Title: CSA G40.21 Steel Requirements
Date: Rev. 2 – November 2013
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Purpose: To remove unnecessary alloy content restrictions for CSA G40.1 steel.

Source: Craig Meier / Doug Miller / George Wilson

Revision: 2

Impact: Elimination of unnecessary restrictions on use of G40.1 may increase options for new tank construction and could result in lower costs.

Background: The Canadian Steel Association (CSA) G40.20 / G40.21 Technical Committee would like to publish the new edition of this document in March 2013. The committee has questioned the need for the requirements of Table 4-2 for CSA G40.21 steel.

There is no need for CSA G40.21 grades found in API 620 to have a special requirement to meet the limitations of Table 4-2.

See Attachment to this Ballot for more background.
Table 4-1—Minimum Requirements for Plate Specifications to be Used for Design Metal Temperatures (Continued)

<table>
<thead>
<tr>
<th>Design Metal Temperature (See 4.2.1)</th>
<th>Plate Thickness Including Corrosion Allowance (in.)</th>
<th>Permissible Specifications</th>
<th>Special Requirements (In Addition to 4.2.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 1</td>
<td></td>
<td>ASTM A516 55, 60, 65, 70</td>
<td>Notes 3 and 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASTM A537 Classes 1 and 2</td>
<td>Note 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASTM A573 58</td>
<td>Notes 3 and 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASTM A633 C and D</td>
<td>Note 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASTM A662 B and C</td>
<td>Notes 3 and 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASTM A678 A and B</td>
<td>Note 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASTM A737 B</td>
<td>Note 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASTM A841 Class 1</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CSA G40.21 38W, 44W, 50W</td>
<td>Notes 2, 3, and 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ISO 630 (1995) E275, E355 Quality D</td>
<td>Notes 3, and 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EN 10025 S 275, S355 Quality J2, K2</td>
<td>Notes 2, 3, and 4</td>
</tr>
</tbody>
</table>

**NOTE 1** All plates over 1 1/2 in. thick shall be normalized.

**NOTE 2** The steel shall be killed and made with fine-grain practice.

**NOTE 3** The plates shall be normalized or quench tempered (see 4.2.4.2).

**NOTE 4** Each plate shall be impact tested in accordance with 4.2.5.

**NOTE 5** The manganese content shall be within the range of 0.80 % to 1.20 %. The steel shall not be rimmed or capped.

**NOTE 6** The material supplied shall not be rimmed or capped.

h) A573.
i) A633 (Grades C and D only).
j) A662 (Grades B and C only).
k) A678 (Grades A and B only).
l) A737 (Grade B only).
m) A841 (Class 1 only).

### 4.2.3.3 CSA Specification

The following CSA specification is approved for plates: G40.21 (Grades 38W, 44W, and 50W only; if impact tests are required, these grades are designated 38WT, 44WT, and 50WT).

Elements added for grain strengthening shall be restricted in accordance with Table 4-2. Plates shall have a tensile strength not more than 20 ksi above the minimum specified for the grade. Fully killed steel made to a fine grain practice must be specified when required.

### 4.2.3.4 ISO Specification

The following ISO specification is approved for plates: 630-1 (Grades E275 and E355 in Qualities C and D only).

Elements added for grain refining or strengthening shall be restricted in accordance with Table 4-2.
Title: CSA G40.21 Steel Requirements

Date: Rev 1—December 2012
      Rev. 4 April 16, 2013 (Recommended for Publication)

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Purpose: To remove unnecessary alloy content restrictions for CSA G40.1 steel.

Source: Craig Meier / Doug Miller / George Wilson

Revision: 4

Impact: Elimination of unnecessary restrictions on use of G40.1 may increase options for new tank construction and could result in lower costs.

Background: The Canadian Steel Association (CSA) G40.20 / G40.21 Technical Committee would like to publish the new edition of this document in March 2013. The committee has questioned the need for the requirements of Table 4-1 for CSA G40.21 steel. They would like to remove G40.21 7.2.1 and Table 4, if API 650 can be modified to remove requirement specific to CSA steels to comply with API 650, Table 4-1.

There is no need for CSA G40.21 grades found in API 620/650 to have a special requirement to meet the limitations of Table 4-1.

See Attachment to this Ballot for more background.
PROPOSED CHANGES

Red means a proposed change, blue means comments to explain the change in red, yellow highlighted bold print means add.

4.2.3 CSA Specifications

CSA Specification G40.21, Grades 260W/(38W), 300W/(44W), and 350W/(50W) are approved for plates. If impact tests are required, WT Grades are specified.

Plates furnished to CSA G40.21 in Grades 260W/(38W), 300W/(44W), and 350W/(50W) is acceptable within the applicable limitations stated below. (If impact tests are required, Grades 260W/[38W], 300W/[44W], and 350W/[50W] are designated as Grades 260WT/[38WT], 300WT/[44WT], and 350WT/[50WT], respectively.) Imperial unit equivalent grades of CSA Specification G40.21, shown in parenthesis, are also acceptable.

a. The W grades may be semi-killed or fully killed. This is not needed since CSA G40.21, section 5.2 does not allow rimmed/capped steel for any of its plate products.

b. Fully killed steel made to fine-grain practice must be specified when required. This is redundant as it is already covered by Table 4-4a and 4-4b.

c. Elements added for grain refining or strengthening shall be restricted in accordance with Table 4-1.

