Area Correction Factors in AccuRate v1.1.4.1

Dong Chen

CSIRO Ecosystem Sciences and CSIRO Energy Transformed Flagship

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SUMMARY

Recently, with the NatHERS software tool accreditation process, there appear confusions in the special treatment of the area adjustment for buildings with partially shared external envelope (walls, floors or ceilings) which has resulted in different interpretations and implementation of area correction factors in different NatHERS software tools. In this note, a brief background of the area correction factor and its implementation in AccuRate v1.1.4.1 are described.

BACKGROUND

The background information presented here is based on the available documentations and recent communications with Dr Angelo Delsante, Mr Doug McPherson from Sustainability Victoria, Mr Tony Isaacs from Tony Isaacs Consulting P/L and Dr Holger Willrath.

During the NatHERS upgrade project, the Ministerial Council on Energy agreed that future NatHERS software tools should remove the naturally occurring bias that results in larger houses being advantaged over smaller houses. The reason for such bias toward larger houses stems from the use of MJ per Net Conditioned Floor Area (NCFA) (m^2) as the measure of the energy efficiency of houses and the following two aspects:

1. Considering two house plans which are in all aspects identical except that one is proportionally larger, the smaller house will have a greater external surface area to floor area ratio since the wall height remains the same or similar for both houses;
2. Smaller houses have been observed to have a higher glass to floor area ratios. This is due to the fact that windows come in modular sizes – window size does not reduce in proportion to room area - and also the aesthetic requirement to not use unreasonably small sized windows.

Consequently, it is expected that a smaller house will require a higher MJ/m^2 for heating and cooling, although its total energy use may be lower. The Ministerial Council agreed that an Area Correction Factor similar to that developed by the Sustainable Energy Authority of Victoria (SEAV) for FirstRate, be developed for new NatHERS software tools. A study was carried out by Mr Tony Isaacs for the then Australian Greenhouse Office in suggesting the Area Correction Factor for the use in AccuRate.

This area adjustment method was produced after consultation with the jurisdictions. Feedback from the BASIX team in NSW was particularly influential as it was desirable to harmonise the BASIX area correction with the NatHERS area correction. Consequently, the shape of the NatHERS and BASIX area correction curves are similar, but the BASIX correction uses a smaller reference area (the average size of all houses in NSW) than the 196 m^2 used by NatHERS.

PROPOSED AREA CORRECTION METHOD

The report prepared by Tony's study in 2004 titled **"**AccuRate Area Correction Model" detailed and acknowledged the complexity of such bias. The following methodologies are extracted from this document and have been updated by Tony to reflect later work he has done with the area correction.

Based on its previous work with FirstRate development, SEAV (now Sustainability Victoria) proposed a simplified method as an interim solution to obtain the area correction factors for each climate zones for use in NatHERS software tools, until further more sophisticated research could develop a better approach. While further research was undertaken, no alternative area correction technique was developed. Thus the interim approach developed by SEAV became the official factor by default.

The area correction factors were obtained by simulating the energy use of an idealised house using NatHERS and changing the floor plan size from 49 m^2 to 625 m^2 in six steps. Figure 1 shows the idealized house design used in developing the area correction factors. Assuming that this house plan should receive the same rating regardless of floor size, the area correction factor (in MJ/m^2) was obtained by comparing the MJ/m^2 of each case to the energy use of the case at 196 m^2 floor size which was around the average of new houses in Australia then.

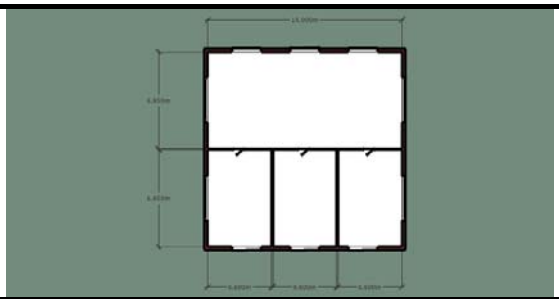
When rating a house, the adjusted annual energy requirement is simply adding the area correction factor (in MJ/m^2) (when the house area is larger than 196 m^2) to or subtracting the area correction factor (in MJ/m^2) (when the house area is smaller than 196 m^2) from the annual energy requirement obtained by NatHERS simulation. At 196 m^2, the factor is set to 0 in all climates.

