Appendix B: Safety Guidelines for TMS Protocols (Adapted from Rossi et al., 2009, 2021)

This appendix outlines safety guidelines for transcranial magnetic stimulation (TMS) based on Rossi et al. (2009, 2021). While the 2009 safety tables remain a valuable reference, the 2021 update emphasizes operational safety principles rather than fixed limits. Researchers at CCBBI should use the reference table below to guide initial protocol design, but all studies must be evaluated in terms of participant risk, stimulation site, and overall safety profile. Protocols exceeding these parameters will require additional safety review by CCBBI TMS Safety Consultants.

Recommended rTMS Safety Limits

Stimulation Frequency (Hz)	% of Motor Threshold	Maximum Train Duration (s)	Minimum Inter-Train Interval (s)	Maximum Pulses per Day
1 Hz	≤ 110% RMT	Continuous	—	1800+
5 Hz	≤ 100% RMT	10	10	~1500–2000
10 Hz	≤ 100% RMT	5	25	~1500–2000
20 Hz	≤ 90% RMT	2	28	~1000
50 Hz	≤ 80% RMT	0.2	30	<600
Theta Burst (iTBS / cTBS)	80% AMT*	Protocol-defined	Protocol-defined	600

* AMT = Active Motor Threshold. TBS protocols generally deliver 600 pulses per session, either continuously (cTBS) or intermittently (iTBS).

Operational Safety Guidelines (Rossi et al., 2021)

The 2020 update recommends evaluating each TMS protocol based on operational risk, rather than adhering strictly to fixed tables. Researchers must remain below parameters known to induce seizures in Magnetic Seizure Therapy (100% MSO, 25 Hz, 10 s train duration). Protocols exceeding the 2009 table should include justification, neurophysiological monitoring, and transparent reporting of adverse events.

Theta Burst Stimulation (TBS)

Standard TBS protocols (iTBS/cTBS) using 80% AMT, 600 pulses, and 50 Hz triplet bursts repeated at 5 Hz are safe and widely used. Seizures are rare and typically associated with deviations from these parameters (e.g., >100% RMT, non-figure-8 coils). Studies exceeding these limits should follow enhanced safety protocols including IRB and CCBBI oversight.

Key Safety Parameters from Rossi et al. (2021)

While formal updates to safety tables were not provided in Rossi et al. (2021), several important safety parameters were emphasized as operational thresholds not to be exceeded. These include:

- Maximum intensity for conventional TMS should remain well below 100% of Maximum Stimulator Output (MSO).
- Maximum stimulation frequency should not approach or exceed 25 Hz for conventional rTMS.

- Maximum train duration should remain well below 10 seconds, especially at higher frequencies.
- Combinations of high intensity, high frequency, and long train duration should be explicitly avoided.
- The seizure threshold parameters for Magnetic Seizure Therapy (MST)—100% MSO, 25 Hz, 10 s—serve as an upper safety boundary.
- Increases in motor excitability (e.g., emergence of visible motor twitches outside of the head/neck) should prompt reassessment of protocol safety.
- Protocols that exceed 2009 guidelines should include safety justifications, enhanced monitoring, and approval by CCBBI Safety Consultants.