Not required. The special alloying limits were formerly in App G prior to the 7th edition. When App G moved into the base document at 7th edition an error was made in connecting the limits to all CSA material when it should have applied only to high strength materials. See the background material on following pages for more detailed historical explanation.

d. Plates shall have tensile strengths that are not more than 140 MPa (20ksi) above the minimum specified for the grade. The tensile strength of each of the 3 listed CSA grades are permitted a max-min range of 25 ksi; however API 36, ENI and ISO steels listed in API 650 (outside of Group VI) are also permitted a tensile strength range > 20 ksi, so this requirement does not appear to be critical outside of Group VI. All of Group VI steels have a maximum permissible range of 20 ksi. Therefore, since CSA grades are not used as Group VI steels, this requirement should not apply.

e. Grades 260W/(38W) and 300W(44W) are acceptable for plate to a maximum thickness of 25mm (1 in.) if semi-killed and to a maximum thickness of 40 mm (1.5 in.) if fully killed and made to fine-grain practice.

Grade 350W (50W) is acceptable for plate to a maximum thickness of 45 mm (1.75 in.) (insert plates to a maximum thickness of 100mm [4 in.]) if fully killed and made to fine-grain practice. These thickness limitations are contained within the CSA specification and do not need to be repeated here—no other steel grade spells out this type of limitation. Correction, CSA only names fully killed for t>40mm.
4.2.7.5 The use or presence of columbium, vanadium, nitrogen, copper, nickel, chromium or molybdenum shall not exceed the limitations of Table 4-1 for all Group VI materials (see Table 4-4a and 4-4b) and CSA G40.21 Grades 350W/(50W) & 350WT/(50WT), ISO 630 Grade E355, and EN 10025 Grade S355.

CSA grade 50T was named in this section when App G became the base std at 7th edition. When we take away the general application of Table 4-4 from all CSA material, we should restore it here [in all its English and metric versions and with and without impact testing (WT & W)] for the higher strength grade it was intended for.

Table 4-1 –Maximum Permissible Alloy Content *(Move to after 4.2.7.5 and before 4.2.8)*

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Heat Analysis (%)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Columbium</strong></td>
<td>0.05</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td><strong>Vanadium</strong></td>
<td>0.10</td>
<td>1, 2, 4</td>
</tr>
<tr>
<td>Columbium (≤ 0.05%) plus Vanadium</td>
<td>0.10</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td><strong>Nitrogen</strong></td>
<td>0.015</td>
<td>1, 2, 4</td>
</tr>
<tr>
<td><strong>Copper</strong></td>
<td>0.35</td>
<td>1, 2</td>
</tr>
<tr>
<td><strong>Nickel</strong></td>
<td>0.50</td>
<td>1, 2</td>
</tr>
<tr>
<td><strong>Chromium</strong></td>
<td>0.25</td>
<td>1, 2</td>
</tr>
<tr>
<td><strong>Molybdenum</strong></td>
<td>0.08</td>
<td>1, 2</td>
</tr>
</tbody>
</table>

1. When the use of these alloys or combinations of them is not included in the material specification, their use shall be at the option of the plate producer, subject to the approval of the Purchaser. These elements shall be reported when requested by the Purchaser. When more restrictive limitations are included in the material specification, those shall govern.

2. On product analysis, the material shall conform to these requirements, subject to the product analysis tolerances of the specification.

3. When columbium is added either singly or in combination with vanadium, it shall be restricted to plates of 13 mm (0.50 in.) maximum thickness unless combined with 0.15% minimum silicon.

4. When nitrogen (≤ 0.015%) is added as a supplement to vanadium, it shall be reported, and the minimum ratio of vanadium to nitrogen shall be 4:1.
Attachment: More Background Information

CSA G40.21 Steel Plate

1) CSA G40.21, 7.2.1 states: "For American Petroleum Institute (API) plate applications listed in API 620 and 650, elements added for grain refining or strengthening (see Table 3) shall be in accordance with Table 4."

2) Table 3 presents limits for C, P, S, Si and "Grain refining elements" for the grades listed in API 620/650. Grain refining elements max = 0.10 with Item (c). Item (c) of Table 3 states "Aluminum may be used as a grain refining element without prior approval by the purchaser and, when so used, shall not be included in the summation of grain refining elements included in Table 3. The elements columbium (also known as niobium) and vanadium may be used singly or in combination up to the total percentage indicated, except where columbium is used singly or in combination with vanadium in plates thicker than 14mm (1/2 in) or in shapes heavier than Group 1, in which case the silicon content shall be 0.15% minimum. This restriction does not apply if the steel fulfills the requirements of Item (b). Item (b) states" At the purchaser's request or at the producer's discretion, the steel may be made with no minimum silicon content, provided that the steel contains a minimum of 0.015% acid soluble aluminum or 0.020% total aluminum content. Some of these limitations are redundantly listed in Table 4-1

3) Essar Steel (Toronto based) manufactures CSA G40.21 steel plate. They were contacted and stated that for the 3 grades allowed by API 620/650, the elements listed in Table 4-1 are not intentionally added to the plate steel in the grades listed in API 620/650, except in the case of 350W/50W where vanadium is added with a maximum limit of 0.10%.

