antelope, Seismic Handler, in-house developed programs) to perform the analyses for magnitude computation.

DAN- proprietary software with in-house modifications

- **4.** If the agency is computing magnitudes not based on some amplitude/period measurement (e.g., moment magnitude Mw) please summarize the details of the technique used. For example, is Mw obtained with a centroid moment tensor, W-phase and/or spectral fitting technique? Not applicable for MN
 - 5. Other restrictions on the calculation of a specific magnitude. For example, is the magnitude measured only for earthquakes of a certain size, as defined by an independent measure of earthquake size? Also, are specific magnitudes computed only for seismic events occurring in specific areas? Used for most earthquakes occurring in eastern Canada as long as there is a visible Lg wave; not used for some offshore events and for very small earthquakes where magnitude is computed at distances of less than 50 km (we don't send many, if any, of the latter to the ISC)

Detailed questions on the magnitudes based on amplitude/period measurements:

6. How the network (event) magnitude and corresponding uncertainty is obtained? For example, is the network magnitude an arithmetic/trimmed mean, median value of the single station magnitudes?

Arithmetic mean; any magnitude with an X beside it was not included in the calculation (Bent and Greene reference below has short discussion of when magnitude readings may be X'd out)

7. Units of the reported amplitudes. Specify if amplitudes are reported in units of trace-amplitude motion instead of ground motion.

Digital counts- conversion factor to ground displacement in nm is included in file sent (under column mag_fact) to the ISC; amp/mag_fact

8. Time-window in which the amplitude measurement is made for the phase type analyzed. For example, for body wave magnitudes, is the time window a flexible time-interval between the P onset and the PP onset or a fixed time window after the first P onset (e.g. 5 s, 10 s or other)? Similarly, for the surface wave magnitudes, is the time window considered a time-interval spanned by waves having group-velocities between, e.g., 3.2 and 4.0 km/s?

User defined- should include Lg wave but no hard limits on time or velocity

9. Orientation of seismograph (horizontal or vertical) from which the measurement is made. For example, is Ms computed using both horizontal and vertical components? Specify also if, as for example might be the case for ML, data from each of the two horizontal components at a single station are used, are data from each component treated as a separate observation in the network magnitude computation, or are the two components first averaged into a station magnitude, which is then treated as a single observation in the network magnitude computation?

vertical

10. Describe the amplitude-response, filter characteristics, or transfer-function of the seismograph or simulated seismograph through which the amplitude measurement is made. For example, is the standard Wood-Anderson seismometer simulation filter used to compute ML?

No filtering; note that we do not adhere to the IASPEI recommendations in terms of frequency range; periods of 0.01-1.3 sec accepted

11. Details of measuring amplitude:

a: For example, does the amplitude correspond to 0.5*(peak-to-trough amplitude), where "peak-to-trough amplitude" corresponds to difference between a maximum positive excursion and a maximum negative excursion of the trace, or is the amplitude instead measured as the maximum absolute excursion from the "zero" position of the seismograph trace?

Half peak-to-trough

b: for example, if the amplitude corresponds to 0.5*(peak-to-trough amplitude), are the "peak" and "trough" respectively the absolute maximum and absolute minimum values of the entire wave-group, or are they the adjacent peak and trough corresponding to the maximum trace excursion that is associated with a single zero-crossing?

adjacent peak and trough corresponding to the maximum trace excursion that is associated with a single zero-crossing

c: for example, are displacement amplitude(A) and period(T) measured at the time of maximum A or at the time of the maximum of the quotient (A/T)?

12. Details of measuring period. For example, is it the time between the neighboring peaks, respectively troughs or twice the time span measured between the largest peak and adjacent trough at which the double amplitude has been measured?

twice the time span measured between the largest peak and adjacent trough at which the double amplitude has been measured

13. To what part of a phase the amplitude-measurement time refers. For example, is the amplitude-measurement time the time of the zero-crossing associated with a peak-to-adjacent trough measurement or is it the time of an absolute maximum or absolute minimum?

Usually at time of absolute maximum value; may be approximate if peak not clear- program picks value from user window and shows window for the wavelength it selected; analyst manually inserts a phase called "trace"which will be at the max. if clear and middle of the narrower window if not clear

Finally, please add publications as well as internal reports or web links that can be quoted to describe the magnitude procedures adopted at the agency and/or any other relevant information which may not have been included in the questions above.

MN is basically mb_Lg but we use MN designation to indicate that we are not using it exactly as it was originally intended.

- Bent, A. L. and H. Greene (2014). Toward an Improved Understanding of the m_N-M_W Time Dependence in Eastern Canada, *Bulletin of the Seismological Society of America*, **104**, doi:10.1785/0120140031.; this paper includes a description of current practice for MN
- Justification for using Nuttli's distant equation for all distances is in a not very informative abstract; it was presented at the Eastern Section SSA meeting but never followed up with a complete paper
- Wetmiller, R. J. W. and J. Drysdale (1982). Local magnitudes of eastern Canadian earthquakes by an extended mb(Lg) scale, *Earthquake Notes*, **53**, 40.