Depth of Field For View Cameras—Part I

by Harold M. Merklinger
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Having established the basic optical principles of view cameras (in “The Scheimpflug Principle”, Shutterbug, Nov. ’92 through March. ’93), we can now tackle the job of calculating depth of field in the traditional manner. Following the standard method, we will assume a suitable standard of image resolution and then determine where an object must lie to be imaged in accord with that standard. Since we are dealing with the view camera, however, the story is more complicated than is the case for ordinary cameras.

We begin in the time-honored way. A lens of aperture diameter, d, intercepts the light from a distant point source and focuses it at distance, A, behind the lens. If we are prepared to accept a circle of confusion of diameter, a, then any other object will be “in focus” if its image lies anywhere in the range A+g to A-g, where g=Aa/d. (There is a slight approximation used here, but the error is usually less than 1%.) Figure 1 will help to understand the geometry. For ordinary cameras we then use the lens equation to determine what object distances correspond to those limits. Within those object distance limits lies the zone of acceptable focus. It is often more convenient to express the lens diameter in terms of the f-number of the lens, N. We make the further assumption that the lens-to-image distance and lens-to-film distance are approximately equal to the focal length of the lens, f. We then find that the distance, g, is approximately equal to the product of the f-number, N, and the allowable diameter of the circle of confusion, a. That is, g is equal to N times a.

Utilizing view camera principles discussed in Part IV of “The Scheimpflug Principle” (Shutterbug, March ‘93) we find the near and far limits of depth of field as shown in Figure 2. First we use the Scheimpflug rule and the hinge rule to determine where the film plane must be to achieve the desired plane of precise sharp focus. A distance, g, either side of the film plane we draw two limiting planes parallel to the film plane. For images focused at either of these limiting planes, the circle of confusion on the film will be the maximum allowable. We then determine where the planes of sharp focus would be for these limiting planes. The results define the boundaries of the region where objects will be acceptably well defined. This region is wedge-shaped, with the sharp edge of the wedge is at the hinge line. The algebra involved in calculating the exact limits is a bit tedious, but the result itself is quite easy to understand.

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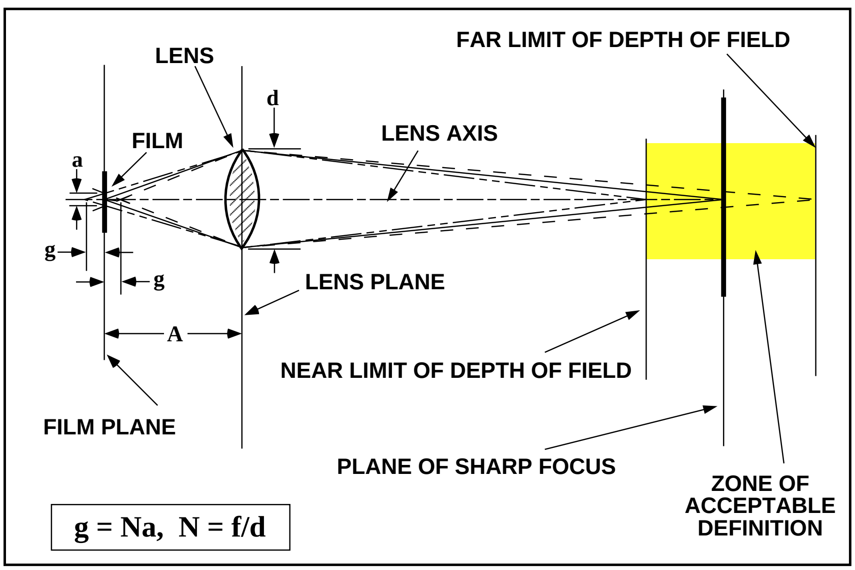

Figure 1: This figure shows how depth of field is estimated for ordinary cameras. A maximum permissible diameter, a, for the circle of confusion is set. Then one uses the lens equation to calculate the near and far limits of depth of field where a small object would be imaged on the film as a circle of diameter, a. Between these limiting planes, any object will be rendered with “acceptable definition”. The distance, g, is equal to the f-number times the diameter of the allowable circle of confusion, a.