The above obtained area correction factors may be referred to as the detached house area correction factors. The basis of the correction is that the smaller a house, the greater its surface area, however, this is not the case for attached units, townhouses or terrace houses, which share areas of walls, roofs or floors with other units which have no net heat loss or gain. When houses share building elements with other units the area correction is not appropriate because the assumption about smaller units having larger surface areas is not true. In order to reduce the amount of adjustment in this situation, SEAV offered the following suggestion for reducing the area adjustment for medium density units by amending the detached house area correction factor according to the ratio of the areas of externally exposed fabric to the total external fabric:

$$Factor_{Attached} = \frac{Factor_{Detached} \times \left(A_{TotalOutFabric} - A_{TotalSharedFabric}\right)}{A_{TotalOutFabric}} \qquad (1)$$

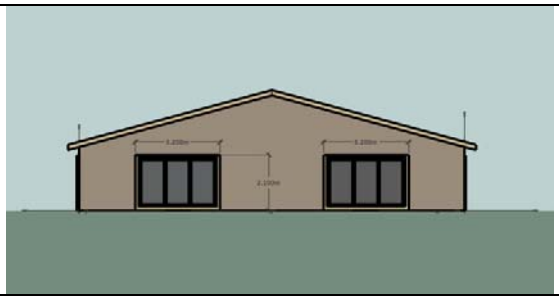
where $Factor_{Detached}$ and $Factor_{Attached}$ are the area correction factors (in MJ/m^2) for detached and attached houses respectively; $A_{TotalOutFabric}$ and $A_{TotalSharedFabric}$ are the total out fabric areas and total shared (with neighbour) fabric areas respectively.

It is noted that there were several revisions to the sets of the area correction factors after 2004. During the pilot test phase for AccuRate, some anomalies were discovered with the area correction – the benefits and disbenefits were too large at regulatory targets as discussed in the Appendix of this note. After feedback from industry was considered, the area correction factors evolved into dimensionless factors in 2005, rather than the original area correction factors in MJ/m^2.

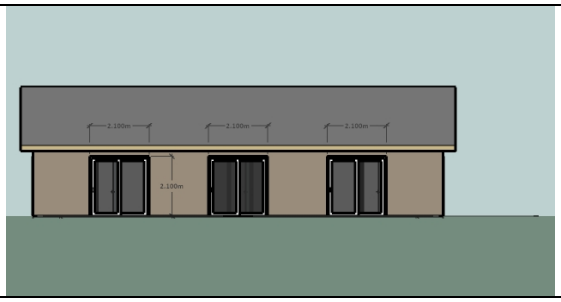


Plan

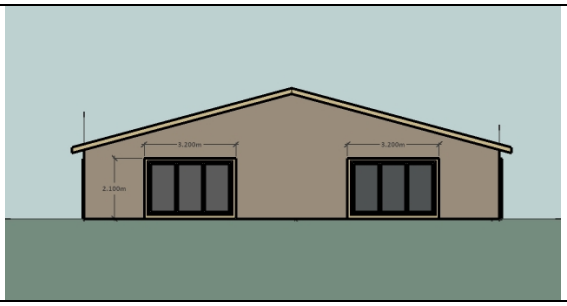
North



East



South



West

Figure 1. The idealized house design used in developing the area correction factors (from Isaacs (2004)

The adjusted annual energy requirement for both detached and attached houses, which is used for star rating, are calculated by Eq. (2):

$$E_{Adjusted} = E_{simulated} \times \left(1 - F_{Detached} \times \frac{\left(A_{TotalOutFabric} - A_{TotalSharedFabric} \right)}{A_{TotalOutFabric}} \right) \quad (2)$$

where $E_{Adjusted}$ and $E_{Simulated}$ are the adjusted annual energy requirement and simulated annual energy requirement (in MJ/m^2); $F_{Detached}$ is the dimensionless area correction factor which is correlated by a polynomial function of the NCFA for each climate. Table 1 lists the latest version of the dimensionless area correction polynomial function parameters for 69 climate zones established in 2006 which is currently used in AccuRate v1.1.4.1 and should have been made available for all NatHERS tool developers since 2006. The dimensionless area correction factor $F_{Detached}$ is obtained using Eq. (3):

$$F_{Detached} = F + Ea_{NCFA} + Da_{NCFA}^2 + Ca_{NCFA}^3 + Ba_{NCFA}^4 + Aa_{NCFA}^5 \quad (3)$$

where *A, B, C, D, E, F* are the polynomial parameters in Table 1 and a_{NCFA} is the NCFA.

