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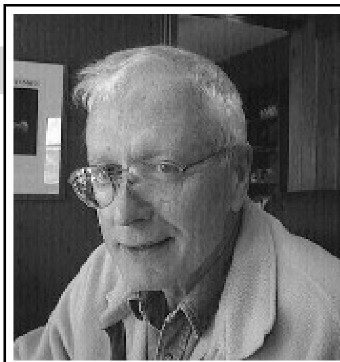

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Squirters Make SCR and HRSG Bolting Easy

The decade of the 1990s saw the introduction of two terms: "HRSG" — Heat Recovery Steam Generator, and "SCR" — Selective Catalytic Reduction. These terms refer to equipment already constructed at power plants to improve their power-generating efficiency or to reduce NOx emissions. Prototype SCRs and HRSGs were built around the country and elsewhere in the world, sometimes linked to the Department of Energy's "Clean Coal" demonstration projects such as at JEA Northside in Florida.

Typical SCR and HRSG steelwork

SCRs and HRSGs have something in common: they both need supporting steelwork with lots and lots of bolts. And the bolts must be tightened correctly. Field installation and inspection of these bolts consumes from 20 to 45 percent of all the field labor man-hours on the project. This labor costs the project owner from US $40 to $80 per man-hour, so the task of minimizing the overall bolting labor becomes an important one. For instance, installing 12 bolts per $60 man-hour will result in an installation cost of $5.00 per bolt, and inspection typically adds another $1.00. So on a job where there is 100,000 bolts, you're looking at $600,000 or more to get them installed.

When the bolting installation labor pool includes laborers, ironworkers, millwrights, and other trades, more or less skilled, and when they sometimes don't even speak the same language, the cost per bolt and the task of minimizing bolting man-hours becomes more difficult. When the bolting inspection personnel are sometimes the least skilled workers on the jobsite, the task becomes more difficult again.

Pressure to avoid late completion penalty clauses also imposes an imperative to get the bolting job done in the least possible time to keep bolting off the critical path. When bolting falls behind, additional labor is often concentrated on it to accomplish in two weeks what normally would have taken four weeks. So bolting effort is often hurried, with all the confusion, overtime, and other problems that entails.

State-of-the-art bolting installation and inspection specifications change frequently, and from jobsite to jobsite, making it difficult for workers to know conclusively that what they are told to do is really correct. Failing certainty, and failing adequate jobsite training, bolting workers revert to old "wives tale" methods that they have learned. Often as not, these methods prove to be incorrect or out-of-date. How many times have you heard that there surely is a certain "torque" necessary to get a bolt installed correctly?

But, bolt installation torque tables, at least for structural steel in North America, were abandoned in 1954, because installing bolts by torque-controlled methods, under real field conditions, is known to produce highly variable results.

Here are the current North American structural bolting specifications in a nutshell:

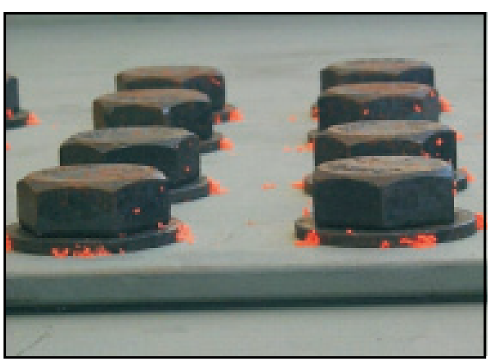
The Research Council on Structural Connections (RCSC) states that high strength bolts can be installed by one of four methods:

1. Calibrated Wrench — Calibrate the torque installation value to be used by bolt production lot, every day, by field testing them in a Skidmore-Wilhelm bolt tension calibrator. Snug the plies, then apply the "calibrated" torque to every bolt. Very laborious, rarely used in construction, and highly variable results can be expected due to the inherent variability of torque aggravated by construction conditions.