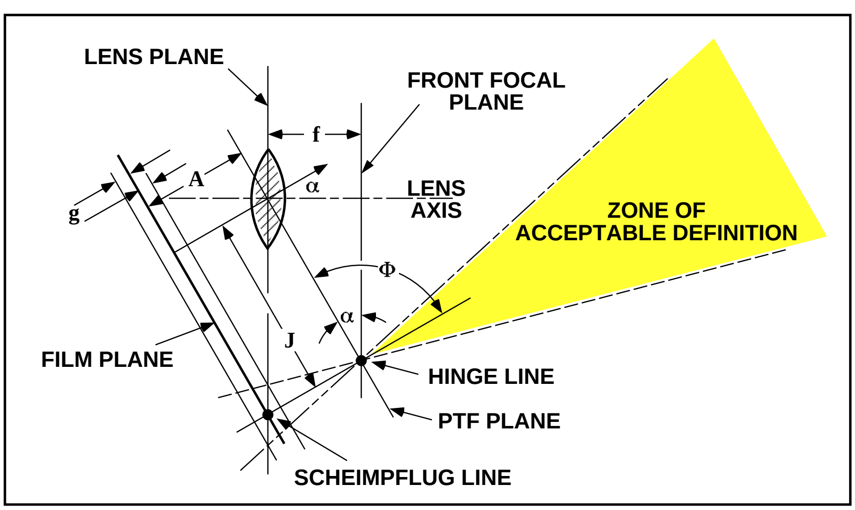

Figure 2: Depth of field for view cameras is calculated in much the same way as for ordinary cameras. In this case the limiting planes define a wedge-shaped zone of acceptable definition. The size and placement of this zone depends in a complicated way upon the lens tilt, a, and the tilt of the plane of sharp focus, F. The optical principles involved were described in “The Scheimpflug Principle, Part IV” previously published in Shutterbug. The Scheimpflug Line and Hinge Line are shown as dots because the lines are actually perpendicular to the paper.

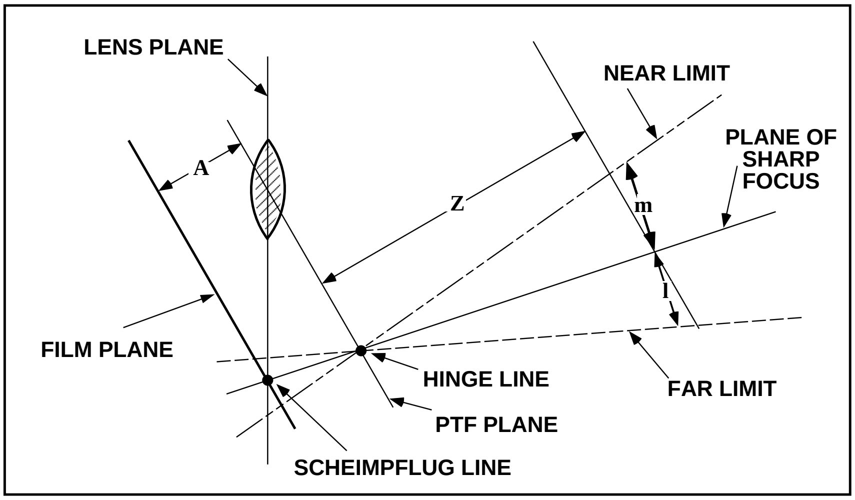

Figure 3: A practical way to describe depth of field for view cameras is illustrated here. Depth of field is expressed as a distance, m or l, measured perpendicular to the plane of sharp focus. The place where depth of field is estimated is understood to be a position along the plane of sharp focus, a distance Z from the lens. Z is measured in a direction perpendicular to the Film Plane. Since the depth of field, m or l, is directly proportional to Z, it is possible to express m and l as a fraction of the distance Z.

confusion to lens aperture size, the analysis implicitly assumed that the lens axis was perpendicular to the film. We know that is probably not the case for the view camera. I will argue that for the purpose of calculating the size of the 'splotch' of confusion, it does not matter whether the lens is tilted or not. If the lens is tilted, the circle of confusion may become an ellipse of confusion, but the maximum dimension of that ellipse will probably be about equal to the diameter of the circle of confusion derived for an untilted lens. We could get picky here, but it just isn't worth the trouble. We have bigger issues to deal with.

