Sunspot Classifications: The prime reference for the Modified Zurich Classification is: Patrick S. McIntosh, Solar Physics, v125 (1990), pp. 251-267, "The Classification of Sunspot Groups"

Abstract: The 3-component McIntosh classification of sunspots was introduced in 1966, adopted for interchange and publication of data in 1969, and has been used increasingly in recent years. The McIntosh classification uses a modified Zurich evolutionary sequence as its first component, class, where two of the Zurich classes are omitted and more quantitative definitions are used. It then adds descriptions of the largest spot (second component) and the degree of spottedness in the group interior (third component) to define 60 distinct types of sunspot groups. Definitions of the McIntosh classification system and their rationale are presented herein. Correlations with solar flares excel those with the earlier Zurich classification, prompting the use of the McIntosh classification in an expert system (Theo) for predicting X-ray solar flares.

The following text was provided by John Kennewell, IPS Australia, November 2004.

In late December 1981 (Dec 17, 1981) there was a change in the way sunspot areas were measured at SOON Observatories.

There are two area reduction techniques:

Technique #1 - Before December 17, 1981 [Count the Squares]

The area of a sunspot was measured using a transparent crosshatched overlay sheet, where the spacing between the individual lines on the crosshatch was one millimetre. Thus one would "count the squares". If the outline of the penumbra lay in one of the squares, then there were two alternative methods of counting:

- Very diligent observers would estimate the fraction of a square millimetre occupied and note it down,

or

- If the spot occupied more than 50% of a square, it would be counted as one sqaure, otherwise ignored.

Adding up all the squares (and fractional squares), one would come up with a total say S sq mm.

Now the measurement was made on a solar image that was adjusted to fit exactly into an 180 mm diameter circle. The area of this circle was thus = pi x (diam/2)2 = 25447 sq mm.

Thus the spot area was computed as 1,000,000 S / 25447 / 2 millionths of the solar hemisphere. The division by 2 is to convert from area of the visible disc to area of the visible hemisphere. This actual calculation was done by a FORTRAN program on the HP1000 computer. One only needed to enter the number of square millimetres measured.

Of course, the above result is the uncorrected area. To correct this area for disc foreshortening, one would estimate the centre of the sunspot group and measure from the disc centre to this point (the value would lie from 0 to 90 mm). This radial distance would also be entered into the abovementioned computer program, and it would provide a corrected area. The program used a modified secant correction. If anyone is interested, the program was called SAREA.

Note that this measurement method was applied to determine both the total umbral area of a spot group and the total penumbral area of the group. Both were reported in the SPOTS code.

Technique #2 - After December 16, 1981 [Overlay template]

In order to reduce the workload on the SOON observer, a simplified spot area measurement system was devised.

First of all, someone decided to drop the umbral area.

Then, instead of counting the squares, someone (I believe at Holloman) devised an overlay which consisted of a large number of circles and ellipses, for a range of (uncorrected) areas. The idea is that one tries to do a best fit of a circle or ellipse to each sunspot in the group. Once a fit is found, the area is simply noted (it is printed next to each group of circles and ellipses). There is thus no computation, except to add up the areas for all the spots in the group. For small unresolved spots, with no penumbra, these are assumed to have an area of 2 millionths of the solar hemisphere.

To correct the above area for foreshortening, another overlay is used. This is essentially a transparent rule, which is lain from the disc centre to the sunspot group centre. It is marked directly with the correction factor, from unity at disc centre to 3 at a fractional solar radius of 0.95. Any group beyond Rv=0.95 is corrected with the same value 3. This does result in an underestimate of area for groups near the limb (see later).

The above correction is thus a matter of multiplying the uncorrected area by the correction factor, and can be done on a hand calculator.

This second method of area determination takes a lot less time than the first, but is not as accurate. There will thus be a change in data quality at the time this change was made (as well as a loss of umbral area reported values). One may well find a greater quantisation of reported areas, because of the finite number of circles and ellipses on the overlay, although some observers will attempt to estimate a value in between the template areas.

References

Patrick S McIntosh (1990), The Classification of Sunspot Groups, Solar Physics, v125, pp. 251-267,