Relationships in Contour Interval, Scales, and Instrument Usage*

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● FOR large-scale preliminary survey mapping it should be stressed that map specifications should result in an economical and efficient balance between map scale and contour interval and the photogrammetric instrument. The considerations which must be made in writing specifications to attain this balance are the focal length of the aerial camera and photogrammetric instrument, the optimum number of times the map manuscript scale (expressed as an enlargement ratio) may be larger than the scale of the aerial photographs, and the C-factor customarily employed for the instrument. Such considerations affect the flight height for the photography, and the flight height will be governed by either the instrument C-factor or enlargement ratio whenever the specified contour interval and map scale are not in balance.

Tables 1, 2, and 3 show the manner in which the flight height is governed by the requirements to attain either the specified map scale or the required contour interval, according to the characteristics of various photogrammetric plotting instruments commonly used in the United States. The 8¼-in. and 6-in. focal length Kelsh stereoscopic plotters with a 5:1 and 7:1 enlargement ratio, respectively, are new instruments presently available. They allow map compilation at scales larger than possible with the older Kelsh instruments of the same focal length.

The flight height listed in column 6 of Tables 1, 2, and 3 will assure compliance with the map scale specification, and the flight height listed in column 9 will assure compliance with the contour interval specification. If the specifications are in proper balance, as for the Kelsh 6-in. focal length and 5:1 enlargement ratio in Table 2, both map scale and contour interval specifications will be complied with at the same flight height. If the specifications are not in proper balance, the flight heights in columns 6 and 9 will be different, and the photographs must be taken at the lower of the two flight heights in order to assure compliance with both specifications.

In all cases, it is assumed that the map compilation scale will be no smaller (but may be larger) than the scale specified for the finished map—that is, no enlargement of map manuscript to produce the finished map is allowed.

The resultant minimum contour interval (column 7 under the requirements to fulfill map scale specifications in Tables 1, 2, and 3) is the minimum contour interval attainable by use of the customary C-factor when the photographs are taken from the flight height (column 6) which will assure compliance with the map scale specifications. If the resultant minimum contour interval is less than specified for the contours, a flight height must be used which is governed by the requirements to fulfill the map scale specifications. If the minimum interval attainable using photographs taken from this flight height would be greater than specified for the contours ([1] column 7, Tables 2 and 3), then the contour interval specifications govern and the photographs must be taken from the flight height (column 9) required to fulfill the contour interval specifications while using the customary C-factor.

The resultant manuscript scale (column 10 in Tables 1, 2, and 3), is the map compilation scale fixed by the instrument enlargement ratio (column 3, number of times map manuscript scale is larger than the photography scale), and the scale of photographs (column 8) taken from the flight height (column 9) required to fulfill the contour interval specifications when the customary C-factor is used. Thus, if this resultant scale is larger than the specified scale, the specified contour interval governs the flight height. If the resultant scale would be smaller than the specified scale ([2] column 10, Tables 1 and 2), then map scale governs, and the photographs must be taken from the flight height required to fulfill the map scale specifications. In all cases, the ac-

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TABLE 1

Map Specifications Scale 100 ft to 1 in
Contour Interval 5 ft

Photogrammetric Instrument	Instrument Characteristics			Requirements to Fulfill Map Scale Specifications			Requirements to Fulfill Contour Interval Specifications If Customary C-Factor Is Used		
(1)	Focal Length, in (2)	Enlargement Ratio (3)	C-Factor Customarily Employed (4)	Photograph Scale, ft to 1 in. (5)	Flight Height, ft (6)	Resultant Minimum Contour Interval, ft (7)	Photograph Scale, ft to 1 in. (8)	Flight Height, ft (9)	Resultant Manuscript Scale, ft to 1 in (10)
Multiplex aeroprojectors	6	2 4 1	600	240	1,440	2.40	500	3,000	208[2]
Balplex stereoscopic plotter	6	3.4 1	1,000	340	2,040	2.55	833	5,000	245[2]
Kelsh stereoscopic plotter	8¼	4.1	1,000	400	3,300	3 30	606	5,000	152[2]
Kelsh stereoscopic plotter	6	5.1	1,200	500	3,000	2.50	1,000	6,000	200[2]
Kelsh stereoscopic plotter	8¼	5.1	1,000	500	4,125	4 12	606	5,000	121[2]
Kelsh stereoscopic plotter	6	7 1	1,200	700	4,200	3 50	1,000	6,000	143[2]
Stereocartograph, Model IV Autograph, Models A5 and A7	8¼	8 1	1,500	800	6,600	4.40	909	7,500	114[2]
Stereocartograph, Model IV Autograph, Models A5 and A7 Stereoplanigraph, Model C8	6	8.1	1,500	800	4,800	3.20	1,250	7,500	156[2]

TABLE 2

Map Specifications Scale 200 ft to 1 in.
Contour Interval 5 ft

Photogrammetric Instrument	Instrument Characteristics			Requirements to Fulfill Map Scale Specifications			Requirements to Fulfill Contour Interval Specifications If Customary C-Factor Is Used		
(1)	Focal Length, in (2)	Enlargement Ratio (3)	C-Factor Customarily Employed (4)	Photograph Scale ft to 1 in. (5)	Flight Height, ft (6)	Resultant Minimum Contour Interval ft (7)	Photograph Scale, ft to 1 in (8)	Flight Height ft (9)	Resultant Manuscript Scale ft to 1 in. (10)
Multiplex aeroprojectors	6	2 4 1	600	480	2,880	4.80	500	3,000	208[2]
Balplex stereoscopic plotter	6	3 4 1	1,000	680	4,080	4 08	833	5,000	245[2]
Kelsh stereoscopic plotter	8¼	4.1	1,000	800	6,600	6.60[1]	606	5,000	152
Kelsh stereoscopic plotter	6	5.1	1,200	1,000	6,000	5 00	1,000	6,000	200
Kelsh stereoscopic plotter	8¼	5.1	1,000	1,000	8,250	8 25[1]	606	5,000	121
Kelsh stereoscopic plotter	6	7 1	1,200	1,400	8,400	7.00[1]	1,000	6,000	143
Stereocartograph, Model IV Autograph, Models A5 and A7	8¼	8 1	1,500	1,600	13,200	8 80[1]	909	7,500	114
Stereocartograph, Model IV Autograph, Models A5 and A7 Stereoplanigraph, Model C8	6	8.1	1,500	1,600	9,600	6 40[1]	1,250	7,500	156