Our biggest problem is how to describe the wedge-shaped region within which objects are acceptably well imaged. The most complete and accurate description is to calculate the tilt angles for the near and far limits of depth of field. To illustrate, Table 1 (on the last page of this article) shows a sample table of results for lenses at f/22 and for an allowable circle-of-confusion of one-fifteen-hundredth of the lens focal length. The table shows the angles for the near and far limits of depth of field for various values of the lens-to-hinge line distance, J (expressed in focal lengths), combined with various tilt angles of the plane of sharp focus. I don't really suggest using this table in normal photography. It would help to be a surveyor and to have a transit handy if you were to attempt to use Table 1. We will use it in an example later in this article, however.

A description of depth of field which is less complete, but perhaps more useful, is given in Figure 3. In this description we describe the depth of field in terms of distance measured perpendicular to the plane of sharp focus. I will use the symbol "m" to denote this distance on the lens side of the plane of sharp focus, and the symbol "l" for the equivalent distance on the far side of the plane of sharp focus.

The next problem is how to describe where along the plane of sharp focus we wish to know the depth of field. One answer would be to measure distance from the hinge line, along the plane of sharp focus. That is useful in some cases, but just about impossible in others. The solution proposed is that we measure distance from the camera lens to a spot on the plane of sharp focus, in a direction perpendicular to the film plane. I will call this distance "Z". In my somewhat limited experience, it is usually easy to estimate this distance, though it will seem a strange way to do business when the camera back is swung more than a few degrees.

I have constructed a second set of tables that tells us the depth of field, m and l, as a fraction of the distance Z. Table 2 is one of these. Again, I have chosen the f-number, N, to be 22 and the maximum allowable diameter of the circle of confusion to be one-fifteen-hundredth of the lens focal length.

Let's apply this table to a real photographic problem. Remember the cement plant from the last article?

Figure 4 gives an approximate cross-section through the scene being photographed. The camera is sitting on a small rise, about even in level with the base of the cement plant tower. Between the camera and the tower is a marshy field, perhaps 10 feet lower than the camera lens. In the foreground are some daisies. The objective is to get the daisies, the grass in the marsh and the tower all in acceptable focus. We know from the expected wedge shape of the zone of acceptable focus, that the depth of field near the daisies will be small. At the tower, that zone must include all of the tower. But the grass must be included too. A rough first guess would be that the plane of sharp focus should pass within inches the daisies and through the mid-height of the

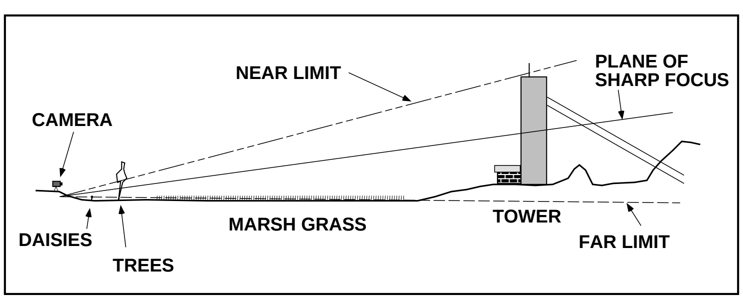

Figure 4: Here's a cross-section of the location where I took a photograph of a cement plant. The objective was to choose the lens tilt and plane of sharp focus tilt such that as much as possible of the landscape is in focus. The near and far limits of depth of field were obtained from Table 2 for J/f equal to 10, and for a tilt of 80° for the plane of sharp focus. The actual photograph, shown in Figure 5, was taken with a 9.5 in. lens at f/22. The lens was tilted downwards by 6°. The camera-to-tower distance is 300 feet.

Figure 5: Here's the photograph taken as shown in Figure 4. I used an old 5 by 7 B&J wooden view camera with a 9.5 inch f/6.8 Dagor lens set at f/22. As predicted, just about everything is in acceptable focus, except the upper portions of the trees and taller bushes.

tower. The camera back must be vertical in order to make the tower perspective correct. This puts the lens-to-hinge line distance at about 8 feet, and hence the tilt required for the 240 mm lens will be about 6°.

The plane of sharp focus must be inclined about 80° relative to the camera back. I achieve this simply by watching the ground glass as I rack the camera back one way or the other until the tower is sharpest about half way up. The tower is about 70 feet high, and it is 300 feet away. I therefore want the values of m and l to be equal to or greater than 35 feet (half the tower height) divided by 300 ft (the distance to the tower measured perpendicular to the camera back). The values of m and l must be 0.117 or larger. I'm in luck: Table 2 gives the value of m as .133 and the value of l as .143. Thus the depth of field at a distance of 300 feet extends from 40 feet above the plane of sharp focus to 43 feet below it. I can use f/22. I can even afford to depress the plane of sharp focus a bit to ensure that the marsh grass is included in the zone of acceptable sharpness. Figure 5 shows the final result.

