Recording Historic Corrugated Iron
A Guide to Techniques

Dirk HR Spennemann
Techniques in Historic Preservation

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Introduction

Corrugated iron roofs of many nineteenth and early twentieth century properties are nearing the end of their life due to progressing decay and are in need of conservation management actions. The same applies to corrugated iron-clad outbuildings on many farms.

Very often, the corrugated iron sheets have decayed to such a degree that they are in need of full replacement if water tightness of the roof is to be maintained. One of the concerns is that the historic information contained in original sheets (via their brand and physical characteristics) is lost in the process of replacement. Thus, adequate documentation of the status quo is desirable. This brief guide sets out the various parameters that should be recorded when documenting structures with historic corrugated iron.

Corrugated Iron

Corrugated iron, i.e. flat sheet-iron that has been cold rolled into a wavy surface, was first patented in the United Kingdom in 1829 (Palmer, 1829). Many manufacturers quickly offered the product once the original patent had run out in 1843. By the 1850s the use of corrugated iron had become widespread; it served mainly as a roofing material, given the structural strength it provides along the long axis of the corrugations. Subsequently, Australia became the premier export market for the British corrugated and galvanised iron industry. It has been posited that corrugated iron has a special place in Australian architecture and aesthetic (Lewis, 1982; Meyers, 1981).

During the mid-nineteenth century, galvanisation (the application of zinc on ferrous metals) became a widespread method of slowing down the corrosion of products made from sheet iron. The common process until the end of the nineteenth century was to first hand-dip and later machine-dip the iron sheets in a pot of molten zinc (at about 450°C) (Davies, 1899, p. 60ff). Hot-dipped galvanised iron shows a surface colour with a characteristic broken pattern, the ‘spangle’ (GalvInfo Center, 2015). In 1888 John Lysaght Ltd developed a four-roll galvanising machine which ensured an even coating and thus provided reliable quality, while at the same time saving on zinc. Galvanised iron produced by this process shows a homogenous surface colour.

Fig. 1. Typical decaying farm building with corrugated iron roof and collapsed verandah (Klemke’s Farm, Edgehill, NSW) (Spennemann, 2015a)

Fig. 2. Typical decaying farm building with corrugated iron used for walls and roof (stables, racecourse, Albury, NSW).

The period between 1894-1895 were the transition years from puddled (and thus soft) iron to steel in the sheet metal trade. While some companies adapted, others failed to modernise and continued to use puddled iron; eventually the latter companies went out of business (e.g. Redcliffe Crown: Spennemann, 2015c).

1. For this a number of publications have been produced by the various state heritage offices (Heritage Branch [Qld], 2014; Heritage South Australia, 1999; Heritage Victoria, 2001; NSW Heritage Office, 1998; WA State Heritage Office, 2013) as well as guidelines by local councils (Brisbane City Council, 2014; Brooks & Loveys, 2014)

2. For an example for the wide range of galvanized iron brands used in a single farm complex, see Spennemann (2015b)

An assessment of the history, marketing and distribution of single brand of corrugated iron (Redcliffe Crown, 1875–1921) showed that several occurrences had been replaced since they had been reported in the literature. As result, it was impossible to verify the variation of the stamp that had been used (Spennemann, 2015c).

3. This document is a revised and substantially enlarged version of an earlier guide (Spennemann, 2015d).
Documentation Criteria and Techniques

Care should be taken to investigate all sheets that can be accessed and assessed. Changes in the type of the sheets (marked vs. unmarked, different brands, etc.) indicate changes to the fabric of the structure such as repair or extensions. Various characteristics of the corrugated iron sheets need to be documented (Table 4).

**Dimensions, length and width**

Historically, corrugated iron tended to be sold in lengths of five to ten feet, even though longer sheets were technically possible (depending on the side of the dipping vats) and were indeed offered by some manufacturers (e.g. Redcliffe Crown: Spennemann, 2015c).