ACCURATE V1.1.4.1 IMPLEMENTATION

As discussed above, for attached units, townhouses or terrace houses, there are shared outer fabrics between the house in consideration and neighbour house(s). The adjusted annual energy requirement should be calculated using Eq. (2). There may be no confusions about the total areas of the shared (with neighbour) fabrics $A_{TotalSharedFabric}$. The interpretation and implementation of the total out fabric areas $A_{TotalOutFabric}$ may have resulted in confusions among different NatHERS tools.

In AccuRate v.1.1.4.1, the total out fabric areas include the following aspects:

- Gross area of external walls (including windows, doors, Opaque Louvre and permanent openings if any);
- Gross area of roofs (including roof windows and skylights);
- Gross area of floors above ground and above outdoor air;
- Total areas of the shared (with neighbour) fabric areas;
- All zones including garage, roof space and subfloor zones are considered in the above calculations.

The total areas of the shared (with neighbour) fabrics include

- Gross area of internal walls adjacent to neighbour;
- Gross area of floors adjacent to neighbour; and
- Gross area of ceilings adjacent to neighbour.

REFERENCES

Isaacs T, AccuRate Area Correction Model, note to Australian Greenhouse Office (AGO), 2004.

Table 1 AccuRate v1.1.4.1 dimensionless area correction polynomial equation parameters[1,2]