Close examination of Table 2 will show some strange things. For one thing, whenever m and l are small (less than about 0.2), they are approximately equal to each other. They are also nearly equal to each other for all values of J when the plane of sharp focus is near 90°. In fact, they will be precisely equal whenever the tilt of the plane of sharp focus is equal to 90° plus the lens tilt angle! This means that for photography with a view camera, depth of field is very often distributed nearly equally in front of and behind the plane of sharp focus. The old rule about focusing one-third of the way through the field is even more often wrong for view cameras than it is for ordinary cameras.

In Tables 1 and 2, you may have noticed a number of table entries shown as "n/a". The "n/a" means "not applicable". The reason the table entry is not applicable is that for the conditions applying to that place on the table, the camera is trying to focus inside its front focal plane. There can be no sharp image at all for an object inside the front focal plane of the lens.

There are also a number of "Inf." entries, signifying "infinite". This means that the depth of field extends to infinity in a direction perpendicular to the plane of sharp focus. As shown in Table 1, however, the bounding plane for sharp focus may extend more than 90° from the plane of sharp focus: the depth of field at 90° may actually extend beyond infinity. This is the limitation built into the description of depth of field I have used for Table 2.

I should point out that Tables 1 and 2 actually apply for more than just the conditions indicated. Let me emphasize first the these tables do apply for all focal lengths. The one restriction is that the table must express the lens-to-hinge line distance, J, in focal lengths: J/f. But furthermore, the tables also apply for other combinations of f-number and allowable diameter of the circle of confusion. The tables apply, as stated, for f/22 and a circle of confusion smaller than f/1500. That is, the tables apply for g=Nf/1500=.015f. The tables could also be used for an aperture of f/11 if the allowable diameter of the circle of confusion, a, were 1/750 times the focal length, or for f/32 if a=1/2180 times the focal length, and so on.

The purpose of my telling this story has been in part to show you that the conventional description of depth of field based upon image resolution is possible for view cameras, as well as for ordinary cameras. It does get rather complicated, however. I would like to thank Mr. Raymond Clark, President of ImageQuest, for asking the questions which led to this analysis. Without his prompting, I would never have attempted the calculations.

Almost forgot, didn't I. I did promise to show you that focusing farther away can make things up close sharper! We'll use Table 1 and a photographic example similar to that of the cement plant to illustrate. Let's pretend that instead of the cement plant, we a photographing a village in a mountain valley. The camera is set up on a peak overlooking the village. The mountain slope is about 20°. We wish to set the camera so that the downslope and the village are in focus. We use either Table 1 or Table 2 to find the facts and figures for a plane of sharp focus tilt of 110° (90° plus 20°). We first choose a lens tilt of 6° (J/f = 10). We draw a sketch of the situation, something like Figure 6. The village isn't really that close; in true scale it would be much bigger, but farther away. In angular terms, however, it's on about the right scale. Using Table 1, we sketch in the near and far limits of depth of field. The near limit is at 102° and the far limit is at 118°. (Notice how in this situation there is more depth of field on the near side than the far side!) These limits nicely cover the village and the grass on the mountain slope, but the top of that tree is going to be out of focus.

We can correct the problem by focusing farther away! By choosing J/f = 50 (instead of 10), the plane of sharp focus gets pushed below the level of the slope, but the near limit, at about 70°, now clears the tree! The grass in the very near foreground will not be in focus, but that may be outside the view of the camera anyway. When the geometry is right, focusing farther away can improve the rendition of near objects.

In the next and final episode, we'll take a somewhat simplified view of depth of field for view cameras. And that simplified explanation will help us understand why it is that focusing farther away can make near objects sharper. I'll even give you the answer in advance: it happens whenever the object is, in an optical sense, behind the camera.