![Fig. 3. Standard nine-foot sheet of corrugated iron. Note that part of the corrugations have been flattened.](Spennemann, 2015a)

Even though the currently accepted mode of documentation is to record all measurements in the International System of Units, that is using the metre scale (and its derivatives), nineteenth- and early twenty-century building materials, in particular prefabricated materials, used the Imperial scale (feet, inches, gauge). Thus it is desirable to record the dimensions either in both metric and Imperial, or in Imperial alone.

Care needs to be exercised when measuring partially flattened sheets of corrugated iron. For example, a standard sheet (Fig. 3) showing eight corrugations, has a width of 24" if the pitch is 3" (standard pitch). A standard corrugation depth of ¾" implies that the flat metal sheet, before rolling, was originally 27⅞" wide. In consequence, any flattening of the corrugations will result in an increase in measured width, to a maximum of 27⅞".

**Pitch and depth of the corrugations**

The corrugations are commonly described in terms of pitch, *i.e.* the distance between two crests, and depth, *i.e.* the vertical distance between the top of the rise and the bottom of the valley (Fig. 4).

![Fig. 4. Corrugated iron. Definition of terms.](Spennemann, 2015a)

During the nineteenth and early twentieth century a wide range of pitch and depth variations were available in Australia and New Zealand, either as standard stock or as specially ordered imports (Table 1). By far the most commonly occurring corrugation is 3" x ¾". Smaller corrugations such as 1" x ¼" (commonly called ‘ripple iron’) also exist, frequently used for ceilings and more ornamental coverings.

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4. Common sense, however, should prevail, as some roofs will require scaffolding to ensure safe access.

5. At a period of 3" and an amplitude of ¾", the length of the arc is 3.477".

6. In mathematical terms, the corrugations are of course a sine wave, with an period (=pitch) and an amplitude (=depth).
Table 1. Corrugation profiles marketed in Australia by Lysaght Ltd (1916, p. 9)

<table>
<thead>
<tr>
<th>Pitch</th>
<th>Depth</th>
<th>availability in 1916</th>
</tr>
</thead>
<tbody>
<tr>
<td>½&quot;</td>
<td>¼&quot;</td>
<td>standard stock</td>
</tr>
<tr>
<td>1&quot;</td>
<td>¼&quot;</td>
<td>standard stock</td>
</tr>
<tr>
<td>1½&quot;</td>
<td>⅜&quot;</td>
<td>supplied to order</td>
</tr>
<tr>
<td>2&quot;</td>
<td>⅜&quot;</td>
<td>supplied to order</td>
</tr>
<tr>
<td>2½&quot;</td>
<td>⅝&quot;</td>
<td>supplied to order</td>
</tr>
<tr>
<td>3&quot;</td>
<td>¾&quot;</td>
<td>standard stock</td>
</tr>
<tr>
<td>3⅜&quot;</td>
<td>⅝&quot;</td>
<td>weight bearing, standard stock</td>
</tr>
<tr>
<td>4&quot;</td>
<td>1&quot;</td>
<td>supplied to order</td>
</tr>
<tr>
<td>5&quot;</td>
<td>1¼&quot;</td>
<td>supplied to order</td>
</tr>
<tr>
<td>5½&quot;</td>
<td>1½&quot;</td>
<td>supplied to order</td>
</tr>
<tr>
<td>6&quot;</td>
<td>1⅜&quot;</td>
<td>supplied to order</td>
</tr>
<tr>
<td>6&quot;</td>
<td>1⅝&quot;</td>
<td>supplied to order</td>
</tr>
</tbody>
</table>

Thickness

Nineteenth century sources refer to the thickness of iron as expressed in ‘gauge.’ The most common type of iron was 24- and 26-gauge. In the absence of commonly accessible sliding callipers that measure in gauge, it is advisable to record the thickness in millimetres and then to convert the measurements. Table 2 provides a conversion of millimetres to gauge.

