



The combined method uses a form of calibrated wrench to snug a connection and Turn of Nut as the final tensioning method. While combining these operations may seem straightforward, the combined method is the most expensive and complicated method within the AISC/RCSC specification. The combined method requires additional weekly wrench testing, in addition to standard pre-installation verification (PIV) testing. Unlike calibrated wrench, that does not specify tool accuracy, combined method tools must have a certified accuracy of at least  $\pm 10\%$ .

Since the combined method includes a more rigorous testing protocol and relies on Turn of Nut, including manufacturer recommended match-marking the assembly and steelwork, whenever possible, the combined method should be abandoned in favor of Turn of Nut.

However, the combined method is the only acceptable method for ASTM F3148 bolts. Since ASTM F3148 bolts are proprietary fasteners, available from a single manufacturing source requiring proprietary installation tools, their installation, inspection, and verification, will not be extensively covered here. However, it is worth mentioning the ASTM F3148 bolts require individual tools for each bolt diameter. The table below lists the tools to be used, per diameter.

Bolt Diameter (inch series) *	Tone model wrench
1/2	TA-4E
5/8	TA-5E
3/4	TA-6E
7/8	TA-7E
1	TA-8E
1-1/8	TA-9E
1-1/4	TA-10E

\* Tools for 1-3/8 and 1-1/2 bolt diameters are not available since these sizes are not included in ASTM F3148. A project using these sizes will need to address this discrepancy early on.

Lastly, since ASTM F3148 bolts have a permanent extension, to permit placement for the tightening tool, connection design must take the additional length of the fastener, into consideration.

While ASTM F3148 bolts are single source 144ksi fasteners, the latest AISC/RCSC also permits nonproprietary 144ksi fasteners, to be added to the ASTM F3125 structural bolt specification, eventually. When nonproprietary 144ksi bolts are added to ASTM F3125, they can be installed, inspected, and verified using any of the tensioning methods described by the AISC/RCSC specification. Only ASTM F3148 fasteners are limited to the combined method.