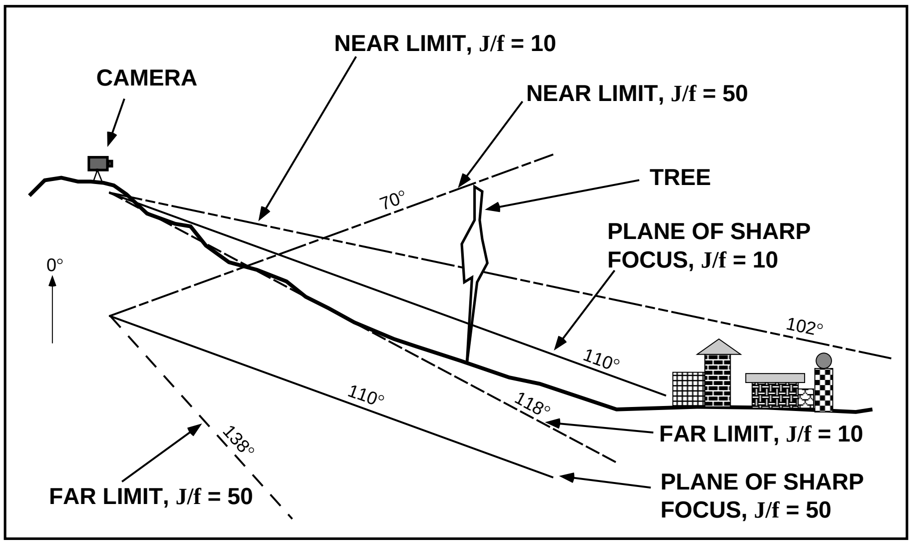

Figure 6: Here's a sketch of an imaginary photo situation. We are taking a picture of a village in a mountain valley. Tilting a 9.5 inch lens by 6° (J/f=10)puts all in focus except for the tree on the slope. Focusing farther away, using a lens tilt of 1.15° (J/f=50), puts the tree in focus. Angles shown are obtained from Table 1. Sometimes with view cameras, focusing farther away puts near objects in better focus! Note also how, in this example, there is more depth of field on the near side of the plane of sharp focus than on the far side! These characteristics will be quite foreign to photographers accustomed only to ordinary cameras.

By Angle

f-number = 22
a/f = 1/1500

Other Combinations:

f-number	a/f
7.8	1/500
11	1/750
16	1/1000
22	1/1500
31	1/2000
44	1/3000
62	1/4000
88	1/6000
124	1/8500

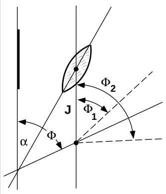

Table gives range from Φ_1 to Φ_2.

LENS J/f	TILT α	PLANE OF SHARP FOCUS TILT (Φ - DEGREES) 1	2	5	10	20	30	40	50	60
10000	0.006	0.3° to 179.4°	0.3° to 179.5°	0.4° to 179.6°	0.4° to 179.6°	0.4° to 179.6°	0.4° to 179.6°	0.4° to 179.6°	0.4° to 179.6°	0.4° to 179.6°
1000	0.057	0.8° to 1.3°	1.4° to 3.9°	2.2° to 162.2°	2.9° to 173.7°	3.3° to 175.3°	3.5° to 175.6°	3.7° to 175.8°	3.7° to 175.9°	3.8° to 176.0°
200	0.29	1.0° to 1.0°	1.9° to 2.2°	4.1° to 6.5°	6.8° to 19.3°	10.2° to 98.4°	12.3° to 140.0°	13.9° to 150.2°	15.1° to 154.7°	16.2° to 157.2°
100	0.57	1.0° to 1.0°	1.9° to 2.1°	4.6° to 5.6°	8.2° to 13.0°	13.7° to 36.7°	17.7° to 73.6°	21.0° to 104.6°	23.9° to 122.0°	26.5° to 131.8°
50	1.1	n/a	2.0° to 2.0°	4.8° to 5.2°	9.1° to 11.1°	16.4° to 25.6°	22.6° to 43.9°	28.0° to 64.2°	33.0° to 83.2°	37.9° to 98.5°
30	1.9	n/a	2.0° to 2.0°	4.9° to 5.1°	9.5° to 10.5°	17.8° to 22.8°	25.3° to 36.8°	32.1° to 52.0°	38.7° to 67.3°	45.2° to 81.6°
20	2.9	n/a	n/a	5.0° to 5.0°	9.7° to 10.3°	18.7° to 21.6°	26.9° to 34.0°	34.6° to 47.1°	42.2° to 60.5°	49.7° to 73.4°
15	3.8	n/a	n/a	5.0° to 5.0°	9.9° to 10.1°	19.1° to 21.0°	27.7° to 32.7°	36.0° to 44.9°	44.1° to 57.3°	52.2° to 69.6°
10	5.7	n/a	n/a	n/a	10.0° to 10.0°	19.5° to 20.5°	28.7° to 31.5°	37.5° to 42.9°	46.2° to 54.4°	54.8° to 65.9°
7	8.2	n/a	n/a	n/a	10.0° to 10.0°	19.8° to 20.3°	29.2° to 30.8°	38.4° to 41.7°	47.5° to 52.8°	56.5° to 63.8°
5	11.5	n/a	n/a	n/a	n/a	19.9° to 20.1°	29.6° to 30.4°	39.1° to 41.0°	48.4° to 51.7°	57.7° to 62.4°
4	14.5	n/a	n/a	n/a	n/a	20.0° to 20.0°	29.8° to 30.2°	39.4° to 40.6°	48.9° to 51.2°	58.3° to 61.8°
3	19.5	n/a	n/a	n/a	n/a	20.0° to 20.0°	29.9° to 30.1°	39.7° to 40.3°	49.4° to 50.7°	59.0° to 61.1°
2	30.0	n/a	n/a	n/a	n/a	n/a	n/a	39.9° to 40.1°	49.8° to 50.2°	59.6° to 60.4°
1.5	41.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	50.0° to 50.0°	59.9° to 60.1°
1	90.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