Table 2. Conversion of gauge (thickness) to mm and inches

<table>
<thead>
<tr>
<th>Gauge</th>
<th>mm</th>
<th>inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>1.245</td>
<td>.049</td>
</tr>
<tr>
<td>20</td>
<td>.889</td>
<td>.035</td>
</tr>
<tr>
<td>22</td>
<td>.711</td>
<td>.028</td>
</tr>
<tr>
<td>24</td>
<td>.559</td>
<td>.022</td>
</tr>
<tr>
<td>26</td>
<td>.457</td>
<td>.018</td>
</tr>
<tr>
<td>28</td>
<td>.356</td>
<td>.014</td>
</tr>
</tbody>
</table>

Nature of galvanisation

Hot-dipped galvanised iron shows a surface colour with a characteristic broken pattern, the ‘spangle’ (Fig. 5, left). Iron galvanised by rollers has a more uniform coating (Fig. 5, right). Hot dipping was the sole technique available until the late 1880s, with some vats having rollers installed. While from the late 1880s full roller-coating became more common, many older galvanising plants continued to hot-dip until well after World War I.

Other methods of galvanisation are more recent, such as colour-painted coating of zinc and aluminium (Colorbond, since 1966) and a coating of zinc and silicon (Zincalume, since 1966) (Bluescope, 2014). More recently, corrugated aluminium sheets have come on the market.

Fig. 5. Comparison of hot-dipped (left) and rolled galvanised iron. Note the pronounced ‘spangle’ of the hot-dipped iron

Material (puddled iron, steel)

The early iron sheets consisted of wrought iron manufactured in the puddling process, which resulted in iron bars with a range of impurities. The iron was then rolled flat into sheets in rolling mills and cut to length. From the mid-1890s onwards, steel was used as the base of corrugated iron sheets. In addition, corrugated sheets can also be made from re-rolled tin (very rare) and in particular Zincalume.

Zincalume and rolled tin can be readily distinguished from iron and steel by using a magnet. It remains difficult to distinguish sheets of corrugated steel from sheets of corrugated puddled iron. The latter tends to be softer and thus more flexible (at the same gauge), but this is difficult to ascertain without comparison specimens, especially when the iron is still in situ, such as on a roof.

Quantity of Sheets

It is advisable to count out the number of sheets used on a roof or structure. The number of sheets can then be correlated with the number of cases that would have been required (Table 3). It can be surmised that stations, with their diverse demands, may have bought corrugated iron by the case rather than as individual sheets. Owners of urban properties may have acquired the required number of sheets from local retailers or wholesalers (see for example the pricing information compiled in Spennemann, 2015c).
Table 3. Composition of cases of 26-gauge galvanised corrugated iron (Gemmell Tuckett & Co, 1875, p. 13; Lysaght Ltd, 1897, p. 7; Lysaght Ltd Pty, 1921).

<table>
<thead>
<tr>
<th>Length</th>
<th>Redcliffe Crown 1875</th>
<th>Lysaght 1897</th>
<th>Lysaght 1921</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 ft</td>
<td>106</td>
<td>115</td>
<td>116</td>
</tr>
<tr>
<td>6 ft</td>
<td>90</td>
<td>96</td>
<td>98</td>
</tr>
<tr>
<td>7 ft</td>
<td>78</td>
<td>82</td>
<td>84</td>
</tr>
<tr>
<td>8 ft</td>
<td>68</td>
<td>72</td>
<td>73</td>
</tr>
<tr>
<td>9 ft</td>
<td>58</td>
<td>64</td>
<td>65</td>
</tr>
<tr>
<td>10 ft</td>
<td>—</td>
<td>57</td>
<td>58</td>
</tr>
</tbody>
</table>

**Brand (if bearing maker’s stamp)**

In many cases galvanised iron, whether corrugated or flat, was marked with a brand or maker’s stamp (Fig. 10–Fig. 14). That paint stamp, either a rubber stamp or a stencil, was applied before the sheet was run through a corrugation machine.