TABLE 3

Map Specifications: Scale 100 ft to 1 in.
Contour Interval 2 ft

Photogrammetric Instrument	Instrument Characteristics			Requirements to Fulfill Map Scale Specifications			Requirements to Fulfill Contour Interval Specifications If Customary C-Factor Is Used		
(1)	Focal Length, in. (2)	Enlargement Ratio (3)	C-Factor Customarily Employed (4)	Photograph Scale, ft to 1 in. (5)	Flight Height, ft (6)	Resultant Minimum Contour Interval ft (7)	Photograph Scale, ft to 1 in. (8)	Flight Height, ft (9)	Resultant Manuscript Scale, ft to 1 in. (10)
Multiplex aeroprojectors	6	2 4·1	600	240	1,440	2 40[1]	200	1,200	83
Balplex stereoscopic plotter	6	3.4.1	1,000	340	2,040	2.55[1]	333	2,000	98
Kelsh stereoscopic plotter	8¼	4 1	1,000	400	3,300	3.30[1]	242	2,000	60
Kelsh stereoscopic plotter	6	5.1	1,200	500	3,000	2 50[1]	400	2,400	80
Kelsh stereoscopic plotter	8¼	5.1	1,000	500	4,125	4.12[1]	242	2,000	48
Kelsh stereoscopic plotter	6	7 1	1,200	700	4,200	3 50[1]	400	2,400	57
Stereocartograph, Model IV Autograph, Models A5 and A7	8¼	8 1	1,500	800	6,600	4 40[1]	364	3,000	46
Stereocartograph, Model IV Autograph, Models A5 and A7 Stereoplanigraph, Model C8	6	8·1	1,500	800	4,800	3.20[1]	500	3,000	62

TABLE 4

CONTOUR INTERVALS AND MAP SCALES IN BALANCE FOR EFFICIENT USE OF PHOTOGRAMMETRIC INSTRUMENTS

Photogrammetric Instrument	Instrument Characteristics			Balance of Contour Interval and Map Scale			
(1)	Focal Length in (2)	Enlargement Ratio (3)	C-Factor Customarily Employed (4)	Map Scale for 1 ft Contour Interval, ft to 1 in. (5)	Map Scale for 2 ft Contour Interval, ft to 1 in (6)	Map Scale for 5 ft Contour Interval, ft to 1 in (7)	Map Scale for 10 ft Contour Interval, ft to 1 in. (8)
Multiplex aeroprojectors	6	2 4.1	600	40	80	200	400
Balplex stereoscopic plotter	6	3 4.1	1,000	50	100	250	500
Kelsh stereoscopic plotter	8¼	4.1	1,000	30	60	150	300
Kelsh stereoscopic plotter	6	5.1	1,200	40	80	200	400
Kelsh stereoscopic plotter	8¼	5 1	1,000	25	50	125	250
Kelsh stereoscopic plotter	6	7.1	1,200	25	50	125	250
Stereocartograph, Model IV Autograph, Models A5 and A7	8¼	8:1	1,500	20	40	100	200
Stereocartograph, Model IV Autograph, Models A5 and A7 Stereoplanigraph, Model C8	6	8.1	1,500	30	60	150	300

tual map compilation scale would be rounded off to the nearest usable scale in feet per inch. In doing this, projection distance tolerances of the instrument lenses would not be exceeded in the mapping operations.

Lack of proper balance between map scale and contour interval specifications will result in inefficient use of photogrammetric plotting instruments. Thus, in compliance with the specifications governing in Table 1, there is not full utilization of the instrument C-factor, because the resultant minimum contour interval attainable (column 7) is less than the specified contour interval when the photographs are taken from the flight height (column 6) governed by the requirements to fulfill the map scale specification.

In compliance with the contour interval specifications in Table 3 there is not full utilization of the instrument enlargement ratio (column 3) when the photographs are taken from the flight height (column 9) governed by the requirements to fulfill the contour interval specification using the customary C-factor.

Table 4 contains map scales in economically efficient balance for contour intervals of 1, 2, 5, and 10 ft and the various photogrammetric instruments. The map scales have been recorded in arithmetical values which will not cause the customary C-factor to be exceeded when the contours are delineated. It is realized that some of the map scales, such as 125 or 250 ft to the inch, are not in common use, and that in actual practice a scale of 100 or 200 ft to the inch would be used. Any variation from the balance given, however, reduces the efficiency of the plotting instrument. For any specific contour interval in Table 4, specification of a map scale larger than listed for that contour will cause the map scale to govern the flight height, and the C-factor actually used will be smaller than the C-factor customarily employed. Specification of a map scale smaller than listed for each contour interval will cause the interval to govern the flight height, and then a scale reduction (photographically, by pantograph, or some other suitable method) from the optimum scale afforded by the enlargement ratio of the photogrammetric instrument will be necessary.