LENS J/f	TILT α	PLANE OF SHARP FOCUS TILT (Φ - DEGREES) 70	80	90	100	110	120	130	140	150
10000	0.006	0.4° to 179.6°	0.4° to 179.6°	0.4° to 179.6°	0.4° to 179.6°	0.4° to 179.6°	0.4° to 179.6°	0.4° to 179.6°	0.4° to 179.6°	0.4° to 179.6°
1000	0.057	3.9° to 176.1°	3.9° to 176.1°	4.0° to 176.2°	4.0° to 176.2°	4.1° to 176.3°	4.1° to 176.3°	4.2° to 176.4°	4.3° to 176.4°	4.5° to 176.6°
200	0.29	17.1° to 159.0°	18.1° to 160.3°	19.1° to 161.4°	20.2° to 162.4°	21.5° to 163.4°	23.2° to 164.4°	25.7° to 165.4°	30.0° to 166.6°	39.6° to 168.1°
100	0.57	29.1° to 138.1°	31.7° to 142.6°	34.7° to 146.1°	38.1° to 149.1°	42.5° to 151.8°	48.5° to 154.4°	57.8° to 157.0°	73.9° to 159.8°	103.3° to 163.0°
50	1.1	42.9° to 110.3°	48.2° to 119.4°	54.2° to 126.6°	61.1° to 132.8°	69.7° to 138.2°	80.8° to 143.2°	95.3° to 148.1°	113.5° to 153.1°	133.8° to 158.4°
30	1.9	51.8° to 94.1°	58.8° to 104.8°	66.6° to 114.0°	75.3° to 122.1°	85.4° to 129.4°	97.3° to 136.1°	110.9° to 142.7°	125.9° to 149.2°	141.3° to 155.9°
20	2.9	57.3° to 85.6°	65.3° to 96.6°	73.9° to 106.5°	83.3° to 115.6°	93.7° to 123.9°	105.2° to 131.7°	117.8° to 139.3°	131.0° to 146.8°	144.3° to 154.4°
15	3.8	60.3° to 81.3°	68.8° to 92.3°	77.8° to 102.5°	87.4° to 112.0°	97.8° to 120.8°	109.0° to 129.3°	120.9° to 137.4°	133.2° to 145.4°	145.7° to 153.5°
10	5.7	63.6° to 77.2°	72.5° to 88.0°	81.9° to 98.4°	91.6° to 108.2°	101.9° to 117.6°	112.6° to 126.6°	123.9° to 135.4°	135.4° to 144.0°	146.9° to 152.7°
7	8.2	65.6° to 74.8°	74.9° to 85.5°	84.3° to 95.8°	94.1° to 105.8°	104.3° to 115.5°	114.8° to 124.9°	125.6° to 134.1°	136.6° to 143.1°	147.6° to 152.1°
5	11.5	67.0° to 73.2°	76.5° to 83.7°	86.0° to 94.1°	95.8° to 104.2°	105.9° to 114.1°	116.1° to 123.7°	126.7° to 133.1°	137.3° to 142.5°	148.1° to 151.8°
4	14.5	67.8° to 72.3°	77.3° to 82.8°	86.9° to 93.2°	96.7° to 103.4°	106.7° to 113.3°	116.8° to 123.1°	127.2° to 132.7°	137.7° to 142.2°	148.3° to 151.6°
3	19.5	68.5° to 71.5°	78.1° to 81.9°	87.8° to 92.3°	97.6° to 102.5°	107.5° to 112.5°	117.5° to 122.4°	127.8° to 132.2°	138.1° to 141.8°	148.5° to 151.4°
2	30.0	69.3° to 70.7°	79.0° to 81.0°	88.8° to 91.3°	98.5° to 101.5°	108.4° to 111.6°	118.3° to 121.7°	128.4° to 131.6°	138.5° to 141.5°	148.7° to 151.2°
1.5	41.8	69.7° to 70.3°	79.5° to 80.5°	89.3° to 90.7°	99.1° to 100.9°	108.9° to 111.1°	118.8° to 121.2°	128.7° to 131.3°	138.8° to 141.2°	148.9° to 151.1°
1	90.0	n/a	n/a	n/a	100.0° to 100.0°	109.9° to 110.1°	119.8° to 120.2°	129.7° to 130.3°	139.5° to 140.5°	149.4° to 150.6°