Over time the stamps tend to bleach, caused both by a decay of the paint and due to physical weathering. An option is to moisten the surface of the stamp with a hand-held spray bottle / flower mister (Fig. 6).

Fig. 6. Wetting the surfaces with a hand-held spray bottle can enhance the recognition of detail.

Ideally, all stamps are photographically recorded as detailed assessments have shown a variability among the impressions, even of the same batch (Fig. 9).

**Colour of the stamp**

While it may be tempting to accurately record the colour of a stamp using Munsell Color Charts (Munsell Color, 1990, 2008), both practical and preservation issues counsel against doing so. For one, to accurately record the colour of each stamp will be very time consuming; as most stamps in situ may be difficult to access in a safe manner without scaffolding. Secondly, accurate colour recording requires uniform light conditions (see Gerharz, Lantermann, & Spennemann, 1988), which cannot be ensured when recording galvanised iron stamps in enclosed spaces, especially roof cavities.

The primary argument against recording colour, however, is that the colour of a stamp changes. Fig 8 shows three examples of Braby’s Sun Barn stencils, all from the same roof of the woolshed at Old Urangeline Station (Spennemann, 2015b). The stencil’s paint decays with a break-down of the oil-based binder, leading to a flaking loss of pigment. This exposes the underlying substrate of zinc. Over the duration of the paint’s existence, that part of the zinc covered by paint oxidised, forming zinc hydroxide and zinc oxide (‘white rust’, Duran & Langill, 2007; Orrcon Steel, 2005).

**Arrangement Pattern**

The historic building literature discusses a variety of methods to overlap the sheets of corrugated iron. A six-inch long end overlap, and a single- (Globe Iron Roofing and Corrugating Co, 1890; McM, 1946, p. 32) or double-corrugation side lap is recommended in the historic construction literature (Branne, 1929, p. 601). This meant, however, that when covering a roof with 26" wide sheets, and a double corrugation side overlap, the sheets only yielded an actual coverage of 24". In addition, a 6-inch end lap and 2 corrugations-wide side lap added 25% weight to the corrugated iron sheeting resting on the roof trusses (Gillette, 1907, p. 531).

Many farmers and other builders chose to maximise the coverage at the expense of strength. The method covering the largest area with the smallest number of sheets is the half-lap (Fig. 7). This entails that the sheets are laid alter-

8. In contrast, stamps on the (protected) underside of the sheet often appear almost ‘new.’

9. Zinc-rich coatings of iron, including hot-dip galvanisation, are alkaline in nature. Oil-based paints react with the alkaline surface, leading to a decay of the binder (saponification).
natingly with the edges of the corrugations pointing down and pointing up.

Fig. 7. Methods of overlapping sheets of corrugated iron.

It is frequently asserted that the striped appearance of many historic roofs is caused by unevenly coated sheets which were laid in alternating fashion (e.g. NSW Heritage Office, 1998). As shown elsewhere (Spennemann, 2015e), the striped appearance is a result of differential corrosion which has nothing do with the method of galvanisation employed in the manufacture of the sheets.

Re-use
Corrugated galvanised iron was frequently salvaged from dilapidated buildings and reused. This is particularly the case in rural support buildings, such as sheds and barns which were often adapted to changing needs. While repairs and the insertion of individual sheets tends to be obvious (Fig. 20), wholesale re-use of sheets may be less easy to detect, especially if the sheets are replaced exactly as they were. Tell tale signs are linear discolourations, where the sheet had once been in contact with the batten of a previous roof, as well as nail / screw holes that do not match up with the battens of the current roof (Fig. 21).

Fig 8. Example of paint decay on sheets of Braby Sun Brand corrugated iron. Woolshed, Old Urangeline Station near Rand (NSW) (Spennemann, 2015b)
Fig. 9. Variability of impressions of a Redcliffe Crown stamp on corrugated iron sheets. All sheets come from the same batch. Station Cook House, Old Urangeline Station near Rand (NSW) (Spennemann, 2015b).