Climate	A	B	C	D	E	F
1	-1.18798688E-14	3.30295867E-11	-3.43614968E-08	1.68021265E-05	-4.41898846E-03	4.19200551E-01
2	-9.75316238E-15	2.71796754E-11	-2.86309894E-08	1.45181471E-05	-4.15259368E-03	4.20913016E-01
3	-7.53731812E-15	2.08748515E-11	-2.21334992E-08	1.16668395E-05	-3.79676175E-03	4.18989960E-01
4	-6.88809806E-15	2.05393447E-11	-2.43599628E-08	1.49526703E-05	-5.00971278E-03	5.61951008E-01
5	-1.56095593E-14	4.27713530E-11	-4.34705997E-08	2.04852714E-05	-5.10244178E-03	4.70167750E-01
6	-3.69253568E-15	1.05874378E-11	-1.23616805E-08	7.86214295E-06	-3.32606945E-03	4.17493461E-01
7	-1.11459534E-14	3.09090112E-11	-3.24246793E-08	1.64612853E-05	-4.70737131E-03	4.75725374E-01
8	0.00000000E+00	8.03643986E-13	-3.03704960E-09	4.29478970E-06	-2.88091926E-03	4.00312785E-01
9	-3.85383319E-15	1.10456264E-11	-1.28488311E-08	8.11094086E-06	-3.32609715E-03	4.11751891E-01
10	-3.40158114E-15	1.06867448E-11	-1.39362552E-08	9.74856936E-06	-4.10626385E-03	5.10384360E-01
11	-6.76171937E-16	3.02093752E-12	-6.10654028E-09	6.33328919E-06	-3.38181485E-03	4.55891457E-01
12	5.67412978E-16	-1.17135512E-13	-3.35675440E-09	5.36749504E-06	-3.27397362E-03	4.52597504E-01
13	3.60414703E-15	-8.67841614E-12	5.50090251E-09	1.29960260E-06	-2.53682387E-03	4.10013852E-01
14	9.24973391E-15	-2.31783318E-11	1.85620926E-08	-3.47324009E-06	-1.78213053E-03	3.70344605E-01
15	7.01759306E-15	-1.77086584E-11	1.38519961E-08	-1.69157079E-06	-2.18486651E-03	4.07450810E-01
16	6.32917359E-15	-1.56252296E-11	1.16555203E-08	-8.50183826E-07	-2.25574010E-03	4.00288384E-01
17	4.54478866E-15	-1.12352519E-11	7.96205890E-09	3.56055916E-07	-2.38920812E-03	4.04860599E-01
18	7.82021869E-15	-1.95550348E-11	1.53084626E-08	-2.21628261E-06	-2.02369872E-03	3.86897393E-01
19	-2.96833303E-15	8.85450681E-12	-1.10699114E-08	7.67769595E-06	-3.39810407E-03	4.31595766E-01
20	6.39090792E-15	-1.56558826E-11	1.15707873E-08	-8.33133806E-07	-2.20568397E-03	3.92954519E-01
21	1.03147878E-14	-2.56393863E-11	2.02945852E-08	-3.68330004E-06	-1.96421905E-03	4.03992325E-01
22	1.00819730E-14	-2.53897114E-11	2.06642198E-08	-4.31870411E-06	-1.62415316E-03	3.59116219E-01
23	9.61480853E-15	-2.38273710E-11	1.87569386E-08	-3.31638159E-06	-1.81442633E-03	3.71048499E-01
24	7.09846601E-15	-1.73394692E-11	1.28837303E-08	-1.15868319E-06	-2.14061620E-03	3.85460032E-01
25	4.90264751E-15	-1.11865168E-11	6.76605667E-09	1.26036151E-06	-2.37815022E-03	3.77000258E-01
26	1.15498934E-14	-2.88417852E-11	2.33054522E-08	-4.96185294E-06	-1.60144805E-03	3.65640635E-01
27	3.43182318E-15	-7.93556459E-12	4.44533348E-09	1.88284884E-06	-2.64389558E-03	4.16238526E-01
28	4.34088585E-15	-1.09921599E-11	8.16500502E-09	-2.03097382E-08	-2.23652794E-03	3.83070353E-01
29	-1.24512953E-14	3.46966369E-11	-3.62281417E-08	1.78241075E-05	-4.68213669E-03	4.41488798E-01
30	-8.86992739E-15	2.46690467E-11	-2.59598131E-08	1.31953241E-05	-3.81504664E-03	3.87407836E-01
31	-1.46783904E-14	4.04223366E-11	-4.13785918E-08	1.96918533E-05	-4.90345634E-03	4.46265623E-01
32	-1.79405042E-14	4.96781786E-11	-5.11077522E-08	2.43289398E-05	-5.96141723E-03	5.39405496E-01
33	-1.16203893E-14	3.25044576E-11	-3.41495780E-08	1.69698912E-05	-4.51640747E-03	4.29133126E-01
34	-8.88777962E-15	2.46906997E-11	-2.60301033E-08	1.33512805E-05	-4.05033593E-03	4.32540149E-01
35	-1.74882838E-14	4.86304852E-11	-5.02940819E-08	2.40728691E-05	-5.89074065E-03	5.25804593E-01
36	-1.06524102E-14	2.96137764E-11	-3.12838414E-08	1.61450960E-05	-4.74620378E-03	4.93940051E-01
37	-9.17240375E-15	2.54993203E-11	-2.67793292E-08	1.35317610E-05	-3.91062536E-03	3.98876440E-01
38	-1.01885809E-14	2.81110302E-11	-2.91605351E-08	1.44440171E-05	-4.15439330E-03	4.23815871E-01
39	-8.74180438E-15	2.43379497E-11	-2.57712283E-08	1.33292991E-05	-4.05325989E-03	4.28630005E-01
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41	-6.17911276E-15	1.73882550E-11	-1.90920617E-08	1.07313501E-05	-3.84859329E-03	4.48082586E-01
42	-5.54256321E-15	1.54333135E-11	-1.69707777E-08	9.83788889E-06	-3.82897022E-03	4.68515448E-01
43	-3.23719545E-15	9.39283511E-12	-1.12800845E-08	7.49799287E-06	-3.30647177E-03	4.18220113E-01
44	3.74772098E-15	-9.00838332E-12	5.78343950E-09	1.14658975E-06	-2.52815226E-03	4.10328309E-01
45	5.44123691E-16	-2.85587146E-13	-2.71744169E-09	4.59815131E-06	-3.04248176E-03	4.29200045E-01
46	2.19857517E-15	-5.10928061E-12	2.37236804E-09	2.34857893E-06	-2.67047970E-03	4.11304310E-01
47	7.65104267E-15	-1.91707808E-11	1.50628358E-08	-2.22984346E-06	-2.00489085E-03	3.86235053E-01
48	6.13251026E-15	-1.50892225E-11	1.11407815E-08	-6.54641818E-07	-2.26895757E-03	3.99609069E-01
49	7.27662696E-15	-1.84515097E-11	1.47770601E-08	-2.38364817E-06	-1.93855401E-03	3.79802956E-01
50	2.51557277E-15	-5.88312714E-12	3.04656410E-09	2.07563820E-06	-2.57924533E-03	4.00870496E-01
51	7.61341356E-15	-1.95811890E-11	1.61993698E-08	-3.20561822E-06	-1.77353912E-03	3.69047436E-01
52	8.85385742E-15	-2.21579907E-11	1.73682136E-08	-2.51749541E-06	-2.23980256E-03	4.32958930E-01
53	8.31609750E-15	-2.09503807E-11	1.66973085E-08	-2.75870972E-06	-1.97691812E-03	3.89930418E-01
54	4.29912375E-15	-1.03911659E-11	6.83183863E-09	1.09673456E-06	-2.58300215E-03	4.22480241E-01
55	1.43349927E-14	-3.68395193E-11	3.14938044E-08	-8.32644630E-06	-1.24655870E-03	3.72750479E-01
56	6.35829179E-15	-1.59942777E-11	1.22178297E-08	-9.60613359E-07	-2.35240885E-03	4.19117091E-01
57	9.90961111E-15	-2.51275349E-11	2.06762902E-08	-4.47290694E-06	-1.58155082E-03	3.55869151E-01
58	1.38426183E-14	-3.51405694E-11	2.93786201E-08	-7.21200296E-06	-1.42025914E-03	3.78956360E-01
59	7.13952353E-15	-1.71901842E-11	1.24921284E-08	-9.77381812E-07	-2.06143267E-03	3.67484906E-01
60	9.42975979E-15	-2.34782843E-11	1.85592567E-08	-3.24439684E-06	-1.90030168E-03	3.84515760E-01
61	1.07866075E-14	-2.71407597E-11	2.21257942E-08	-4.73730541E-06	-1.60164475E-03	3.62182323E-01
62	1.13603209E-14	-2.85042950E-11	2.31625870E-08	-4.95081514E-06	-1.65653806E-03	3.76936891E-01
63	1.05690718E-14	-2.64133194E-11	2.12444700E-08	-4.28676164E-06	-1.68696031E-03	3.67547874E-01
64	1.20885408E-14	-3.02972107E-11	2.46553294E-08	-5.39925115E-06	-1.58784342E-03	3.72282725E-01
65	7.44595465E-15	-1.82162641E-11	1.37449118E-08	-1.63478994E-06	-1.94216411E-03	3.60570641E-01
66	7.64840700E-15	-1.86424633E-11	1.39361624E-08	-1.50840981E-06	-2.06000157E-03	3.76623262E-01
67	1.35254103E-14	-3.41731958E-11	2.83974215E-08	-6.91473606E-06	-1.34702891E-03	3.59702957E-01
68	9.33500120E-15	-2.30187737E-11	1.79657281E-08	-3.06829212E-06	-1.79167685E-03	3.61968879E-01
69	6.04731068E-15	-1.42898874E-11	9.76447749E-09	6.88476556E-08	-2.21204762E-03	3.72316457E-01