Table 1: This table shows the tilt angles of the planes bounding the region of acceptable definition for lenses at f/22. An angle of 0° indicates that the plane is parallel to the film plane.

Fractions

f-number = 22
a/f = 1/1500

Other combinations:

f-number	a/f
7.8	1/500
11	1/750
16	1/1000
22	1/1500
31	1/2000
44	1/3000
62	1/4000
88	1/6000
124	1/8500

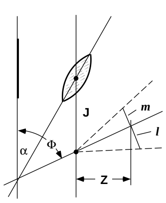

Table gives value of *l* or *m* for Z = 1.

LENS J/f	TILT α	PLANE OF SHARP FOCUS TILT (Φ - DEGREES) 1 *m*	1 *l*	2 *m*	2 *l*	5 *m*	5 *l*	10 *m*	10 *l*	20 *m*	20 *l*	30 *m*	30 *l*	40 *m*	40 *l*	50 *m*	50 *l*	60 *m*	60 *l*
10000	0.006	0.71	Inf.	0.83	Inf.	0.93	Inf.	0.98	Inf.	1.04	Inf.	1.14	Inf.	1.29	Inf.	1.53	Inf.	1.97	Inf.
1000	0.057	0.183	0.300	0.323	0.96	0.55	Inf.	0.72	Inf.	0.87	Inf.	1.00	Inf.	1.14	Inf.	1.36	Inf.	1.72	Inf.
200	0.29	0.025	0.027	0.069	0.082	0.183	0.299	0.323	0.94	0.51	14.24	0.64	Inf.	0.76	Inf.	0.91	Inf.	1.11	Inf.
100	0.57	0.005	0.005	0.025	0.027	0.090	0.113	0.183	0.297	0.325	0.88	0.435	1.90	0.54	3.28	0.64	4.01	0.76	3.51
50	1.1	n/a	n/a	0.005	0.005	0.036	0.040	0.090	0.113	0.183	0.289	0.261	0.495	0.331	0.70	0.398	0.85	0.468	0.92
30	1.9	n/a	n/a	0.000	0.000	0.014	0.015	0.047	0.053	0.110	0.143	0.165	0.239	0.215	0.331	0.261	0.407	0.306	0.456
20	2.9	n/a	n/a	n/a	n/a	0.005	0.005	0.025	0.027	0.069	0.081	0.109	0.139	0.146	0.194	0.179	0.241	0.211	0.276
15	3.8	n/a	n/a	n/a	n/a	0.001	0.001	0.014	0.015	0.047	0.053	0.079	0.094	0.108	0.133	0.135	0.168	0.159	0.195
10	5.7	n/a	n/a	n/a	n/a	n/a	n/a	0.005	0.005	0.025	0.027	0.047	0.052	0.068	0.078	0.087	0.101	0.104	0.120
7	8.2	n/a	n/a	n/a	n/a	n/a	n/a	0.001	0.001	0.012	0.013	0.027	0.029	0.042	0.046	0.057	0.063	0.070	0.077
5	11.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.005	0.005	0.014	0.015	0.025	0.027	0.036	0.038	0.046	0.049
4	14.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.002	0.002	0.008	0.009	0.017	0.017	0.025	0.027	0.034	0.036
3	19.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.000	0.000	0.003	0.003	0.008	0.009	0.015	0.015	0.021	0.022
2	30.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.001	0.001	0.004	0.005	0.008	0.009
1.5	41.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.001	0.001	0.002	0.002
1	90.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