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Method</th>
<th>Issues to be considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>Measure in inches (cm) with steel tape</td>
<td>Measurement to mm may be too accurate, as original sheets were cut to foot length with some margin. In addition edge corrosion occurs (Fig. 14)</td>
</tr>
<tr>
<td>Thickness</td>
<td>Measure in mm with sliding caliper, convert to gauge (Table 2)</td>
<td>Edge thickness may vary due to corrosion, it is recommended to use a ‘clean edge’ (preferably the covered lip) and to take several measurements. Given the relative thinness of the iron, minor amount of dirt or corrosion deposits (of the zinc) may mask the small variations between gauges (essentially 0.1 to 0.15 mm); it is advisable to brush the edge to be measured, or to rub both sides with a cloth</td>
</tr>
<tr>
<td>Pitch &amp; depth</td>
<td>Measure with ruler &amp; sliding calipers</td>
<td>Measurement in mm or inches. Time consuming and error prone (Fig. 16–Fig. 17)</td>
</tr>
<tr>
<td></td>
<td>Use a plasterer’s comb to record at scale 1:1, then measure in office</td>
<td>Accurate and speedy method (Fig. 18–Fig. 19). It also permits to cross-check profiles while on site</td>
</tr>
<tr>
<td>Galvanisation</td>
<td>Observation &amp; photography</td>
<td>Hot-dipped galvanisation shows the characteristic spangle</td>
</tr>
<tr>
<td>Material</td>
<td>Observation &amp; assess flexibility</td>
<td>If required, a magnet can be used to distinguish flat sheets of lead flashing from iron flashing</td>
</tr>
<tr>
<td>Brand</td>
<td>Photography</td>
<td>Washed out / faded stamps may require moistening with a hand-held spray bottle. —Images may benefit digital post-processing /enhancement (contrast and levels). Marks may be partial (when flat sheets are cut for spouting and flashing)(Fig. 13). Use flash in (partial) sunlight, if the corrugations cast shadows</td>
</tr>
<tr>
<td>Colour</td>
<td>Makers stamps occur in a number of colours.</td>
<td>Variations in colour have been observed. Some of these may be due to different colour (hues) used in the original stamp, while others are due to paint decay</td>
</tr>
<tr>
<td>Original use</td>
<td>Observation &amp; photography</td>
<td>Look for linear discolourations and nail holes</td>
</tr>
<tr>
<td>Arrangement</td>
<td>Observation</td>
<td>Record nature of overlap (corrugations)</td>
</tr>
<tr>
<td>Count</td>
<td>Observation</td>
<td>Watch out for partial sheets</td>
</tr>
</tbody>
</table>
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**Fig. 10.** The maker’s marks can be hidden.

**Fig. 11.** The maker’s marks can be hidden.

**Fig. 12.** The maker’s marks may be complete (Spennemann, 2015c).

**Fig. 13.** The maker’s marks may be incomplete (Spennemann, 2015a).

**Fig. 14.** The maker’s marks can be faint (Spennemann, 2015a).

**Fig. 15.** Corroded edges may impair accurate measurements (Spennemann, 2015a).
Fig. 16. Measuring pitch with ruler.

Fig. 17. Measuring depth with callipers.

Fig. 18. Using a plasterer's comb to take off the corrugation at a scale of 1:1.

Fig. 19. Recording the corrugation at a scale of 1:1 for later accurate measurement.

Fig. 20. Evidence of patching a roof with different sheets. (Spennemann, 2015b).

Fig. 21. The discolouration, as well as the nail holes show that this sheet has been salvaged from elsewhere and reused. (Spennemann, 2015b).
Bibliography


Lysaght Ltd, John. (1899). The metal trades' referee and storekeepers' guide : being a table of weights, measurements, and other ... useful information. Melbourne: John Lysaght.

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