2. Turn-of-Nut — Snug the plies, scribe a line across the nut and bolt shank, then rotate the nut a prescribed amount of rotation which varies with bolt length and diameter. With good snugging and diligent workers and supervision, this method can produce good results. Shortcuts in this method can result in very poor results, and after it's done it's impossible to determine if it was done correctly.

3. Twist-Off Bolts — A special bolt is provided with a splined extension on the shank, and a special wrench grips the splined end and simultaneously turns the nut until the splined end shears off at a neck that has been manufactured into the bolt shank. Favored by many erectors because the action of shearing of the splined end is erroneously considered to always produce the correct bolt tension. Recent RCSC provisions now make it imperative to check these bolts in a Skidmore to see that the actual tension that is developed in these bolts at break-off is above minimum. This laborious checking procedure

Regular and squirter DTIs



Closeup of squirt

must use sample bolts that have been exposed to the same conditions as the bolts that are about to be tightened in the steelwork.

4. Direct Tension Indicators (DTIs) — DTIs are the only bolting method completely independent of the torque resistance of the bolt set. There are two types:

a. Standard DTIs — Steel washers with raised bumps on one side which are engineered to compress ONLY at a certain bolt tension, regardless of torque. These are inspected by means of attempting to insert a feeler gage into the DTI bump space to be sure that the bumps are sufficiently compressed. If they are, the bolt MUST be tensioned correctly, regardless of torque.

b. Squirter DTIs — Exactly the same steel washers, but which have had bright orange silicone deposited into them so that the action of compressing the bumps ejects some of the silicone radially outward through little grooves, showing the bolt installer and inspector that the bumps have been sufficiently compressed. Feeler gages are only used to calibrate the squirt event or to occasionally check bump compression as the work progresses.

Here is a list of bolting problems that cause inefficient field operations:

a. Inadequate information on site specifying which method is to be used to tighten the bolts.

b. Inadequate understanding that it's bolt tension that is needed, not torque, and the difference between the two.

c. Inadequate attention paid to "snugging" (that is, getting the plies firmly together before starting the tightening procedure) the joints.

d. Poor bolt storage conditions which allow deterioration of the bolt/nut friction factor, leading to higher-than-necessary torque resistance, tool wear, breaking bolts, and puzzled inspectors.

e. Misleading torque wrench arbitration inspection procedures.

f. Galvanized hardware that doesn't seem to work

TC bolt connection

very well.

g. Improper relubrication of twist-off bolts in the field which can lead to hidden thread stripping failures.

h. Incorrect placement of the DTI on bolts.

Squirter DTIs were developed in an attempt to compensate for these situations, and therefore to make field bolting as foolproof as possible. Here's the tightening method when squirters are used:

a. Snug the joint by partially tightening all the bolts in the connection, partially compressing the DTI bumps, but making sure no or very little silicone is showing at this point.

b. On the second pass, drive all the bolts until the silicone shows more or less all around the squirter DTI. "Drive them till they squirt!" becomes the method.

Squirters = Happy Bolters

When squirters are used, the costs savings can be 25 percent of the bolting installing and inspection time, which in the example above amounts to $1.50 per bolt. Out of this savings comes the cost of the squirter DTI, around $0.50, leaving something like $1.00 per bolt net savings for the owner of the project. But more than just the real dollar savings, when squirters are used, it's just plain simple. "Snug — no squirt. Then just make it squirt on the final pass." If the inspector can walk by within a couple of days, the silicone is usually still visible, making his or her job the simplest of all.

Squirters have been used on these and other HRSG and SCR projects:

- PG&E Athens, NY Combined Cycle, Bechtel — HRSG
- Reliant Energy Houston area, 12 sites, Babcock & Wilcox — SCRs
- Southern Company's Plants Miller and Autagaville, Williams Power — SCRs
- Oxychem Fluor Daniel Hahnville LA — HRSG
- Louisville Gas & Electric, Mill Creek and Wilson Stations — SCRs
- AES Granite, Ridge, NH — HRSG
- Reliant Mid-Atlantic, Hunterstown, PA — SCR