LENS J/f	TILT α	PLANE OF SHARP FOCUS TILT (Φ - DEGREES) 70 *m*	70 *l*	80 *m*	80 *l*	90 *m*	90 *l*	100 *m*	100 *l*	110 *m*	110 *l*	120 *m*	120 *l*	130 *m*	130 *l*	140 *m*	140 *l*	150 *m*	150 *l*
10000	0.006	2.86	Inf.	5.53	Inf.	144.5	148.8	Inf.	5.54	Inf.	2.86	Inf.	1.97	Inf.	1.53	Inf.	1.29	Inf.	1.14
1000	0.057	2.41	Inf.	4.10	Inf.	14.45	14.88	Inf.	4.13	Inf.	2.42	Inf.	1.73	Inf.	1.37	Inf.	1.15	Inf.	1.00
200	0.29	1.41	59.6	1.90	5.95	2.89	2.98	5.65	1.94	40.4	1.43	Inf.	1.13	Inf.	0.93	Inf.	0.78	Inf.	0.66
100	0.57	0.92	2.64	1.14	1.96	1.45	1.49	1.90	1.17	2.57	0.95	3.45	0.79	4.07	0.66	3.50	0.56	2.12	0.462
50	1.1	0.54	0.90	0.63	0.83	0.72	0.74	0.82	0.65	0.90	0.57	0.94	0.496	0.90	0.427	0.78	0.362	0.58	0.296
30	1.9	0.350	0.475	0.393	0.469	0.433	0.446	0.467	0.413	0.486	0.374	0.484	0.334	0.452	0.293	0.391	0.251	0.306	0.205
20	2.9	0.240	0.296	0.266	0.302	0.288	0.297	0.304	0.283	0.311	0.263	0.305	0.240	0.283	0.213	0.247	0.184	0.199	0.152
15	3.8	0.181	0.213	0.200	0.222	0.216	0.222	0.226	0.216	0.229	0.204	0.224	0.188	0.209	0.169	0.184	0.148	0.152	0.124
10	5.7	0.120	0.134	0.133	0.143	0.143	0.147	0.150	0.147	0.152	0.142	0.149	0.133	0.140	0.122	0.126	0.109	0.108	0.094
7	8.2	0.081	0.089	0.091	0.097	0.099	0.102	0.104	0.104	0.107	0.103	0.106	0.099	0.101	0.093	0.094	0.084	0.083	0.075
5	11.5	0.055	0.059	0.063	0.066	0.069	0.071	0.074	0.075	0.077	0.076	0.078	0.075	0.076	0.072	0.073	0.068	0.067	0.062
4	14.5	0.041	0.044	0.048	0.050	0.054	0.056	0.059	0.059	0.062	0.062	0.064	0.062	0.064	0.061	0.062	0.059	0.059	0.056
3	19.5	0.027	0.029	0.033	0.035	0.039	0.040	0.043	0.044	0.047	0.047	0.050	0.049	0.051	0.050	0.052	0.050	0.052	0.050
2	30.0	0.013	0.013	0.017	0.018	0.022	0.022	0.026	0.027	0.030	0.030	0.034	0.034	0.037	0.037	0.041	0.040	0.045	0.043
1.5	41.8	0.005	0.005	0.008	0.009	0.012	0.012	0.016	0.016	0.020	0.020	0.024	0.024	0.029	0.029	0.034	0.033	0.040	0.039
1	90.0	n/a	n/a	n/a	n/a	n/a	n/a	0.000	0.000	0.002	0.002	0.004	0.004	0.008	0.008	0.013	0.013	0.022	0.022

Table 2: It is often more useful to show the depth of field in linear distances rather than angles. In this table, depth of field measured perpendicular to the plane of sharp focus is indicated as a fraction of distance measured from the lens. Distance from the lens must be measured in a direction perpendicular to the film plane. Figure 3 will help to explain the geometry.

Author's Note: These tables are not exactly those used in the original *Shutterbug* article. Rather, they are taken from the book *FOCUSING the VIEW CAMERA*.