[1] Based on Tony Isaacs' spreadsheet of 07/01/06 for the new 69 climate files. The correction is a fifth-order polynomial with NCFA as the independent variable. Column F is the constant term, column E the linear term, etc;

[2] At NCFA less than 50 m^2 set the NCFA to 50 m^2; For NCFA over 1000 m^2 set the NCFA to 1000 m^2.

APPENDIX: ANOMALOUS RESULTS FOR LARGE UNITS WITH SHARED FABRIC

The surface area correction works well for smaller units below the reference size of 196 m^2, as it reduces extent of the benefit given for units with large shared areas. For units larger than the reference area the adjustment works in a counter intuitive fashion: it makes it easier for large units with large shared areas to reach five stars. The table below shows this anomaly:

Floor Area	Shell Area	Shared area	Detached Factor	Adjusted factor	Effective 5 star target (MJ/m^2)
49	165.2	131.6	30%	94%	158.7
196	526.4	459.2	0%	100%	148.9
400	992	896	-22%	102%	145.9
49	165.2	0	30%	70%	213.2
196	526.4	0	0%	100%	148.3
400	992	0	-22%	122%	121.8

The table above shows the effective 5 star target in MJ/m^2 after the application of the area correction for a small, medium and large house. The houses are assumed to be square and have a 2.4 m high external wall. The shared areas assume that the floor, ceiling and half the external wall area shared with another unit.

With no shared fabric the area correction appropriately makes 5 stars harder to achieve at 400 m^2 than at 196 m^2. With a large shared area, however, the 5 star target is significantly easier than with no shared area, yet the unit will have a substantial advantage in achieving 5 stars due to its large area of shared external surface.

A number of solutions to this anomaly were discussed three years ago. These solutions involved performing a further set of simulations of the reference houses with various areas of shared fabric to derive a new shared area correction. However, the work did not proceed and further work is needed to design a better correction method for houses with shared building fabric.