4) Arcelor Mittal has published a Cross Reference of Canadian Steels as follows:

<table>
<thead>
<tr>
<th>CSA G40.21-04 Grade</th>
<th>ASTM Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>260WT/38WT</td>
<td>A36/A516-60</td>
</tr>
<tr>
<td>300WT/44WT</td>
<td>A572-42</td>
</tr>
<tr>
<td>350WT/50WT</td>
<td>A572-50/A633C</td>
</tr>
</tbody>
</table>

A36 and A516-60 are not subject to the limitations of Table 4-1 in API 650. A572 has minimum copper limits of 0.20%. A633C has a columbium range restriction between 0.01%- 0.05%. G40.21 and A516 have a minimum of 0.20% copper if specified, but no maximum.

Current API 650

4) "4.2.7.5 The use or presence of columbium, vanadium, nitrogen, copper, nickel, chromium or molybdenum shall not exceed the limitations of Table 4-1 for all Group VI materials (see Table 4-4a and 4-4b) and ISO 630, Grade E355." **No CSA steel is listed under Group VI. However Table 4-1 is still needed to meet 4.2.7.5 for Group VI materials.**

2) No other API 650 plate that is outside of Group VI except ISO 630 Grade E355 is subject to the requirements of Table 4-1. The adherence of E355 to Table 4-1 came from agenda item 620-297 and 650-684 (D-Miller, 2009).
API 650 Historical

1) Second Edition, 1964: CSA G40.8 Grades A and B plate was first recognized in API 650. No metallurgical limits are stated.

2) Third Edition, Suppl 2, 1969: Appendix G was added providing a special design basis for high-strength steels with improved notch-toughness. At that point the limits on alloying existed but were only applied to API G.10 steel (an API specific grade defined within App G).

3) Fourth Edition 1970: CSA G40.8 is listed as having a minimum thickness of 1-1/2". No metallurgical limits are stated. Appendix G expanded application of the alloy limits table to all steel in App G tanks (i.e. all high strength, high stress basis tanks) Appendix G was added providing a special design basis for high-strength steels with improved notch-toughness (a copy of Appendix G was not located for this edition of API 650).

4) Sixth Edition 1978: CSAG40.21 – Grades 38W and 44W was recognized in the base document. CSAG40.21 Grade 50T was recognized within App G. Appendix G still applied the alloying limits to all App G plates (G.2.a) but note 7 under Table G-1 was created which was tied to CSA grade 50T only. Note 7 named the alloy limits table again (redundant given G.2.a) and required 50T to have a maximum of 20 ksi above the minimum tensile strength specified. Elements added for grain refining or strengthening were restricted to Table G-2 and plates were required to have a maximum of 20 ksi above the minimum tensile strength specified (again, no Appendix G available).

5) Seventh Edition 1980: The rules of Appendix G became the API 650 base document. Alloy limits were applied to all Group VI materials and to CSA 50T (2.2.6.5). 50T is like today's 50WT but 50WT is better in that it is always impact tested. 50T was not impact tested. Section 2.2.3 addressed all CSA material. It stated the alloying limits and the 20 ksi rule and did not limit which grades. But by comparison with 2.2.6.5 and that prior editions it is rather obvious it was an editorial error to make these special limits apply to all CSA grades. CSA G40.21 Structural Quality Steel had the same grain refining and tensile limits as in the Sixth Edition, only Table 2-1 had replaced Table G-2. Table 2-1 is identical (with some minor editorials to the notes) to the Current Edition Table 4-1. In section 2.2.6 General Requirements for Delivery the following was stated: "The use or presence of columbium, vanadium, nitrogen, copper, nickel, chromium, or molybdenum shall not exceed the limitations of Table 2-1." This applied to any steel plate, not just CSA plate. CSA maximum thicknesses were specified as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Max Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>38W, 44W</td>
<td>1.0&quot;</td>
</tr>
<tr>
<td>38T, 44T</td>
<td>1.5&quot;</td>
</tr>
<tr>
<td>50T</td>
<td>'1.5&quot; (insert plates to 2&quot;)</td>
</tr>
</tbody>
</table>

6) Ninth Edition, Addendum 4 1997: Table 4-1 is identical to the current edition. Section 2.2.3 corresponds to 4.2.3 in the current edition and is identical. except for minor wording changes. Section 2.2.6.5 changed to: "The use or presence of columbium, vanadium, copper, nickel, chromium, or molybdenum shall not exceed the limitations of Table 2-1 for all Group VI materials (see Table 2-3) and ISO 630, Grade Fe 510." The limitations of Table 2-1 no longer applied to non Group VI materials except ISO 630 Grade Fe 510 and CSA G40.21.